BMS INSTITUTE OF TECHNOLOGY

& MANAGEMENT

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Avalahalli, Yelahanka, Bengaluru-560064

Department of Electrical and Electronics Engineering

Faculty Research Publications

August 2019- July 2020

EEE Faculty Research Publications 2019-20

1	Madhu Palati, "*Simulation studies on Modeling of Marx circuit and pulse forming line with Blumlein*", Journal of Seybold Report, Volume 15, Issue 7, 2020, pp.1900-1908.
2	Manjunatha Babu P, Ozwin Dominic D'souza, Shilpa G, Babu Naik G, "*Computerization of Railway Gateways using PLC*", Journal of Seybold Report, Volume 15,Issue 7, 2020,pp.1909-1912.
3	Ozwin Dominic D'souza, "*Accident Detection System Using GSM & GPS Technology*", Journal of Seybold Report, Volume 15, Issue 7, 2020,pp.1891-1894.
4	Babu Naik G, Shilpa G, Ozwin Dominic Dsouza, Manjunatha Babu P, "*Identifying the Frequency and Voltage Level at the Grid Connected Synchronisation Failure*", Journal of Seybold Report, Volume 15,Issue 7, 2020,pp.1913-1919.
5	Shilpa G, Babu Naik G, Manjunatha Babu P, Ozwin Dominic Dsouza, "*Simulation and hardware implementation of single stage bridgeless boost rectifier for low voltage energy harvesting applications"*, Journal of Seybold Report, Volume 15,Issue 7, 2020,pp.1885-1890.
6	B.M. Manjunatha, S. Nagaraja Rao, A.Suresh Kumar, K. Shaguftha Zabeen, Sanjay Lakshminarayanan and A. Vishwananth Reddy, "*An Optimized Multilevel Inverter Topology with Symmetrical and Asymmetrical DC Sources for Sustainable Energy Applications*", Engineering, Technology and Applied Science Research (ETASR), Vol. 10, No. 3, 2020, pp. 5719-5723.
7	Prashant N.A, Anirudha K.S, B.Manjunath ,Bhargav Reddy.B, Balaji Subramanyam M.K, "*Comparative study of buck-boost, zeta and sepic dc-dc converters for maximum power point tracking applications in pv systems*", Journal of Emerging Technologies and Innovative Research (JETIR), Vol.7, Issue 5, May-2020, pp.453-457.
8	N Ramarao, Girija S, Gokul Manikanta T, Shiva Kumar K R, Vinod P, *"Design & Development of Water Management System"*, International Journal of Engineering Research & Technology (IJERT),Vol. 9 Issue 03, March-2020,pp.192-198.
9	Narapareddy Ramarao, Kavya P, Deepa M. S, Sinchana Gowda, Vaishnovi H, *"Review of Methods for Automatic Segmention of Brain Tumor in MRI Images"*, International Journal of Engineering Research & Technology (IJERT), Vol. 9, Issue 07, July-2020,pp.1003-1010.
10	Manjunatha Babu P, Kaushik Gowda H N, Kushagra Dhawan, Kacharla Balasai Nikhil, Govardhan, "*Real Time Forest Flora Monitoring System"*, International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 06 , June 2020,pp.6089-6094.
11	Kattimani H.D., Abhijit Kumar, Anirudh Aravind, Aafaq Altaf Wani, Yaqoob Qasim Sofi, "*Comparative Study of Different Sleep Monitoring Methods*", Journal of Emerging Technologies and Innovative Research (JETIR), Volume 7, Issue 6, June 2020, pp.1480-1488.
12	Kattimani H.D, Sayalee Sanjay Kahandal, Mohammad Adil Ansari, Nikita Chuhan, Rupansha Khare, "*Solar Powered Portable Electrical Vehicle Charging Station*", International Research Journal of Engineering and Technology (IRJET), Volume 07, Issue 07, July 2020, pp.541-547.

13	Ozwin D Souza,Suhana Kanum N, Chaithra B C, B Ashwini, *"Robotics for Inspection of High Voltage Transmission Lines*", Journal of Emerging Technologies and Innovative Research (JETIR), Volume 7, Issue 7, July 2020,pp.28-33.
14	Manjula BK ,Guru Prasad Agali ,Ravi raj , Girish Kumar LN ,Raj kavin, "*Two axis motion control with interpolation using PLC"*, Journal of Emerging Technologies and Innovative Research(JETIR), Volume 7 ,Issue 6, June 2020,pp.891-899.
15	Babu Naik G, Shiva Prasad K R, Madhu Chandra M, Keerthi Gururaj, Madhusudhan H K, *"Comparative study of Variable frequency drive to run an AC Induction motor using synchronized and unsynchronized PWM generator, with and without filter*", Journal of Emerging Technologies and Innovative Research (JETIR), Vol. 7, Issue 6, June 2020, pp. 2059-2065.
16	Dr. Sanjay Lakshminarayanan, Ghulam Shafiq Rasuli, Abdullah Laghmani, Hashmat , Awanish Kumar Panday, *"Home security system based on Finger print and face recognition",* Journal of Emerging Technologies and Innovative Research (JETIR), Volume 7, Issue 7, July 2020, pp. 2110-2114.
17	Nagaraj D.C, Saumya Mishra, Sesha Gopal S, Swati Naikodi, Manaswi Tiple, *"Design of an Electrical Drive-Train for the Retrofit of a Conventional Auto-Rickshaw into an Electric Auto-Rickshaw"*, International Journal of Innovative Research in Technology,Volume 7, Issue 1, June 2020, pp.853-858.
18	Vikram Chekuri, Firas Ahmed, Sharath S.K, Shivakumar Somasagar, Akilesh S.K, *"Vehicle Monitoring using IOT and Automatic Stop-Start System"*, International Research Journal of Engineering and Technology (IRJET), Volume 7, Issue 6, June 2020,pp.6883-6886.
19	Ruchitha D, Sarvesh Naik, Sadiq Abbasi, Deepak Singh, Rajnikanth K, *"Fuel Level Indication and Mileage Calculation using IoT",* International Research Journal of Engineering and Technology (IRJET), Volume 07, Issue 07 , July 2020, pp.2398-2403.
20	Shilpa G , Srijan Mishra, Abhishek Kr. Yadav, Vinod Kumar, Sarthak Gupta, *"Smart Cities Based on Internet of Things (IoT) –A vision, Architectural Elements and Future Applications",* Journal of Emerging Technologies and Innovative Research (JETIR), Volume 7, Issue 7, July 2020, pp 1350-1358.
21	Madhu Palati, Sinchana S, Aditi D A, Awati Spandana, *"Analysis of Different Approaches for Utilization of Pulsed Power",* Journal of Emerging Technologies and Innovative Research (JETIR), Volume 7, Issue 7, pp 456-463, July 2020.
22	Dr Prashant A , Rohan Chinni CL, Sompalli Saketh, Entha Rohith, Harshit Vaish, *"High Frequency Smart Inverter Incorporating Super capacitor and Solar MPPT",* Proceedings of "International Conference on Smart Electronics and Communication (ICOSEC 2020)" 10-12, September 2020 , Trichy, India.(Accepted)

Simulation studies on Modeling of Marx circuit and pulse forming line with Blumlein

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Abstract: *Conventional Marx generators are used for generating lightning impulse in laboratories. In certain pulsed power applications Marx circuit without wave shaping resistors is used for generating of high voltage pulses. In food processing applications most often rectangular pulses are used in non- thermal processing of food. Pulse forming line or Blumlein is often used to generate rectangular pulses. In this paper Marx circuit along with Blumlein is used for generating high voltage pulses, behavior of the circuit by varying different parameters is studied using PSPICE simulation software. Marx circuit with cascaded Blumlein and Pulse forming line (PFL) with Blumlein are studied, effect of Marx circuit inductance, peaking switch inductance, load impedance on the output voltage waveform are studied*

Keywords: Marx circuit, Blumlein, Pulse forming line, Pulsed field, load impedance

1. INTRODUCTION

In Pulsed power engineering, generation of pulses of very short duration is preferred to minimize the losses, and high energy intensity can be achieved in the load circuit. In the field of industrial, nuclear, civilian etc. pulsed power plays an important role [1]. Pulsed power system broadly comprises of main source, intermediate source and load. Typically it consists of High voltage source, rectifier, charging resistor, high voltage capacitor with switch which takes few seconds to charge and discharge at faster rate in the order of microseconds. One of the popular methods of generating high voltage pulses is using Marx generator. Marx circuit works on the principle of charging all the capacitors in parallel and discharging them in series through a spark gap into the load circuit. The output voltage depends on number of stages and will be equal to n times the charging voltage. The main drawback of this Marx circuit is it involves n number of spark gap and increases the time duration of the pulse. Also the internal inductance of the capacitors, forward path, return path and spark gap inductance affect the pulse width. More the inductance, more the pulse width, in certain applications short pulse width is required hence Marx circuit has to be operated along with any of the pulse forming line or peaking circuit or Blumlein or inductive voltage adders.

In this paper Along with Marx, Blumlein was used and in other circuit pulse forming line with cascaded Blumlein is used for generating high voltage pulses. Rishi verma et al. developed a three stage cascaded Blumlein which delivers approximately 70 kV under match load condition i.e. 300ohms, the wave forms were generated for different load impedances and were compared. Simulation was carried out using PSPICE software and the wave forms were obtained for different values of switch inductance, it was observed that for higher switch inductance the pulse width was increased and wave shape was distorted. Also the effect parasitic impedance was studied [2].

Noor et al. proposed double Blumlein generator with two switches to control output pulse to produce different pulse duration with positive and negative polarity by changing the source voltage. Delay was created by operating the switches and output pulse of 20 kV

was generated. Also the circuit was developed in PSPICE by considering each switch inductance as 10 nH, load impedance as 200 ohms and input voltage as 10 kV [3]. Nunnally [4] presented the major components of pulsed power system and their limitations. Two proto type models were developed which generate a pulse of 50ns and 1 µs duration respectively. Fundamental requirements of stacked Blumlein (SBL), energy storage, dielectric used and different types of switches for different types of SBL were also explained.

J. P. M. Mendes et al. developed a n-stage Marx generator operated with semiconductor switches and the output is connected to k number stages of Blumlein. Proto type model was developed, repetitive bipolar pulses of 1 kHz were obtained with a voltage magnitude of 1000V. Also the researcher explained there is a need to increase the efficiency, decreasing the commutation time of switches and improve the impedance matching of the proposed system and the work will be carried further [5]. Durga Praveen et al. developed a 1MV, 50 kA pulse power system producing a output pulse of 100ns duration. The system comprises of Marx generator with five modules with, bipolar charging is adopted to charge the capacitors of all modules. The output of Marx is connected to a Blumlein with inductance of 15µH and capacitance of 11nF respectively. The output impedance of 18 ohms is connected through an SF6 pressurized spark gap connected to Blumlein. The prepulse, Main pulse and Blumlein charging were recorded on the Digital storage oscilloscope and analyzed the drop in the main pulse voltage [6].

From the above context it is evident that high voltage pulses of short duration can be obtained by combination of Marx, Pulse forming line, Blumlein etc., therefore in the present work simulation was performed for different combinations and effect of various parameters on the output wave form are studied.

2. Modeling of combination of Marx circuit with Blumlein

Seven stage Marx generator each stage having two capacitors (each of rating 0.15µF, 50 A kV) in series are bipolar charged to full voltage. The total inductance of the Marx including the internal inductance of capacitors, forward path, return path, load circuit, spark gaps together comes to 3µH. On open circuit the ideal voltage at load terminals will be 700 kV. Equivalent circuit of Marx and its output waveform when discharged into a load of 13 ohms are shown in Figure 1(a) and Figure 1(b) respectively. For a certain application the Marx-1 has to drive the load circuit which has an equivalent load resistance of 13 ohms and the desired current is 20 kA and Full width half Maximum (FWHM) is 200ns. FWHM is the time interval between 50 percent magnitude of voltage points on front and tail portion.

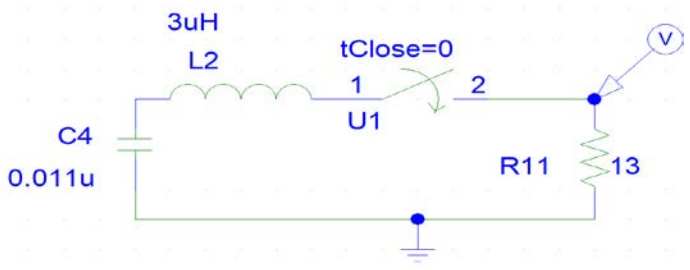

Figure 1a. Equivalent circuit of Marx

From Figure 1b, Full width half Maximum is 389ns hence to achieve this Marx with another configuration is implemented. In this configuration each capacitors of 90nF, 50 kV with internal inductance of 60 nH in lieu of 0.15µF, 50 kV with internal inductance of 140nH. The total equivalent capacitance during discharge comes to 6.4nF and the total optimized Marx inductance comes to 1.3µH [6]. The equivalent circuit of Marx-2 and its

output waveform is shown in figure 2a and Figure 2b respectively. In this configuration the required output current of 20 kA and FWHM of 200ns can be met. From figure 2b it is observed that FWHM of 197 ns is obtained.

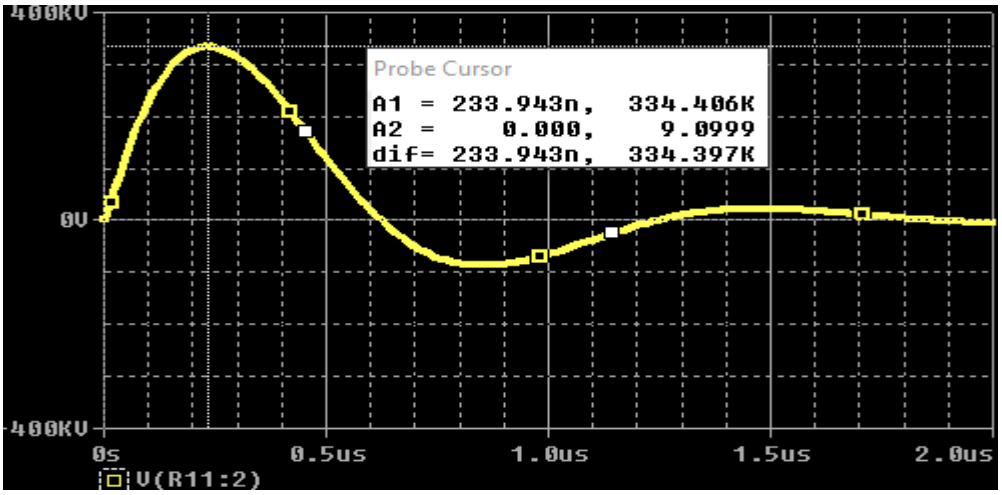

Figure 1b. Output voltage wave form of Marx-1

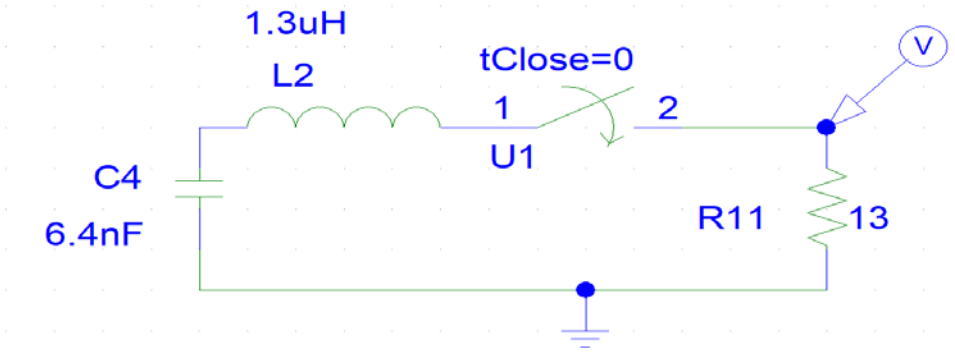

Figure 2a. Equivalent circuit of Marx-2

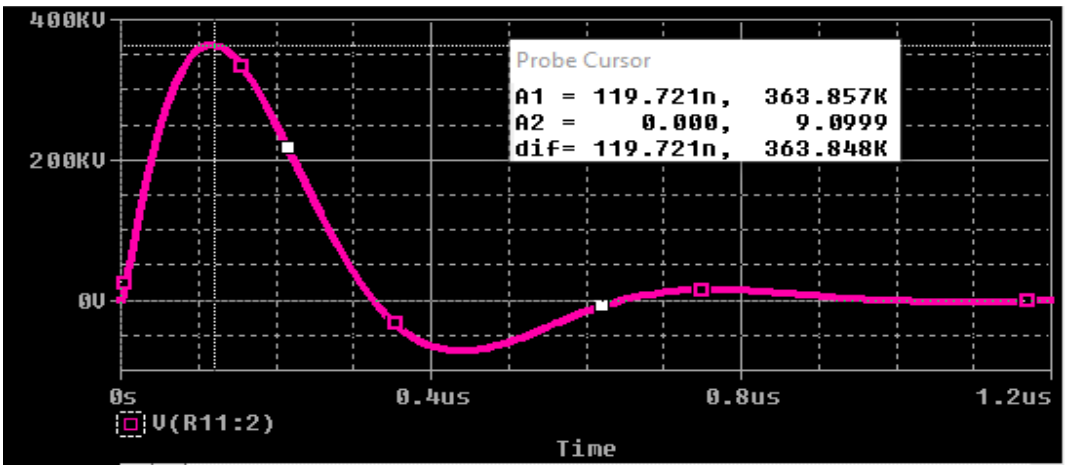

Figure 2b. Output voltage wave form of Marx-2

Blumlein technique is one of the popular methods of generating high voltage short rectangular pulses. The characteristic impedance of the line is given by

$$Z_O = \sqrt{\frac{L}{C}} \quad ------ \qquad (1)$$

Where L is the inductance of the line in Henrys per meter and C is the capacitance of the transmission line in farad per metre.

The transition time along the transmission line from end to another end is given by

$$t_O = l * \sqrt{\frac{\epsilon_r}{c}} \qquad (2)$$

Where l is the length of the transmission line, ϵ_r is the dielectric permittivity of the insulating medium used in the line and c is the velocity of light.

Pulse width T will be twice the transition time and is given by

$$T = 2 * t_O \qquad (3)$$

For applied voltage V, V_o is the output voltage at the load terminals which is having a load impedance of Z_L . The energy per pulse is given by

$$E = T * \frac{Vo^2}{Z_L} \qquad (4)$$

For a cascaded Blumlein as shown in figure 3, each transmission line is having characteristic impedance of $Z_o/2$ and transition time as t_o. For matched load condition the load impedance should be made equal to characteristic impedance i.e. $Z_L = Z_o$. In general the voltage across the load during matched load condition and open circuit condition is given by equations (5) and (6) respectively, Where n is number of stages of Blumlein

$$V_O = n * \frac{V}{2} \qquad (5)$$

$$V_O = n * V \qquad (6)$$

In the present work RG213 coaxial cable is considered as transmission line which has a characteristic impedance of 50 ohms and capacitance of 100 pF/m, the inductance estimated using equation (1) is 0.25 µH/m. By considering transition time t_o as 50ns, the cable length is estimated by

$$l = \frac{t_o}{\sqrt{L\,C}} = \frac{50 * 10^{-9}}{\sqrt{0.25 * 10^{-6} * 100 * 10^{-12}}} = 10m$$

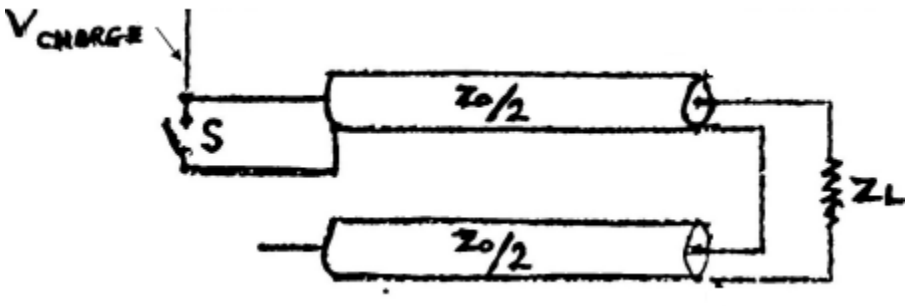

Figure 3. Equivalent circuit of 2 stage cascaded Blumlein

Marx-1 is having a characteristic impedance of 16.5 ohms and Marx-2 is having characteristic impedance of 14 ohms. Since to get maximum output the load has to be matched with total impedance. Therefore, Marx-1 along with cascaded Blumlein is terminated with load impedance of 66.5 ohms. Similarly Marx-2 along with cascaded

Blumlein is terminated with 64 ohms as shown in Figure 4a and figure 5a respectively. The corresponding output waveforms are shown in figure 4b and figure 5b respectively.

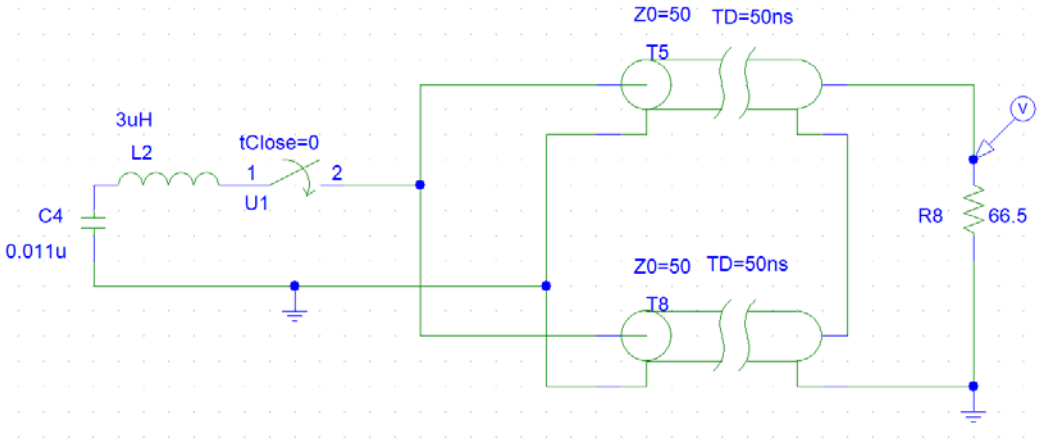

Figure 4a. Equivalent circuit of Marx-1 with cascaded Blumlein

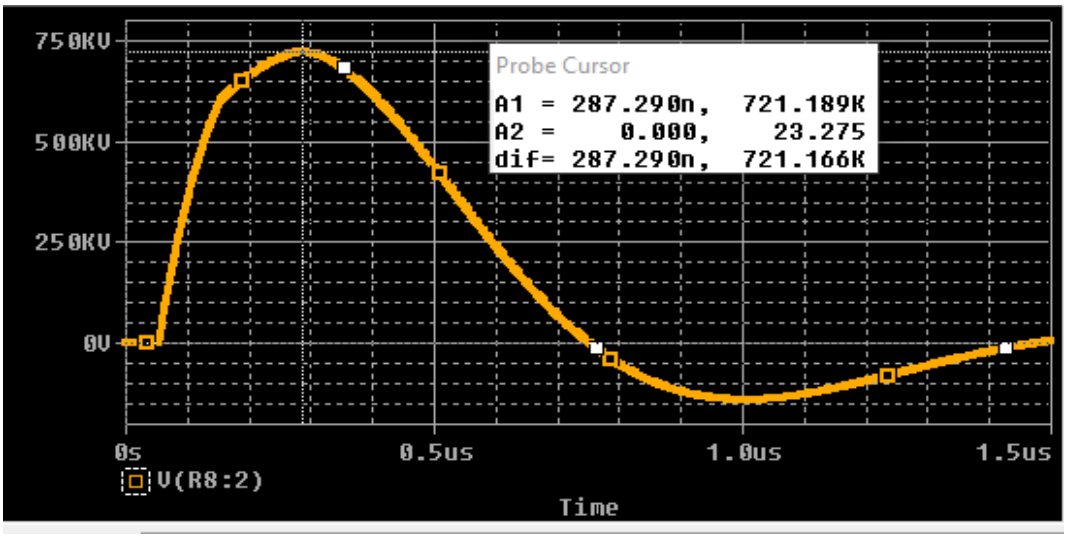

Figure 4b. Marx-1 output voltage waveform with cascaded Blumlein

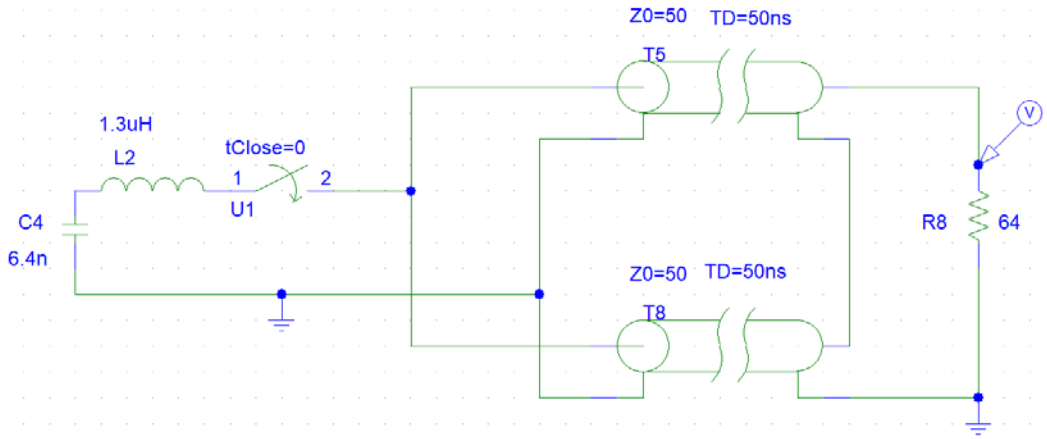

Figure 5a. Equivalent circuit of Marx-2 with cascaded Blumlein

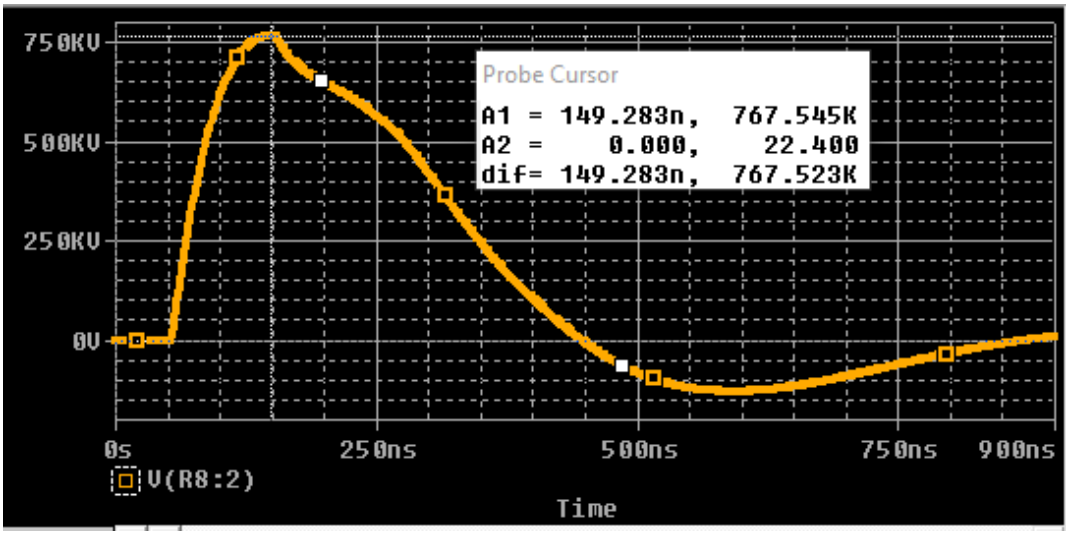

Figure 5b. Output voltage waveform of Marx-2 circuit with cascaded Blumlein

3. Modeling of combination of Pulse forming line with Blumlein

An attempt was made to work on combination of pulse forming line with cascaded Blumlein. A ten stage pulse forming line is shown in figure 6a and the corresponding rectangular wave shape output was shown in figure 6b. The first stage and last stage charging inductor is of different value to reduce the overshoot in front and tail portion of the rectangular pulse, this is achieved by trial and error combination of inductor values [8]. To obtain shorter pulse width number of stages are reduced to five as shown in figure 7a and the corresponding output is shown in figure 7b, at the same time energy delivered to the load will be reduced with compromise in energy and pulse duration number of stages can be decided.

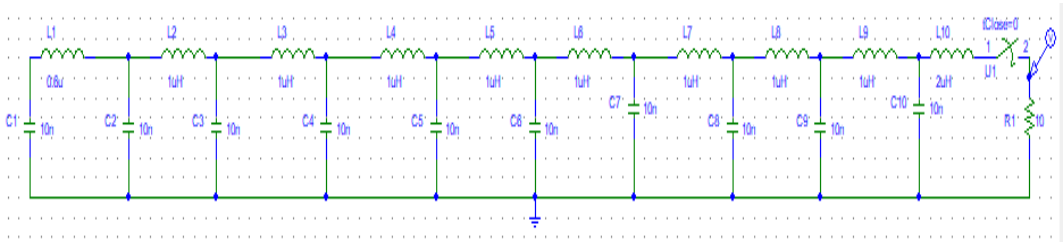

Figure 6a. Equivalent circuit of ten stage Pulse forming line

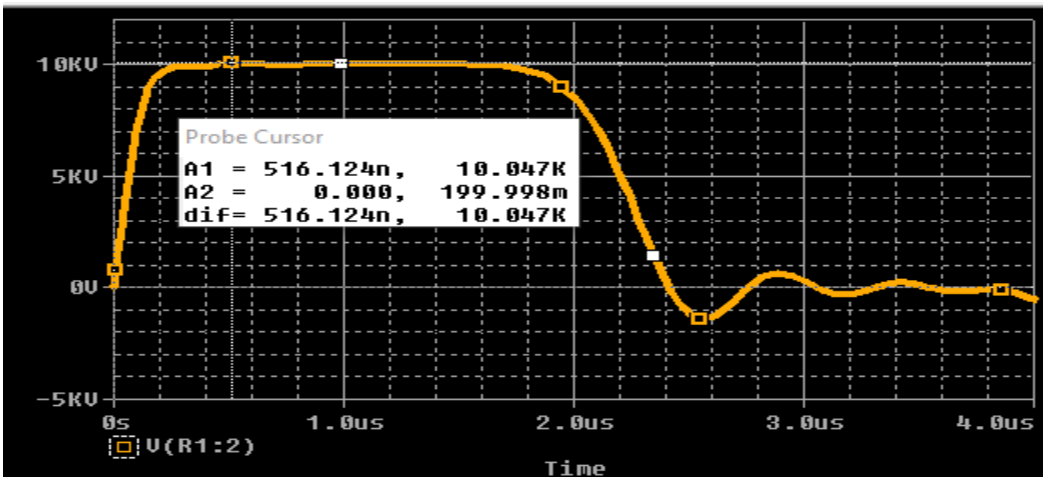

Figure 6b. Output voltage waveform of ten stage pulse forming line

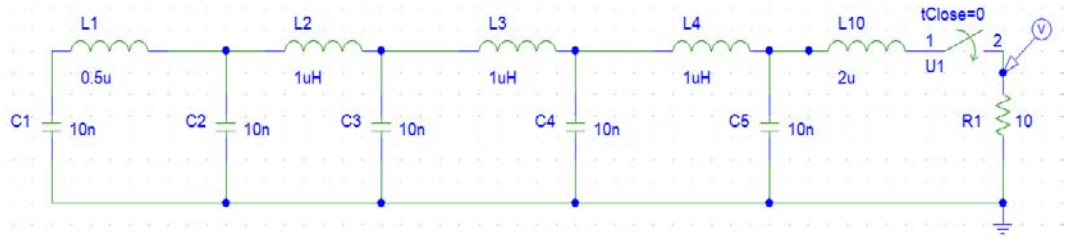

Figure 7a. Equivalent circuit of five stage Pulse forming line

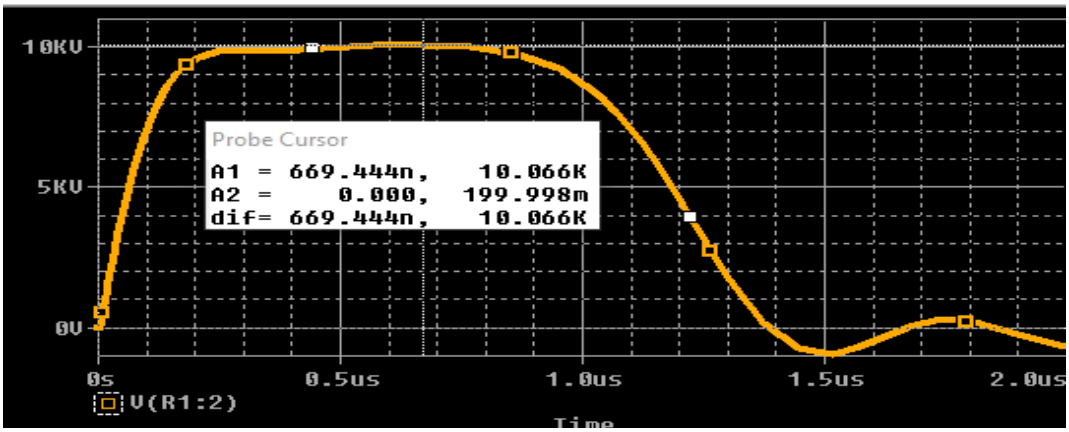

Figure 7b. Output voltage waveform of five stage pulse forming line

In certain applications the output voltage required to be more, then the pulse forming line output should be combined with Blumlein to get more voltage, depending on the number of stages the voltage get multiplied. In this work single stage and 2 –stage combinations were attempted as shown in figure 8a and figure 9a respectively. The output waveforms are shown in figure 8b and figure 9b respectively.

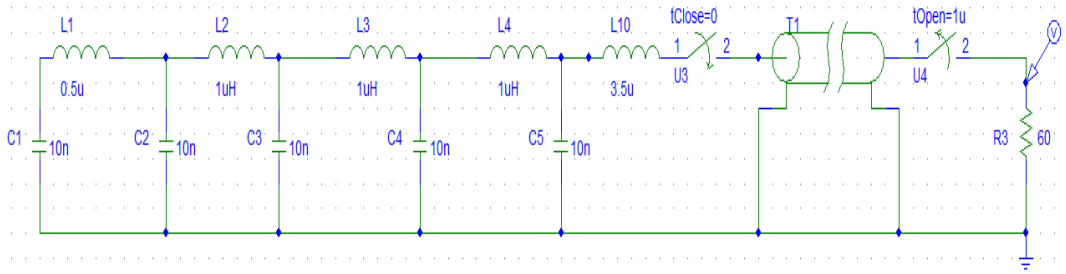

Figure 8a. Equivalent circuit of five stage PFL with Blumlein

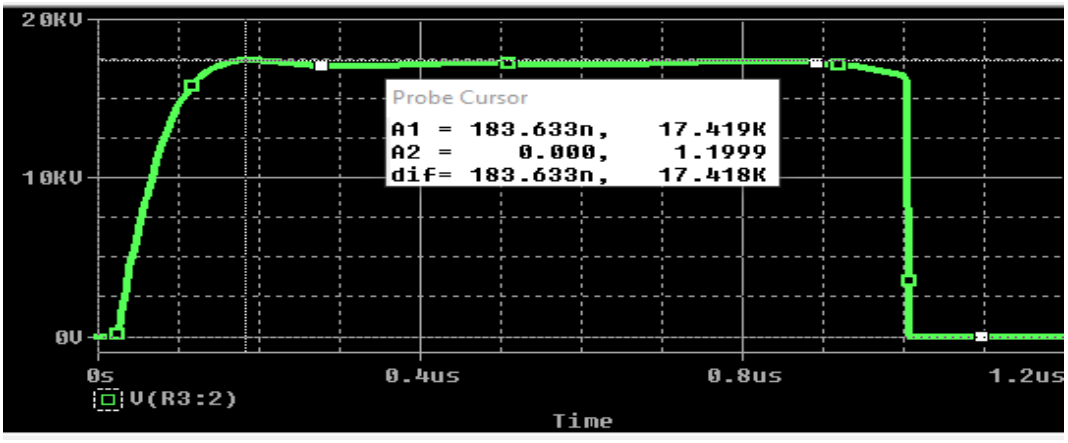

Figure 8b. Output voltage waveform of five stage PFL with Blumlein

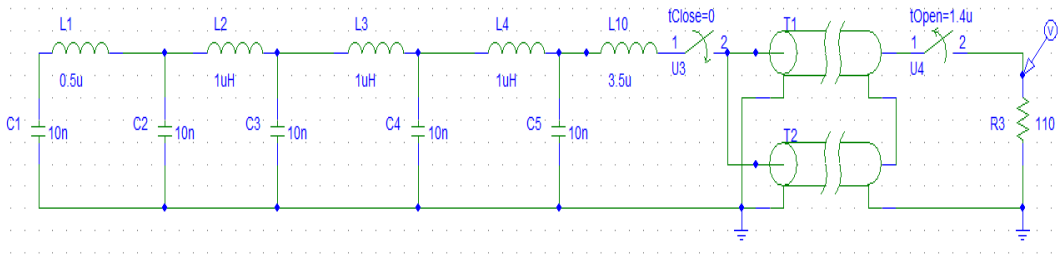

Figure 9a. Equivalent circuit of five stage PFL with cascaded Blumlein

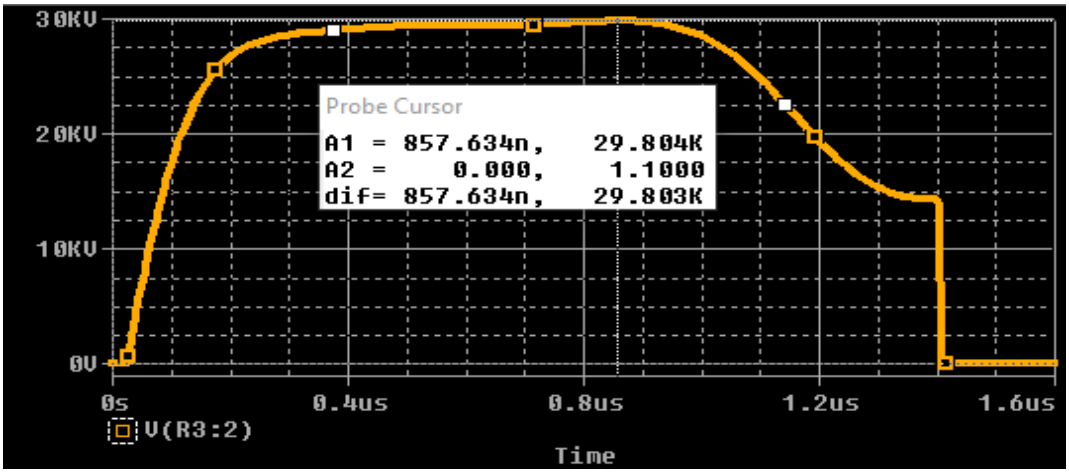

Figure 9b. Output voltage waveform of five stage PFL with cascaded Blumlein

4. Results and Discussions

Simulation on two different Marx generators with combination of cascaded Blumlein are performed, output voltage and FWHM are measured and the values are shown in Table1

Table1 Output parameters of Marx generator with Blumlein combination

S.No	Pulse circuit	Output voltage (kV)	FWHM (ns)
1	Marx-1	334.4	389
2	Marx-2	363.85	197
3	Marx-1 with 2-stage Blumlein	721.18	438.4
4	Marx-2 with 2-stage Blumlein	767.54	234

From table-1 it is observed that Marx-2 with double stage Blumein combination gives more output voltage with less FWHM values. All these values were obtained under matched load conditions, if the load is not matched then there will be reduction in peak voltage and negative portion of the waveform magnitude increases, hence it is always preferred to operate under matched load conditions. Simulation on PFL with ten stages, five stages and combination with single stage and two stages Blumlein was performed, the results are shown in Table2.

Table 2 Output parameters of PFL with Blumlein combination

S.No	**Pulse circuit**	**Output voltage (kV)**	**Pulse width (μs)**
1	PFL with ten stages	10.04	2.4
2	PFL with five stages	10.06	1.4
3	PFL with five stages with single stage Blumlein	17.4	1.0
4	PFL with five stages with two stage Blumlein	29.8	1.4

It is observed that PFL with five stages along with 2 –stage Blumlein gives more output voltage of 29.8 kV with pulse width of 1.4µs. To reduce the pulse width another switch is used to limit the time on the decaying tail waveform, the time to open the switch can be decided based on the time at which 50% of the magnitude appears on the tail portion of the waveform.

5. Conclusion

Different types of pulse circuits with Blumlein combination were studied, the behavior of output voltage and the pulse width were observed by performing simulation using PSPICE software, if the circuit inductance increases there will be decay in the output waveform. Even switch inductance will have significant effect on the wave shape, therefore in reality point to point electrode configurations will be used pressurized SF6 gas. If load impedance is not same as source impedance then there will be distortion in wave shape, pulse shape will not be proper, therefore the pulse circuits with combination of Blumlein to be operated under matched load condition. If rectangular pulse configuration is to be achieved then PFL with Cascaded Blumlein is preferred else Marx with Blumlein can be used.

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COMPUTERIZATION OF RAILWAY GATEWAYS USING PLC

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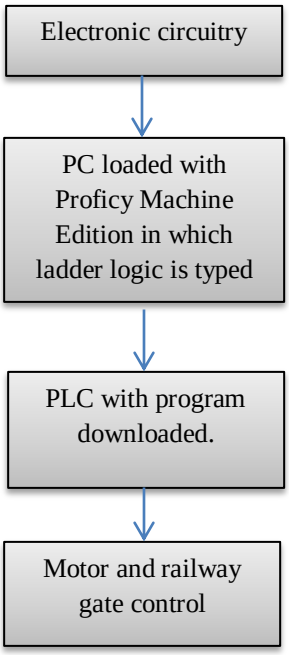
Abstract — The railway crossings are vulnerable to large number of accidents which are often deadly. In India, most of the railway crossings are manually operated by gatekeepers. In order to overcome this problem, automatic level crossing has been introduced by replacing the gatekeepers operating the gates using a Programmable Logic Controller.
Firstly it deals with decrease in time for which the gate is being kept closed and secondly it provides protection to the road employers by dipping the coincidences. By retaining the automatic railway gate control near railway crossing the arrival of the train is identified by the sensors placed 2 Km away from the gate. The process is automatic error due to physical operation is prevented. The time for which the gate is closed is less compared to the manually operated gates.

Keywords— Programmable Logic Controller (PLC), General Electrical (GE), Infra-Red (IR), Light Emitting Diode (LED, printed circuit board (PCB).

I. INTRODUCTION

A Programmable Logic Controller, PLC or Programmable Controller is a special form of microprocessor based controller that uses programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting, and arithmetic in order to control machines and processes. It is designed to be operated by engineers with perhaps a limited knowledge of computers and computing languages. They are not designed so that only computer programmers can set up or change the programs. Thus, the designers of the PLC have preprogrammed it so that the control program can be entered using a simple, rather intuitive form of language. The term logic is used because programming is primarily concerned with implementing logic and switching operations. Input and output devices in the structure is being controlled and associated to the Programmable Logic Controller. The worker then arrives a sequence of directions, a program, into the memory of the PLC. The controller then monitors the input and output according to this program and transmits out the control rules for which it has been programmed.
The Programmable Logic Controllers have the great advantage that the same elementary controller can be used with a extensive range of control systems. To change a control system and the rules that are to be used, all that is necessary is for an operator to key in a different set of instructions. There is no need to rewire. The result is flexible, cost effective system that can be used with control systems, which fluctuate quite extensively in their environment and complication.

II. Block Diagram Implementation



The prototype uses microprocessor based PLC, namely Versa Max from GE. The ladder logic is downloaded. On detecting an obstruction the IR sensor operates and when two consecutive IR sensors designated for gate opening are operated the gate is closed combined with a siren and LED indicator. When the latter IR sensors entitled for gate opening

are operated the gate is opened. Alongside the buzzer and the LED are turned off. The working of the IR sensor is such that at any point of time the adjacent two sensors designated for opening are operated on AND logic and the latter two also operate on AND logic. This is done so as to ensure that the gate does not open for any tiny obstructions which do not need to be accounted for such as a bird or human being etc.

For the above model the electronic circuitry involves the relays and IR sensors used here as it is needed to step up the +5 volts given by the IR sensor to the PLC, the relay does this job. The output from the PLC is also given to the motor driver from the relay, since further the +24 volts from the plc needs to be stepped down to match the rating of the motor and correspondingly keep the limits of the motor driver. Variation in the speed of gate opening can either be done by using appropriate timer design or by means of voltage control given to energize the field of the motor.

III. SOFTWARE

Algorithm:

1. Go to start, next databases, then choose GE Fanuc and then choose Proficy Machine Edition.
2. Choose logic designer - PLC theme.
3. Ok.
4. Select the suitable selection to open a project.
5. Select from the list the project that you want to open.
7. Ok.

To enhance a target to a project:

1. Use project flap of the navigator, right-click on project node and point to target.
2. Go to GE Fanuc Remote Input/output.

A new target appears in the Project tab of the Navigator. When expanded, the new target contains a default Hardware Configuration, logic blocks, and miscellaneous components.

To confirm a target:

Project flap of the Navigator, right-click a target and choose validate.

Logic developer - PLC checks all items below the target for syntax errors. Any errors noticed are noted in the build tab of the feedback zone.

To go online to a GE Fanuc PLC:

1. In the Project flap of the Navigator, ensure that all the target PLCs are offline.
2. Right-click the target and choose Set as Active Target.
3. Do one of the following:

■ Right-click the active target and choose Go Online.

To start a GE Fanuc PLC:

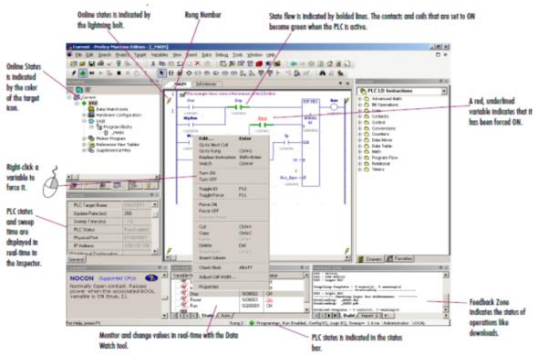
In the Project flap of the Navigator, right-click a target, point to online commands, and then choose Start PLC.

The target PLC begins executing its program.

To stop a GE Fanuc PLC:

1. In the Project tab of the Navigator, right-click a target, point to Online Commands, and choose Stop PLC.
2. Select an option.
3. Click OK.

The target PLC stops executing its program.



GE Proficy Machine Edition

IV. HARDWARE

Infra-Red Sensor: Fig: 1 is the Infrared sensors include the infrared source like blackbody radiators, tungsten lamps, and silicon carbide. In case of active IR sensors, the sources are infrared lasers and LEDs of specific IR wavelengths. Infrared transmission, which includes vacuum, atmosphere, and optical fibers. Optical components such as optical lenses made from quartz, CaF2, Ge and Si, polyethylene Fresnel lenses, and Al or Au mirrors, are used to converge or focus infrared radiation. Likewise, to limit spectral response, band-pass filters are ideal.

Finally, the infrared detector completes the system for detecting infrared radiation. The output from the detector is usually very small, and hence pre-amplifiers coupled with circuitry are added to further process the received signals.

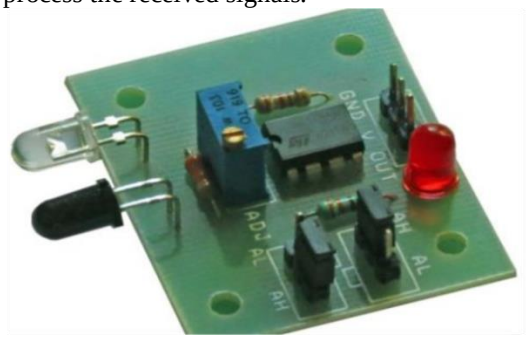


Fig:1 Infrared Sensor

Motor Driver: Fig; 2 Which contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.
Enable pins 1 and must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

Fig :2 Motor Driver

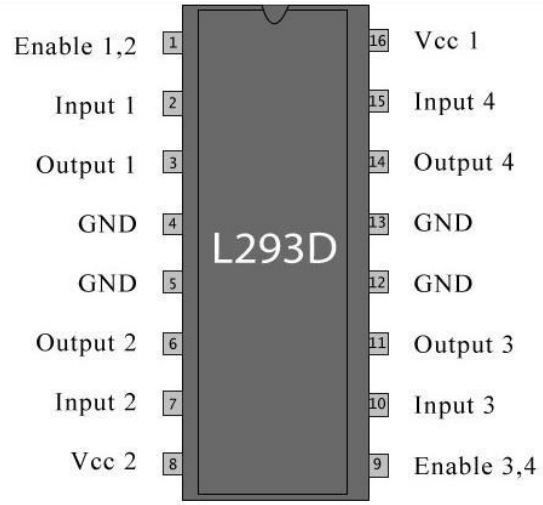


Fig 3: Pin Diagram

Fig 3 is L293D is a H-dual bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

Pin description

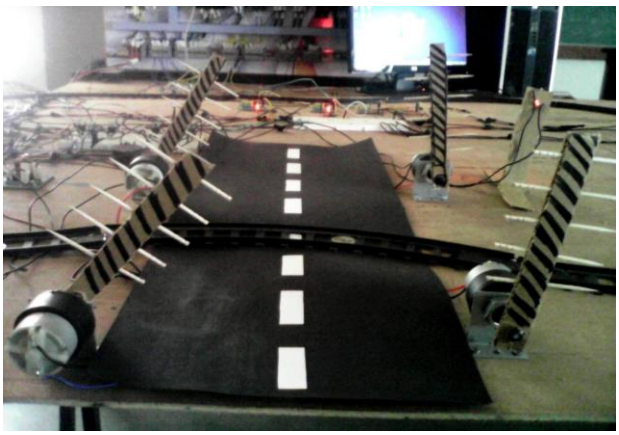
Pin No	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	Vcc 2
9	Enable pin for Motor 2; active high	Enable 3,4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	Vcc 1

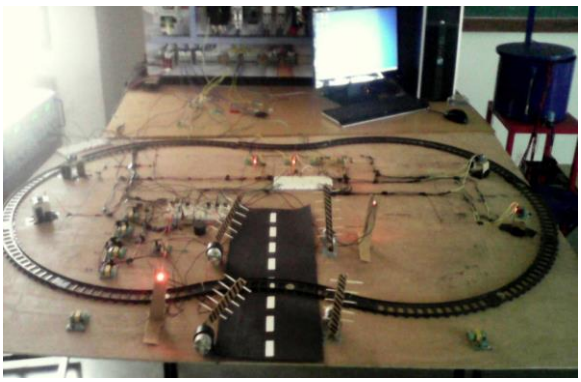
Permanent magnet DC motors: It has similar characteristics of DC shunt wound motors in terms of torque, speed, reversing and regenerative braking characteristics. However, PM DC motors have starting torque several times that of shunt motors and their speed load characteristics are more linear and predictable. Torque varies a lot with speed, ranging from maximum to zero torque at maximum. An increase in torque requires a decrease in angular velocity and vice versa.

V RESULTS and DISCUSSION

It has been observed that as the engine approaches the first sensor it receives an obstruction and gives a +5 volts output to the relay, simultaneously as the engine reaches the next sensor and the last bogie reaches the preceding sensor , the latter sensor also gives a +5 volts output to another relay. The two outputs are logically ANDED. A NC relay is activated and a voltage of 24 volts is given to the PLC. Based on the ladder program given to the PLC one of the 8 output pins are activated, in turn activating the buzzer and the LED. Alongside, as the engine approaches the second sensor the gate is closed by the second output of the PLC triggering the NC relay, which in turn triggers the motor driver rotating the motor shaft.
Next as the engine approaches the 3rd sensor through an LED light the vehicles are signaled that the gate is going to be opened and on reaching the last sensor the gate is opened. Yet again the output of each

sensor i.e. +5 volts is given to two relays and then to the PLC. The output of the PLC is given to the relay and motor driver. Finally the gate opens due to the rotation of the motor in the opposite direction.
The gate has been designed with lower obstruction so as to prevent low heighted vehicles specifically 2 – wheelers from trespassing below the barricades.
Certain important parameters have to be kept in mind during the programming and set up, namely:
1. The timing between the gate opening and closing.
2. The sequence in which the gates have to be closed so as to have traffic control.
3. Accurate siren and LED indication
4. Sensitivity calibration of the sensors and their housing.
Distance between the corresponding pair of IR sensors and appropriate timing of gate opening and closing play a crucial role in determining the accuracy of the unmanned railway gate operation.
The prototype model has been successfully implemented with a gate delay between gate operations for three seconds. The corresponding pictures have been attached below.





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Accident Detection System Using GSM & GPS Technology

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Abstract— The brisk growth of technology and enhancement in infrastructure has made our lives easier. The invention of new technology has also immensely increased the traffic hazards and the road accidents by multi-folds. Many accidents take place regularly which causes huge loss of life and property due to the availability of poorly placed emergency facilities. The work discussed over here provides the best possible solutions to address these drawbacks of existing emergency system. An accelerometer can be used in a car alarm application so that dangerous driving can be found. It can be used as a crash or rollover detector of the vehicle before and after a crash. With signals from an accelerometer, potential dangerous accidents can be detected early. The project work comes into picture in the situation where a vehicle meets with an accident, which triggers the vibration sensor to sense the change in signal value or if a car rolls over, and the micro electro mechanical system sensor will identify and sends the signal to ARM controller. Microcontroller sends the alert message through the GSM MODEM including the location to law enforcement control room or an emergency rescue team. So that the authorities can immediately trace the location through the GPS MODEM, after receiving the information.

Key Words— MEMS, GSM, ARM, MODEM

I. INTRODUCTION

An accident is an adverse incidental and unplanned event that could have been avoided if the circumstances leading to that perticular mishap had been recognisedand acted upon suitablty, prior to its occurrence. Most researchers who study unintended injury avoid using the term "accident" and focus on factors that add to risk of severe injury and that reduce injury incidence and sternness.

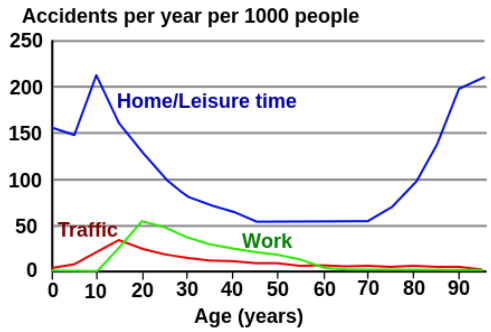


Fig. 1: Accidents vs Age

As per the report published by the World Health Organization, road traffic injuries caused an estimated 1.25 million deaths worldwide in the year 2010. This reveals us the fact that the fatality rate is 1person per 25 seconds. Across the globe only 28 countries, representing have ample laws that deal with the so called five risk factors (speed, drink–driving, helmets, seat-belts and child restraints). Over a one third of road traffic deaths in low- and middle-income countries are found in pedestrians and cyclists sectors. Yet, less than 35% of low- and middle-income countries have policies and law and enforcement in place to protect these road users. In numbers one can say that 17.4 per 100,000 people. Low-income countries have the maximum annual road traffic 24.1% fatality rate standing at 24, 100 000, while the rate in high-income countries is lowest, at 9.2 per 100 000.

74% of road traffic deaths occur in middle-income countries, which account for 70% of the world's population, but only 53% of the world's registered vehicles, burdens for 74% of world's road deaths. In low-income countries it is even worse. Only one percent of the world's registered cars produce 16% of world's road traffic deaths. This indicates that these countries bear a disproportionately high burden of road traffic deaths relative to their level of motorization

There are large disparities in road traffic death rates between regions. As per the survey in Africa, deaths due to road accident is far ahead (increasing 26.6 per 100 000 population), compared with European Region (decreasing 9.3 per 100 000).

Almost 50% of world's road traffic deaths take place amongst motorcyclists (23%), pedestrians (22%) and cyclists (5%) – i.e. "vulnerable road users" – with 31% of deaths among car occupants and the remaining 19% among unspecified road users.

People aged between 15 and 44 years account for 59% of global road traffic deaths. Almost 77% road deaths are linked to male sex.

In an overpopulated country like India there are places where terrains like hilly area plateaus, river crossings are present. Due to unacceptable road services accidents are bound to happen and increasing year on year basis. India faces the highest number of accidents and accidental fatalities in the world.

The maximum number of accidents are reported from the transport sector i.e. road as well as railways. Some approximations claim that Indian roads alone accounted for approximately 105,000 accidental fatalities in 2010. This is almost 15 percent of the global road fatalities when India has just 1 percent of the total global vehicles. The incidents of accidental deaths have shown increasing trend during the decade of 2000-2010 with an increase of 50 percent in the year 2010 as compared to the year 2000. Some approximations claim that Indian roads alone accounted for approximately 105,000 accidental fatalities in 2010. This is almost 15 percent of the global road fatalities when India has just 1 percent of the total global vehicles. The incidents of accidental deaths have shown

increasing trend during the decade of 2000-2010 with an increase of 50 percent in the year 2010 as compared to the year 2000.

As per the survey done in 2010 by the ministry of highway authority, Tamil Nadu (15,409 deaths) is leading the table followed by Andhra Pradesh (15,337 deaths), Uttar Pradesh (15,099 deaths) and Maharashtra (14,063 deaths) in the highest number of deaths due to road accidents. As far as cities are concerned, Delhi (7479 cases) is leading the unfortunate list followed by Bangalore (6490 cases) and Mumbai (4008 cases). I is found that trucks and two-wheelers were the major contributors for over 40 % of the accidents taken place. Moreover road accidents, accidents taking place at the workplace also cause an alarming risk to employees' safety. It is difficult to get reliable data of occupational diseases and workplace accidents in India due to lack of specific system for reporting and recording. The statistics put forth by Greenpeace, India, reveals that, as many as 16 accidents have so far taken place from 1990–2010 in India's civilian nuclear power installations in which several people lost their lives.

The advancements in technological and sociological improvements have helped the automobile manufacturers to reduce the traffic mishaps during the past few decades; It is found that a 1% increase in seatbelt usage will have the effect to save about 136 lives [1]. Advanced safety features like electronic stability control, showed significant promise for reducing injuries. The in dept data of crash analysis studies have revealed that approximately 34% of fatal traffic accidents could have been avoided with the use of electronic stability control safety feature [2].

Furthermore, every minute that an injured crash victim does not receive timely emergency medical care can cause a large difference in their survival rate, e.g., analysis shows that reducing accident response time by one minute corresponds to a six percent difference in the number of lives saved [3]. This is a very noticeable factor.

An efficient approach for reducing traffic sufferers, therefore, is to lessen the time between when an accident occurs and when first responders, such as medical personnel, are dispatched to the location of the accident. Automatic collision notification systems use sensors embedded in a car to record the accident detection [4]. These systems without any delay, dispatch emergency signals to medical personnel to intimate the serious accidents. Thus by eliminating the time between accident occurrence and first responder dispatch reduces fatalities by 6% [5]. Conservative vehicular sensor systems for accident detection, such as BMW's Automatic Crash Notification System or GM's OnStar, notify emergency responders immediately by making use of the in built cellular radios and sense car accidents with in-vehicle sensors, such as accelerometers and airbag deployment monitors.

II. HARDWARE REQUIREMENTS

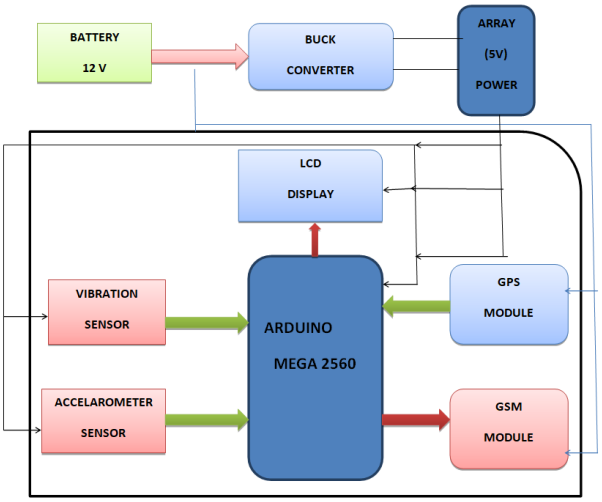


Fig.2: Basic block diagram

The block diagram of the system is as shown in the figure 2. The design involves 2 steps, (i) Designing of power circuit. (ii).Designing of communication circuit.

Designing of power circuit

The components used in the project requires different voltage levels, to get the required levels of voltages the buck converter is used. The parts like GSM & GPS module requires 12V supply hence the voltage to them will be given by the battery directly. The components like LCD, ARDUINO, Vibration sensor & Accelerometer requires 5V supply the 12V will be converted in to 5V level sing a buck converter and the same voltage is also connected to power array and from the array it will be given to LCD, ARDUINO, Vibration sensor & Accelerometer.

Designing of communication circuit

The communication circuit involves the receiving the signals from the sensors & depending on the sensor input to make the further processing. Arduino is the heart of the system which receives the signals from vibration sensor & Accelerometer sensor. The program in the arduino is written in such a way that when both output will be high it will send the longitude & latitude data to the number stored in the program. The same will be displayed in the LCD. The longitude & latitude data will be obtained with the help of GPS & will be processed in the Arduino Mega 2560. The location information in terms of longitude and latitude will be sent to mobile number which is stored previously via GSM module.

III. HARDWARE IMPLEMENTATION

Arduino with Piezo sensor:

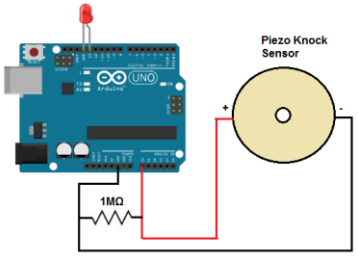


Fig3. Piezo circuit

The output of the piezo electric sensor will be connected to the analog input of the Arduino mega (refer fig 3)

4.2 Arduino with accelerometer

The output of the accelerometer will be connected as follows: SCL of Arduino is connected to SCL of the Arduino and SDA of Arduino is connected to SDA of the Arduino. This is shown in fig 4.

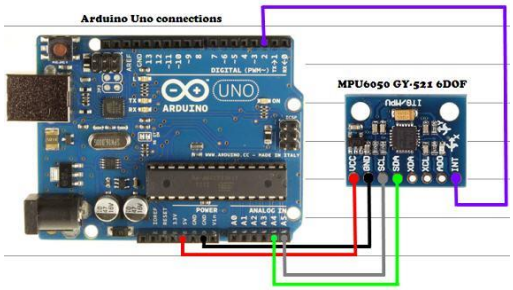


Fig 4: Connection of accelerometer with arduino

4.3 Arduino with GPS

Fig 5 and 5 shows the connection scheme of arduino with GPS and SM respectively.

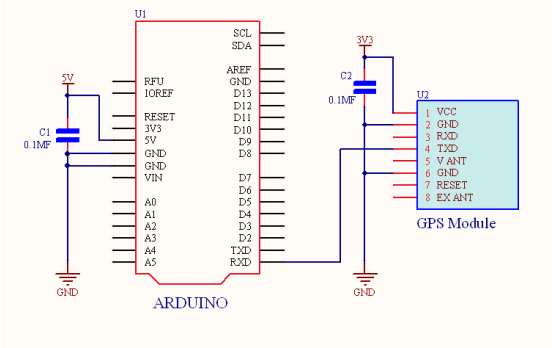


Fig. 5. The connection of the GPS module with arduino

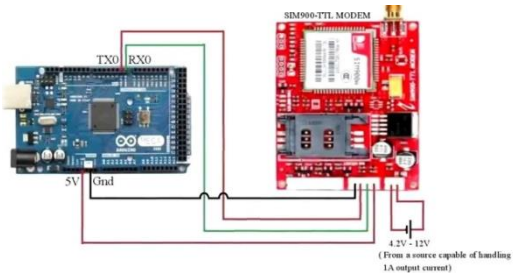


Fig.6. Arduino with GSM

Arduino with LCD:

Here the connection is to be done as per the connection diagram shown below. For LCD interfacing one can even refer the datasheet of Arduino.

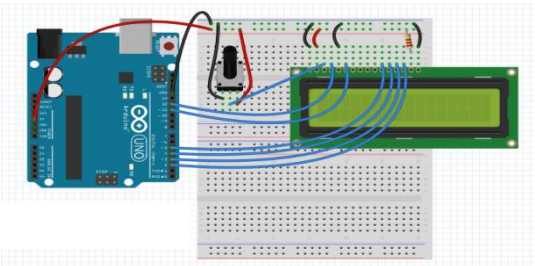
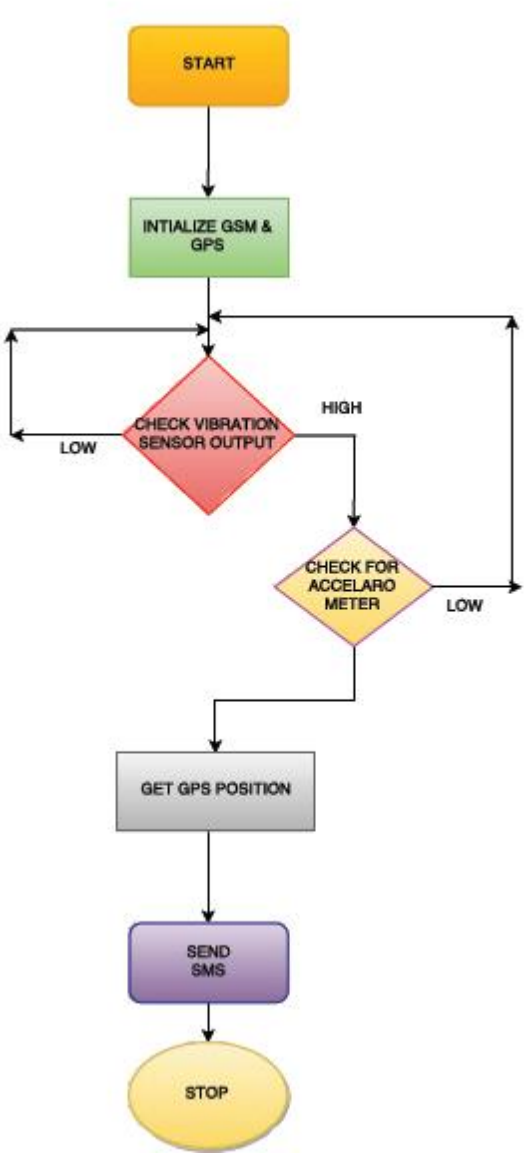


Fig. 7. Arduino with LCD

IV. Process Flow

The process flow of the work is as shown below



STEP1: Once the system is turned on immediately it will initialize the GSM & LCD display. This has to be initialized to go to further status.

STEP 2: When both the devices are initialized immediately the algorithm will check for the status of the vibration sensor. If the sensor output is high then it jumps to next step. If the sensor output stays low then it will roll back to step 1.

STEP 3: If the Piezo output is high then it will check the status of accelerometer, if it is high then it will go to next step.

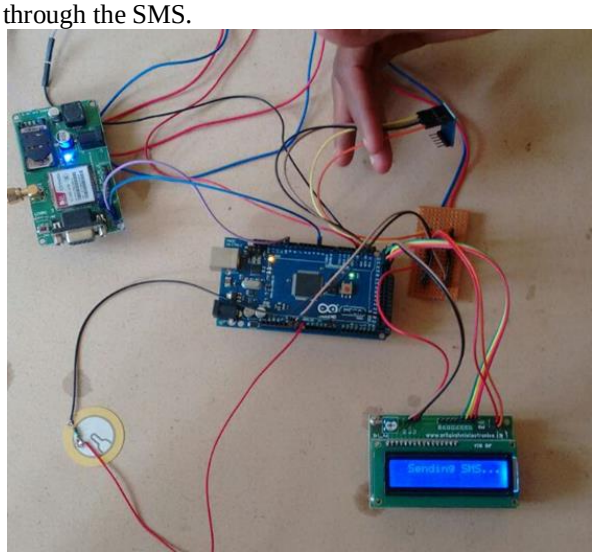
STEP 4: Once both sensors output is high then it will initialize the GPS & it will search for the location.

STEP 5: Once it identified the location it will send the message to the stored number.

V. RESULTS & DISCUSSION

The work is implemented and executed with a prototype. The prototype worked well and the results met our expectations. When only piezo electric sensor is high but the accelerometer is at the same position then the status

of the bike will be indicated as follows. The output of the accelerometer is high but if the piezo sensor is low then there will be no changes in the status of the devices.
When both the sensors is high then GPS will be search for the location & it will keep on searching for location, once it will complete its job then the location will be sent through the SMS.



After finding the location the locations will be displayed in the LCD display.

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IDENTIFYING THE FREQUENCY AND VOLTAGE LEVEL AT THE GRID CONNECTED SYNCHRONISATION FAILURE

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***Abstract*—**
This paper is prepared to the system that sensing the abnormalities conditions of frequency and voltage from the external supply source to the power grid and detects the synchronization failure at any sudden change in the supply to grid connected system. There are many power generating units which will be connected to the grid level synchronization. For any irregularity of the voltages or frequency in the given limits to the grid, it is mandatory that feeder should be automatically detached from the grid side which gives the results as Islanding state. This may hazards to the large systems of cause the injury of grid system. To avoid these hazards condition before operating the grid connected system, better to keep one alarm to improve the grid synchronization failure an alternative arrangements can be reserved standby to avoid whole system.

Key Words: **Regulator, LM339, BC547, 555Timer, MC and LCD Display**

I. INTRODUCTION

This paper provides an idea that seems rather imminent today and supplements them with a few visionary thoughts. Numerous new movements are already creative variations in the electric utility infrastructure including the extension of the current grid with micro grids and mega grids, widespread sensors, etc... It will results to impression of Automatic Grid synchronization conception. By increasing the electrical energy to the load side demand, the lifestyles become changed and energy used system have made the world population fully dependent on power systems energy level, which have the need of a consistent and constant power system to the grid level. Eve though, the power system has the highly nonlinear systems, which having variations it's operating of energy generating endlessly. Consequently, it is more stimulating and uneconomical to create the power system be stable for all turbulence. The system has designed regularly to handle a single outage at a time [1]. But, during the past decade numerous major brownouts were stated and all of them in progress with single outages. This paper primarily based on techniques to minimize blackouts.

The distributed generators will be developed based of the rank of the electric utility of power system and additional to this the power system parameters have the well-organized in the way to assurance the suitable process of the electric utility. One of the major problems having with the power system generations plant to develop the potential of islands which may be employed in a standard way proceeding of electric utility if the grid has failed. There will be numerous power generations sources associated to the grid such as wind energy, hydel power, thermal power, solar energy etc.… to resource power for the consumer. These power generating sources needed to supply power by considering the guidelines of the Indian policy to the grid side. These guidelines of Indian policy hold possession a voltage and frequency variation within boundaries [3]. The direction of central electricity board authority of India Guidelines 2010, deviation of the power system voltage would be of ± 5 percent and the frequency should operate nearby 50 Hz and further frequency should drive within this value of 49.2 to 50.3 Hz or slightly variant of frequency specified at the gird coding, except at the transient condition for subsequent the tripping operation. If slightly deviance from the appropriate boundary at the grid level, so, it is necessary that like feeder should operate automatically become detached from the grid side which may be result as islanding. This will breaks in enormous measure the brown-out or black-out of the grid power synchronization. Thus, it is needed to have proceeding the power system which be able to attention the grid in the advance, so that substitute preparations will be reserved for backup to avoid whole grid level failure. Islanding indications to the condition of the distributed generator (DG) endures to power a location, though electrical grid power from the electric utility is no lengthier.

Islanding will be hazardous to electric utility labors, who may not be comprehend the situation in the circuit still supplying the power, and we can avoid the automatic reconnect of the load side devices. The collectively information were made for islanding mode of operation to the grid connected supply that will be having solar power panels attached to the grid system. In the condition of the black-out, the solar power panels continuing to generate the power for continuously if the irradiance is enough. By having this circumstance, the sources line turn out to be an "island" with power surrounded by a "SEA" of unpowered to the lines. For this shake, the purpose of solar power inverters are planned to supply the power to the grid level. Grid are required to have the automatic anti-islanding electrical system. Electrical circuit inverters are convert the DC to AC [4]. Grid-cooperative inverters are having the necessity is that, they will generate AC power supply to the contests of the current power accessible for the grid. Considering this circumstance of a house system by an array of solar power panels on the roof Inverters are attached to the panels and will convert the variable DC

current provided that by the panels into AC power that makes equals the grid supply [5]. If the grid is detached, the voltage level at the grid side probable to drop to zero and a clear suggestion will be given as an indicator that services disruption. Although, considering this cases at the time of house load exactly able the output of the solar panels at the instant of the grid disturbance. In this context the solar panels can supply the power continuously, which may be used to house's hold load. At this situation there is no clear indication that interruption has been occurred. Generally, when the load and production are correctly matched called as balanced-condition, will give the failure of the grid can effect in numerous added transient signals will be developed [2]. Like one example, the voltage is almost decreasing in line voltage, which is having a signal of potential fault condition. Though, such activities can measure the normal operation mode, like the starting of the huge electric motor.

II. HARDWARE REQUIREMENTS

A. *Main Block Diagram*

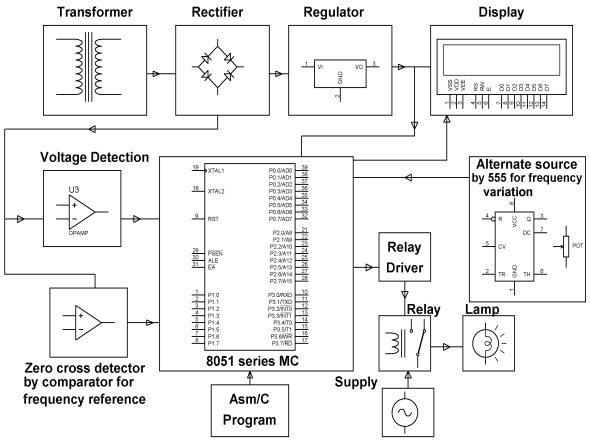

Fig.1: Basic Block Diagram

Hardware components of the Transformer are having the voltage range: 230V – 12 V AC supply, the Voltage regulator of LM 7805, Rectifier circuit, Filter, LM358, LM339, BC547, IN4007, Microcontroller: AT89S52/AT89C51, 555-Timer, Liquid Crystal Display:LCD

i. TRANSFORMER

Transformer will convert the AC signal from the primary voltage to the secondary voltage with a slight loss of power. The Step-up transformers will increase the voltage and step-down transformer will reduce the voltage. Almost power supplies will be used of step-down transformer to reduce the hazards high voltage to a small voltage harmless.

The input source side of the transformer winding is called the primary winding and the output load side transformer winding is called the secondary winding. In between these too primary winding and secondary winding there will be no electrical connection manually instead of this there will be like alternating current will produce the magnetic field in the iron core of the transformer. The two limb of lines of the in the central of the circuit symbol indicate the core. Transformers excess very little power so that power out is equivalent to the power in. The transformer of the voltage will be stepped down and current will be stepped up.

The ratio of the number of turns having of the primary winding and secondary winding called the turn's ratio, will be determined by the ratio of the primary and secondary voltages. A step-down transformer has the large number of turns on its primary side which will connected to the high voltage of mains supply, and the secondary side of the winding will have the less number of turns will give the low output voltage of the transformer.

ii. Voltage Regulator 7805

The LM78XX/LM78XXA having three terminal portal of positive regulator are available in the TO-220/D-PAK set and will give the numerous within range of the output voltages will create the useful for a widespread range of different applications. This type of employments will have the internal current limiting period and making the principle of thermal end and harmless operating area safety. The temperature sinking is provided at the terminal points and will carry the current over 1 Ampere of the output Current. Though it is planned for primarily secure voltage regulators and these devices can be used with the external components to gain the voltages and currents for required level.

iii. LM339 & BC547

The LM339 will have the four independent voltage comparators with good results of the offset voltages requirement as very low value of 20 millivolt for maximum of each comparator, which will be designed precisely to have a function of power supply to the over a widespread area of the voltages. Procedure of the power supply is possible to have the low power supplies and draws the current which is having independent of the magnitude of current of the voltage power supply. These are the comparators have a unique solution and their characteristic of the input voltage common-mode range contains ground level, though they will operates voltage power supply. The LM339 having series connection is designed to have the straight interface of TTL and CMOS. While operating these two parameters of positive and negative power supplied to the LM339 is directly interface with the MOS logic and low power were drain to distinct advantage in excess of a standard comparators. The NPN Epitaxial of Silicon Transistor is from The BC547 transistor. The BC547 has the general-purpose of transistor is low plastic packages components. These transistors will be used for switching operation mode and it will amplifies the voltages and currents of 45V and 100 mA for N-P-N transistors.

iv. Internal Arrangement of 555 TIMER IC

The timer includes two operational amplifiers composed with an RS Bitable element. Adding this, an inverting output buffer is collective that considering the sourced or sink to the load side. A switch transistor: TR1, will be provided by means of quickly discharging at the capacitor. The 555-timer standard were kept to the 8th pin of DIL and the input of the supply voltage is in between of 4.5V and 15V. This one will be encompasses to the normal range for TTL devices and some other devices is suitable for ideally will be used in combination of TTL.

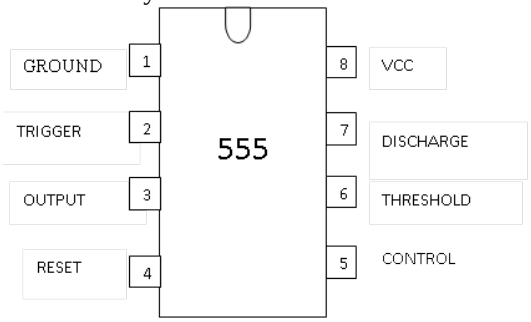

Fig. 2: Pin out diagram of TIMER IC555

B. *Main Block Diagram*

The field of parameters were monitored by the Microcontroller chip by the assistance of user printed with the alert message of LCD and remote monitoring for faulted condition of transmission lines. The IC's of the Microcontroller having input port for giving the fault condition of system parameters and as well as will give the 'Stop' signal through the Radio Frequency signal Receiver. The output of the microcontroller port is used send the fault coding condition to the encoder of DTMF while the relay switching operation is required for isolation of the power from the utilization of load side.

i. AT89S52 Technical Description:

AT89S52 has a low power operating system and high performance of the CMOS with 8-bit microcontroller of 8K bytes flash memory. This device is made of with an Atmel's high density having a nonvolatile storage technology with the industry standard of 80C51 instruction and pin. Turning on chip flash allows the storage program for re-writing the programmed structure in the system or with a conventional non-volatile storage programmer. By combining of 8-bit CPU by programmable flash having monolithic chip. The Atmel AT89S52 has the very important to the microcontroller which will be providing the highly flexible data and cost effective data to the numerous embedded controlling applications. The AT89S52 gives the following standard category likes: flash of 8K bytes, on-chip oscillator, RAM-256 bytes, three 16-bit timer (or) counters, 32 Input/output lines, the timer, full duplex serial port, two data pointers, a six-vector: two-level interrupt architecture and the clock circuitry. Including with the AT89S52 have been developed with a static logic of having operation of down to zero frequency and it will support the two software suitable power saving modes of operation. The main aims to stops the CPU with a permitting of the following the points like: RAM, timer and counters, serial port connection, and interrupt the date system to continuing the working. As Power is going down the operation of RAM protects contents, however, the system is going to be freeze the oscillator and deactivated all other components from the working functions till the next action is going to operate or hardware are going to be reset.

II. Liquid Crystal Display:

LCDs are used for many application in relations of providing the valuable boundary for the worker and correcting. Hitachi 44780 type of LCD controllers simple available a relatively interface between a processor and an LCD. The 44780 type based LCDs has the pins: 14 in a row and pin centers: 0.100".

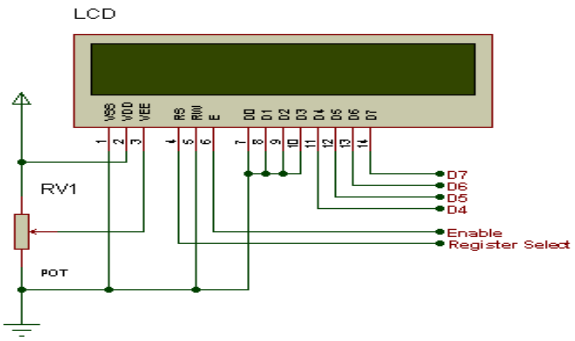

Fig. 3: LCD Display

A. *Processors of Embedded*

Embedded C program used for many applications such as in Automotive electronics, electrical vehicles, automobiles, space systems and in military systems were common, and even day to day life in domestic utilizations like washing machines, telecommunication groups, photographs and video displays.

The common embedded system having projects are multipurpose, cost restrictions, be likely to use low cost computers such as the 8051 domestic devices are measured. The popularity of 8051 IC's are having within the permitted resources accessible main of the such devices are having about RAM has 256-bytes, and the accessible system processor having the power 1000 times less when compared to the desktop computers. Finally the result will be developed with the embedded program of novel challenges, even for the skilled desktop computers.

IV. Experimental Procedure

A. Circuit Connections:

The pin no. 40 is connected to the 5V power supply of the output. The first LM339 is connected to the Pin no. 0.0, the second LM339 is connected to the Pin no.0.1 and Relay is connected to the Pin no. 0.2 as a part of port no. 0 of microcontroller. The LCD of data lines are connected to the Pin no. 2.0 to pin no. 2.7 of the microcontroller of port 2. Read for pin no. 3.5, Write for

pin no. 3.6 and Enable to the pin no. 3.7 of LCD's as a port of 3 microcontroller.

B. Working operation:

Islanding mode of the grid connected system is having the two category. First one voltage and second one is frequency. As per Indian policy the frequency should maintain the 50 Hz and within the frequency range should be maintained, more than this cannot be considered. 555-timer is an astable mode operation and we can vary the frequency by using Resistance (R) value. With the known values of Resistance (R) and Capacitance (C) together the frequency output ranges will be generated with using of multi vibrator of 555-timer. The pin no. 3.0 of microcontroller is the output as port of 3 and has the varying the frequency ranges are in between the 46Hz to 4Hz by using the variable resistance with a selector switching operation, thus it has frequency at pin no.3.0. Now the frequency can be given to the pin no. 3.0 with a switch operation will be given directly frequency of closer to 50Hz, it is very difficult test it. The purpose of choosing the 555 timer is to give the frequency ranges with a selected a ranges of value frequency are 49Hz or 50Hz or 52 KHz which will be tested with 555 timer for this program. In this program, the output of 555-timer which is fed to the microcontroller of 48 Hz below the range or the above 52Hz. The reliable microcontroller outputs will depend on the HIGH which is the switching operation of ON or OFF to the load and it will indicate the islanding mode of the frequency taken part.

According to the voltage behavior we have considered two comparators that is one input is for inverting terminal and other which we have voltage range. Primarily it will be considered as two output comparators connected to the pin no. 0.1 and pin no. 0.2 of microcontroller and remaining will set as low voltage for HIGH and high voltage for LOW. After variant of the input voltage at R8 will give the rectified voltage of DC voltage as HIGH will give the high command to the system LOW for low command of the microcontroller. This program have the command signals are low to high and high to low to the microcontroller program.

i. Adjustment of Low Voltage Trip: The voltage of 220V is set by the VARIAC. Slowly vary the LVSP in the clockwise direction after variation lamp will start glowing. Now don't adjust the settings operation and it will measures the low voltage is 220V and LCD will give the same frequency and voltage will display as low valve.

ii. Adjustment of High Voltage Trip: Select the voltage to 250V by adjusting the VARIAC with a led and lamp will give the OFF and at this condition frequency will measures same value and voltage will give the stable condition. Now vary the HVSP in the direction of anticlockwise direction after this lamp will start glowing which will give the frequency as same value and voltage will measure the high value.

iii. Testing of Voltage Range: Select the voltages range below 220V to higher than the 250V by adjusting the VARIAC. At this condition led and lamp will glow together. In the range of the voltages are 220V and 250V then the led and lamp will not glow and it will measures the value of frequency 50Hz and voltage will give as stable.

iv. Adjustment Frequency Range Trip: When the frequency is given to the inverter location at the voltage under the stable condition, then the LCD will measures the less than the 50Hz frequency and led and lamp will glow. Now adjust the frequency in the counter direction until it will shows the near to the value of 50Hz frequency on the LCD screen. This results the frequency desired value for setting. By varying the frequency of 52Hz above and 48Hz below the led and lamp will glow and on the LCD screen will give the frequency value and voltage will measure the stable condition. For testing of frequency it is very hard to vary the frequency so for this 555 timer is used for inverter output of the frequency.

v. At Normal Condition: In normal condition the led and lamp will not glow, so at this condition frequency will measure the 50Hz and voltage will measure the stable condition. For any abnormality of the voltage collection or the frequency collection the led and lamp will glow together at the grid synchronization failure. This program will be stated that if any cases of frequency is low or high and the voltage may be written that in either high or low, at this condition the microcontroller of the LCD screen will be displayed the grid operation condition, finally relay will operate the ON or OFF to the consumer side load.

C. Measurement of Viscosity

We need to find the room temperature for filling the oil level in the tank, so that cylindrical tank is required for filling oil by the motor. The orifice is used to operate the ball with stop clock-on and stop clock-off. The flow of oil can be measured with desire value.

V. RESULTS

A. Voltage comparison for Under Voltage and Over Voltage conditions

1. Over Voltage Condition:

	Frequency(Hz)	Voltage
Normal Condition	50	Stable
Over Voltage Condition	50	High

Table 1: Over Voltage Condition

1(a): Over Voltage Condition: Normal Condition

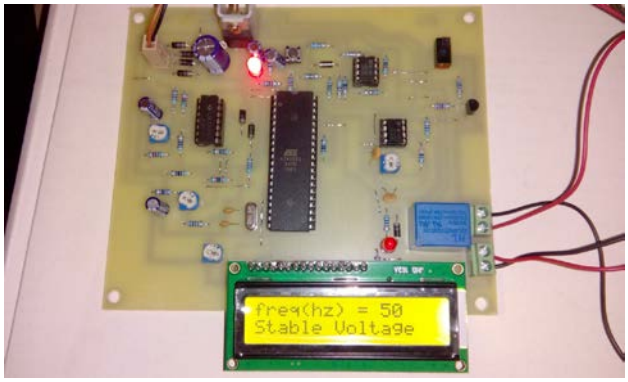

Fig. 4(a): Normal Condition

1(b): Over Voltage Condition: Over Voltage

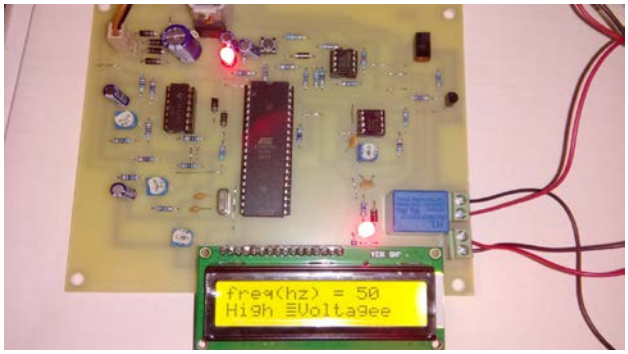

Fig. 4(b): Over Voltage

2. Under Voltage Condition:

	Frequency(Hz)	Voltage
Normal Condition	50	Stable
Under Voltage Condition	50	Low

Table 2: Under Voltage Condition

2(a). Under Voltage Condition: Normal Condition

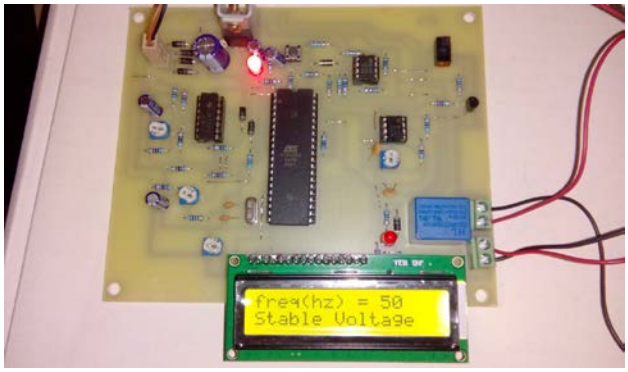

Fig. 5(a): Normal Condition

2(b): Under Voltage Condition: Under Voltage

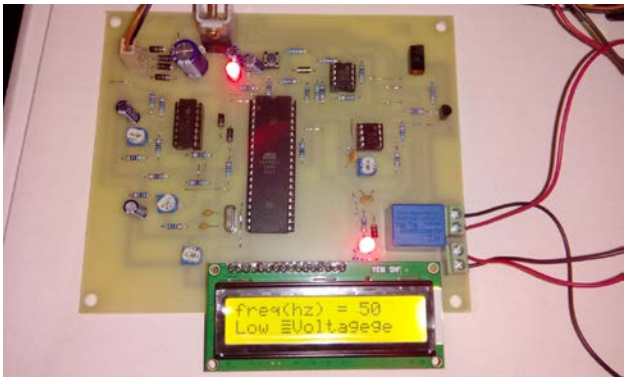

Fig. 5(b): Under Voltage

B. Frequency comparison for over frequency and under frequency conditions

1. Over Frequency Condition

	Frequency(Hz)	Voltage
Normal Condition	50	Stable
Over Frequency Condition	55	Stable

Table 3: Over Frequency Condition

1(a): Over Frequency Condition: Normal Condition

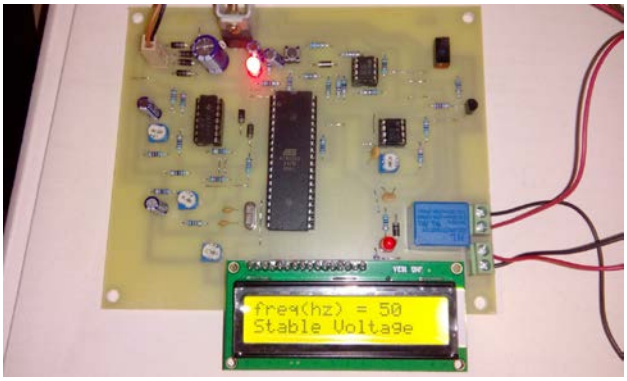

Fig. 6(a): Normal Condition

1(b): Over Frequency Condition: Over Frequency

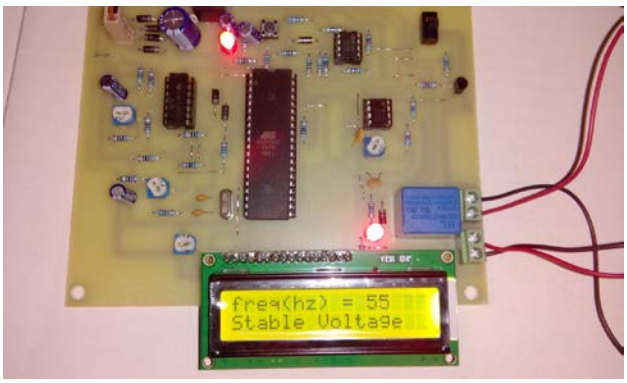

Fig. 6(b): Over Frequency

2. Under Frequency Condition

	Frequency(Hz)	Voltage
Normal Condition	50	Stable
Under Frequency Condition	45	Stable

Table 4: Under Frequency Condition

2(a): Under Frequency Condition: Normal Condition

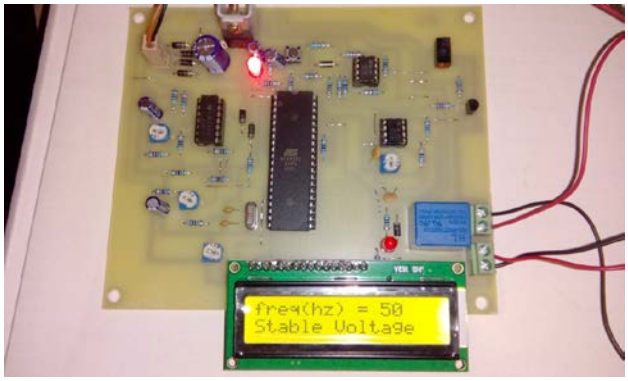

Fig. 7(a): Normal Condition

2(b): Under Frequency Condition: Over Frequency

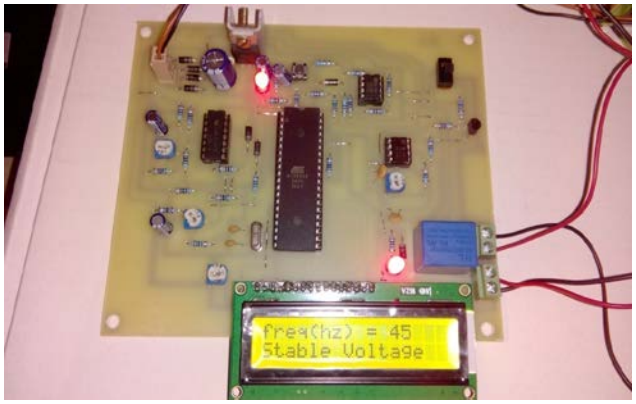

Fig. 7(b): Under Frequency

VI. CONCLUSION

The experimental work carried out based on the hardware implementation using 8051 microcontroller. The microcontroller monitors under/over voltage and under/over frequency conditions which was being derived from a set of 555 timer for the grid synchronization. The results were compared and carried out the best performance.

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SIMULATION AND HARDWARE IMPLEMENTATION OF SINGLE STAGE BRIDGELESS BOOST RECTIFIER FOR LOW VOLTAGE ENERGY HARVESTING APPLICATIONS

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Abstract—
The conventional ac to dc converters which use diodes for rectification have considerable forward voltage drop thereby increasing the power loss and complexity for energy harvesting system. A bridgeless boost rectifier is an integration of boost and buck- boost rectifier to condition the positive and negative half cycles of the input ac voltage, respectively. In this paper, a single-stage ac to dc power electronic converter is used to efficiently convert the energy with low voltage outputs. The input ac voltage is 0.4 V amplitude. This ac voltage is rectified and boosted to 3.3 V dc. The converter is designed and tested at 50 kHz switching frequency. The converter design also minimises the size, weight, and power losses which is very essential in low voltage energy harvesting systems. The theoretical analyses are validated by the simulation and hardware implementation.

***Keywords*: Energy harvesting system, ac-dc converter, bridgeless boost rectifier**

I INTRODUCTION

The power converter should rectify the input ac voltage and then boost and regulate the dc output voltage to a voltage level required by the loads. The power electronic circuits for energy harvesting systems, plays a key role in the interface between transducer and electronic load. The electrical characteristic of the power converter determines the functionality and efficiency of the integrated system. The physical characteristic will determine the size of the integrated systems. The power electronic circuits used should regulate the power delivered to the load and actively manage the electrical damping of the transducers. Then only maximum power can be transferred to the load. A miniature energy harvesting system has strict requirement on the size and weight of power electronic interfaces.

The conventional ac to dc converters can be used for energy harvesting applications. The converter usually consists of two stages. The first stage consists of a diode bridge rectifier and the dc-dc converter forms the second stage to regulate the rectified dc voltage. However, the diode bridge would cause considerable voltage drop, making the low voltage rectification less efficient or infeasible.

Instead of conventional p-n junction diodes, CMOS diodes with low voltage drops are used in the bridge rectifiers. The CMOS diodes include diode-connected passive MOSFET, which adopts threshold voltage cancellation techniques and MOSFET, which is actively controlled by a comparator. In both the cases, the low voltage-drop diode techniques require either additional bias networks or external comparators. Hence the complexity and the power loss of the circuitry would increase. In some converters, transformers are used as boosters in first stage to overcome the voltage drop in semiconductor devices. Then the size of the transformer would become very large when used in low-frequency energy harvesting applications. Another approach to maximize the conversion efficiency in low-voltage rectification is use of bridgeless direct ac to dc converters. These topologies either use bidirectional switches and split capacitors or two parallel dc to dc converters to rectify positive and negative input voltages separately. In split-capacitor topologies, due to the low operation frequency of specified micro generators, the capacitors have to be large enough to suppress the voltage ripple under a desired level. The increased size and number of energy storage components make those topologies impractical due to the size limitation of energy harvesters. The limitations of split capacitors could be eliminated by using two synchronous MOSFETs, but the additional switches would invite extra switching loss and driving circuit dissipations. The common power conditioning interface used is boost converter due to its simple structure, voltage boosting capability and high efficiency. The advantage of buck-boost converter is the ability of it to step up the input voltage with a reverse polarity. Hence, buck-boost converter can be used to condition the negative voltage cycle. Also, the boost and buck-boost topologies would share the same inductor and capacitor to meet the miniature size and weight requirements of energy harvesters. Hence a bridgeless direct ac to dc converter is used to overcome all the drawbacks and maximize the conversion efficiency in low voltage rectification.

II PRESENT WORK

In any power electronic circuit, the biggest challenge is to reduce the power loss and increase the efficiency. The power loss in diode bridge rectifier circuits is constant as each leg of the diode can cause up to 2V of wastage in power. Hence, instead of diodes, the MOSFETs can be used in the construction of bridgeless rectifier. The recent improvements in MOSFET have become added advantage terms of cost as well as size.

A bridgeless boost rectifier is a combination of boost and buck boost converter. The converter consists of a boost converter which comprises of S1, L and D1 in parallel with a buck-boost converter with S2, L and D2.The output dc bus is realized by using a single capacitor. During positive half cycle of the input voltage, the output capacitor is charged by the boost converter and in the negative half cycle of the input by the buck boost converter. This solves the problems of dual polarity output from boost converter when an ac input is applied.

When the input voltage is positive, the circuit operates in boost mode when S1 is turned ON and D1 is reverse biased. When the input voltage becomes negative, the buck-boost mode starts with S2 turned ON and D2 is reverse biased. MOSFETs with bidirectional conduction capability work as two-quadrant switches and ensure the circuitry functionality in both positive and negative voltage cycles. The switching signals of S1 and S2 are dependent on the polarity of the input voltage. During the positive input cycle, S1 is turned ON and S2 is controlled by the boost control scheme. In the negative input cycle, S2 is turned ON and S1 is controlled under the buck-boost conditioning strategy. The output voltage is filtered by a passive low pass filter and then fed to ADC of the controller. The difference between ADC output and the desired voltage is calculated and compensated through the PID algorithm to generate an adjustable duty cycle signal.

This converter is operated under discontinuous current conduction mode (DCM). This will reduce turn ON and turn OFF losses of the switches. The diode recovery losses of the boost and buck-boost converter diodes can also be reduced by DCM operation. To determine the input voltage polarity, a sign detector is used. The sign detector consists of a voltage reference, an op-amp and the on chip analog comparator. The op-amp operates as an analog adder, where a dc bias (voltage reference) is added to the input voltage. The signal summation is compared with the voltage reference to detect the polarity.

The single stage Bridgeless Boost Rectifier circuit (fig. 1) consists of six modes of operation. Modes I-III are for positive input voltage where S1 is turned ON and diode D1 is reverse biased. The rectifier works as a boost circuit all through the Modes I-III. Modes IV-VI are for negative input voltage where S2 is turned ON and diode D2 is reverse biased.

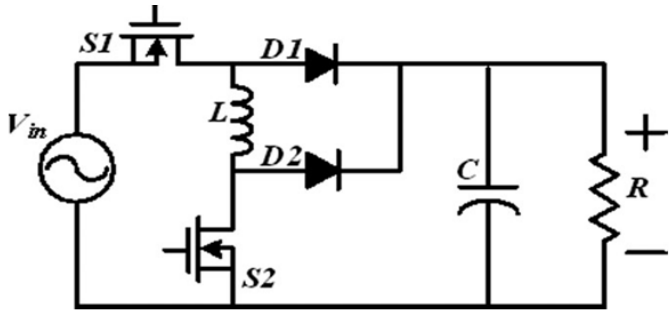

Fig. 1 Bridgeless Boost Rectifier circuit

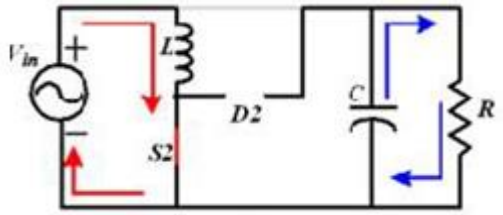

Fig. 2 Mode I

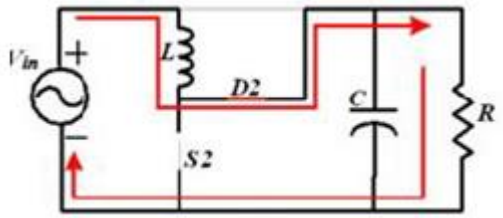

Fig. 3 Mode II

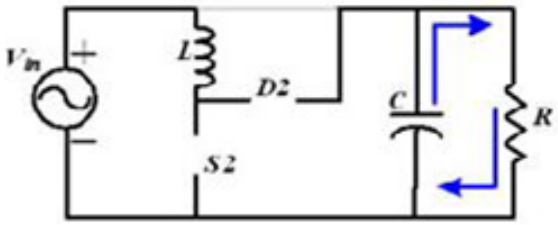

Fig. 4 Mode III

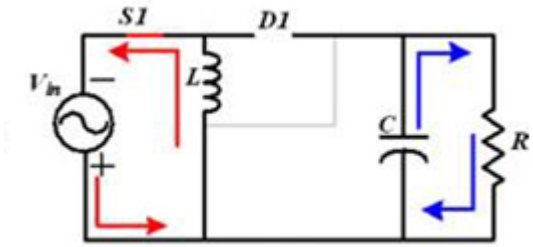

Fig. 5 Mode IV

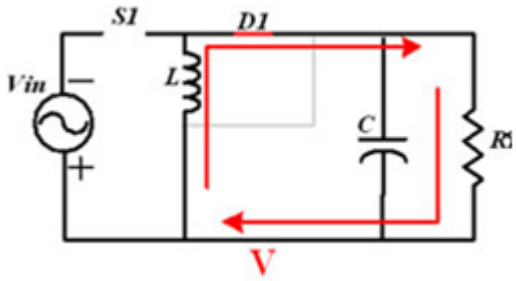

Fig. 6 Mode V

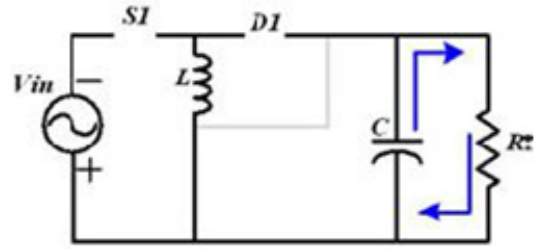

Fig. 7 Mode VI

During Mode I (Fig. 2), switch S2 is turned ON under zero current switching (ZCS) condition to reduce the switching losses and switch S2 is already conducting. Both the diodes are reverse biased in Mode I. Initially inductor current is zero. Then the inductor L is energized by the input voltage as both S1 and S2 are conducting now. The inductor current increases linearly. The energy stored in output filter capacitor C powers the load and the capacitor discharges.

During Mode II (Fig. 3), S2 is turned OFF. During this mode diode D2 is turned ON, hence switching loss occurs. The energy stored in the inductor during Mode I is transferred to the load, hence inductor current decreases linearly. The capacitor C charges during Mode II operation.

During Mode III (Fig. 4), when inductor current becomes zero, D2 is automatically turned OFF. The load is again powered by energy stored in capacitor C. The converter would return to Mode I if the input voltage is still in positive cycle by turning ON S2.

During Mode 4 (Fig. 5), for negative input cycle, S1 is turned ON under ZCS conditions. Initially before S1 is turned on, inductor current is zero. Now the energy is transferred to inductor 'L' again, and the output filter capacitor C powers the load.

During Mode 5 (Fig. 6), S1 is turned OFF. Diode D1 is turned ON. The energy stored in inductor 'L' during Mode IV is transferred to the load. Inductor current decreases linearly.

During Mode 6 (Fig. 7), diode D1 is turned OFF when inductor current decreases to zero. The load is then powered by the energy stored in the output capacitor C.

The control circuit for the bridgeless rectifier is as shown in Fig. 8.

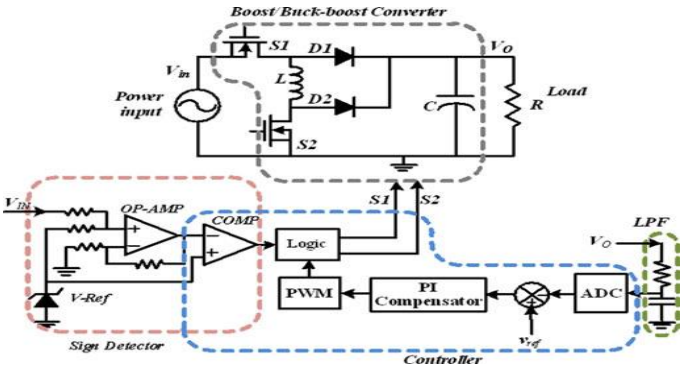

Fig. 8 Control circuit for the rectifier

III SIMULATION AND HARDWARE

The single stage bridgeless rectifier model is simulated using PSIM and MATLAB Simulink. The (Fig. 9) shows the complete simulation model in PSIM software. Fig. 10 shows the simulation model of rectifier using MATLAB tool.

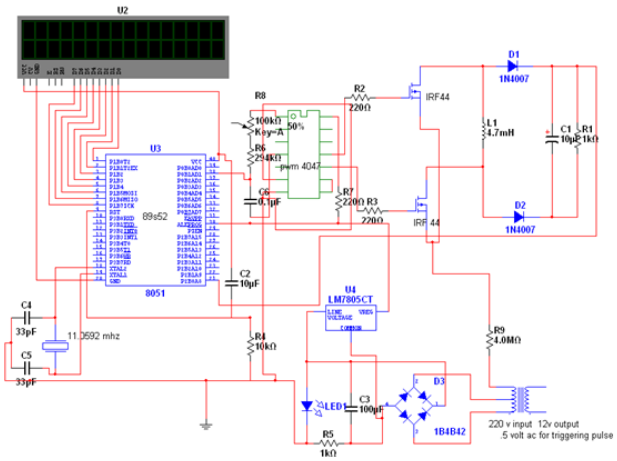

Fig. 9 Simulation model using PSIM

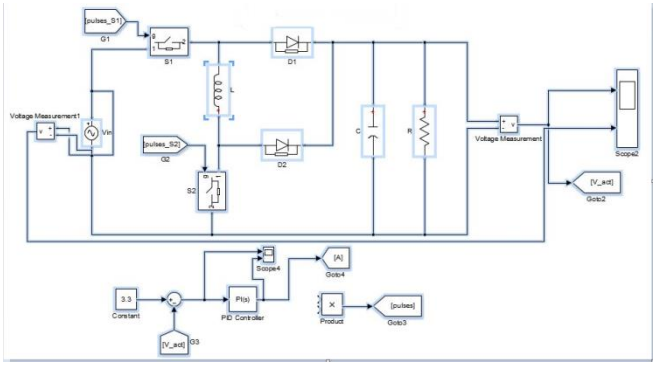

Fig. 10 Simulation model of rectifier using MATLAB

The following hardware components are used in the converter circuit:

1) AT89C52 - 8 Bit Microcontroller for the generation of PWM signals

2) An inverter IC CD4069 for isolating the control circuit and the driver IC

3) MOSFET SI9926CDY

4) Schottky Diodes DFLS120L-7

5) Capacitor C3225Y5V0J107Z, 100 µF

6) Inductor DR74-4R7-R, 4.7µH

7) Resistor 200 Ω

IV RESULTS

The simulation results obtained in PSIM and MATLAB are shown below.

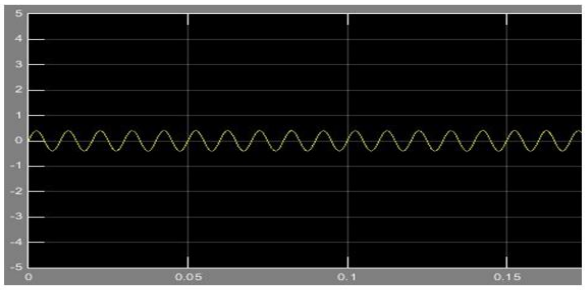

Fig. 11 Input voltage in MATLAB

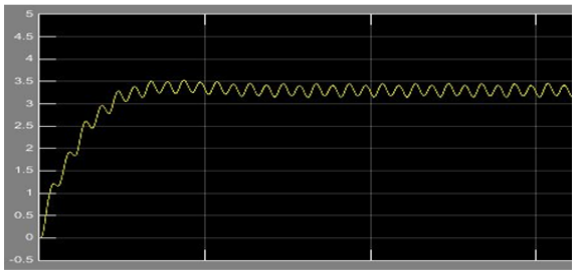

Fig. 12 Output voltage in MATLAB

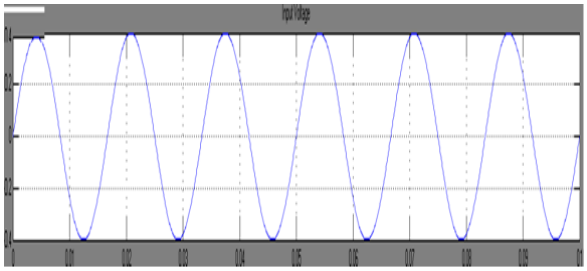

Fig. 13 Input voltage in PSIM

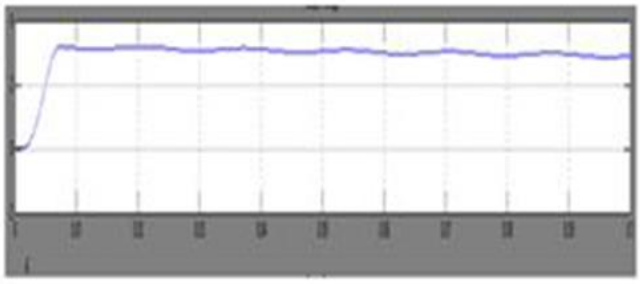

Fig. 13 Output voltage in PSIM

The hardware implementation of single stage bridgeless rectifier is as shown in Fig. 14. As seen from Fig. 16, the output voltage is regulated at 3.3V dc with approximately 0.2V voltage ripple.

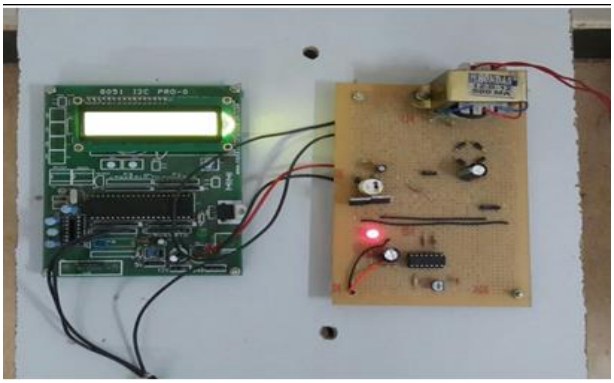

Fig. 14 Hardware of rectifier

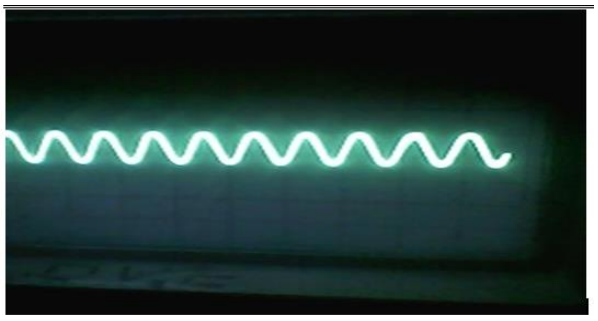

Fig. 15 Input voltage

Fig. 16 Output of rectifier circuit

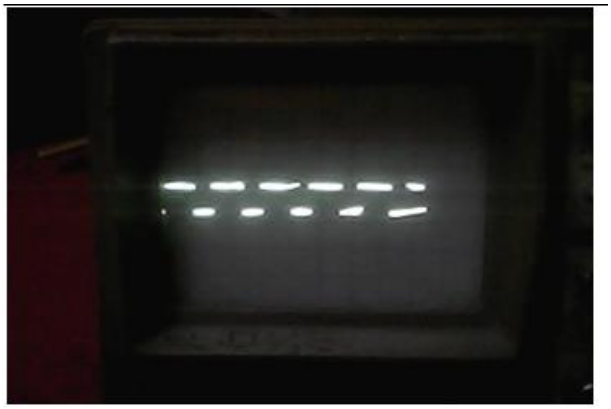

Fig. 15 Output of microcontroller

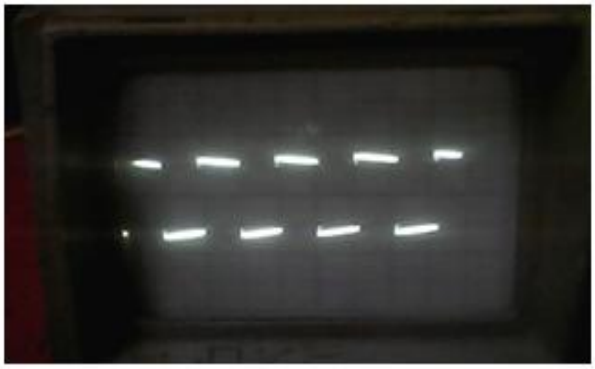

Fig. 16 Output of PWM

V CONCLUSION

The ac to dc low voltage energy harvesting converter avoids the conventional bridge rectification. The converter combines a boost converter and a buck-boost converter to control the positive input cycles and negative input cycles respectively. The converter is operated to step up the low ac voltage to a high dc voltage. Only one inductor and one filter capacitor are used in this topology. The converters are operated in discontinuous current conduction mode to reduce the switching losses and for simple control. This low voltage bridgeless rectifier achieves the maximum conversion efficiency employing minimum number of passive energy storage components.

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An Optimized Multilevel Inverter Topology with Symmetrical and Asymmetrical DC Sources for Sustainable Energy Applications

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Abstract—**This paper proposes an optimized Multi-Level Inverter (MLI) topology with symmetrical and asymmetrical DC sources for sustainable energy applications. The proposed MLI has optimized components to reduce size, cost, and installation area in comparison with traditional MLIs. It also improves output power quality by reducing harmonics in the stepped output, and hence it can be used for sustainable energy applications with a grid interface. The proposed inverter is equipped with six switching devices, one clamping diode, and two DC sources. It produces a five-level stepped output when using symmetrical DC sources and a seven-level stepped output when using asymmetrical DC sources. In this topology, the six switching devices are divided into two units, namely the level generator and the polarity generator units, the switches used in the level generator are responsible for producing the required number of levels in the form of rectified stepped output and the switches used in the polarity generator are responsible for converting the rectified stepped waveform to stepped AC output. The simulation results verify the operation of the MLI when fed with linear load with symmetrical and asymmetrical DC sources, and the experimental output results are presented for validation.**

Keywords-optimal multilevel inverter; symmetrical; asymmetrical; total harmonic distortion

I. INTRODUCTION

Multi-Level Inverters (MLIs) are popularly used devices for power conversion in grid-connected systems, industrial applications, electric vehicles, Uninterruptible Power Supply (UPS) devices, FACTS devices, etc. MLIs are capable of generating an output voltage with near sinusoidal wave shape. In addition, they have features like producing output with reduced Total Harmonic Distortion (THD), reduction in power losses due to the lower switching frequency, reduced dv/dt stress and un-necessity of filters which results in size and cost reduction of the overall inverter [1-4].

The classical topologies of MLIs are diode clamped MLI or Neutral Point clamped (NP-MLI) [5], Flying Capacitor MLI (FC-MLI) [6] and Cascaded H-bridge MLI (CH-MLI) [7], and are used in various industrial applications. However, NP-MLI and FC-MLI suffer from limitations compared to CH-MLI, limitations such as the larger number of switching devices, the requirement of clamping diodes and capacitors, voltage-unbalancing issues across the capacitors etc. Due to the simple structure of CH-MLI, it can be easily integrated with renewable energy sources. Over the last years, research has focused on emerging topologies to overcome the limitations of the conventional MLI. CH-MLI consists of H-bridges with independent DC sources across each bridge. The magnitude of all voltage sources can be either the same or different. In symmetric CH-MLI, the magnitude of all voltages sources will be equal, whereas in asymmetric CH-MLI, the magnitude of all voltage will be different [8, 9]. The asymmetric inverters generate more levels in output as compared with symmetric MLIs with the same topology or the same number of power electronic switches and sources. Therefore, cost, size, complexity, THD, and losses of the asymmetric inverters are reduced [12]. Authors in [13-15] tried to reduce the number of switches to overcome the cost constraint, and improve the quality of output voltage waveform by increasing the number of levels in the output voltage.

This paper presents a single-phase MLI topology with symmetrical and asymmetrical voltages, which uses a reduced number of components compared to the existing topologies

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[16-18]. This configuration is the extension of the topology proposed in [10], which can be extended to three-phase [17].

II. PROPOSED TOPOLOGY

Similar to the recently introduced hybrid MLIs, the proposed inverter also consists of two circuits. The first one is a level generating circuit, it works at the fundamental or at a high frequency and the second one is the H-bridge circuit operating at the fundamental frequency. The first circuit generates a positive stepped waveform across the H-bridge and the second generates positive and negative stepped waveforms in the output voltage. The generalized figure of the proposed optimized MLI is presented in Figure 1. The circuit can be powered with symmetrical or asymmetrical voltage. In the symmetrical topology, all input voltage magnitudes are maintained at equal values: V_1: V_2:V_3:V_4 : : : V_k=1:1:1:1 : : : 1 and in the asymmetrical voltage topology, the voltages are maintained with the ratio of V_1:V_2: V_3:V_4: : : : V_k = 1 : 2 : 3 : 4 : : : k, where: k represents the number of voltage sources. The level generating circuit is used for generating the positive stepped voltage levels across the H-bridge. It consists of voltage sources, level generating switches, and diodes to prevent the reverse of the current. The H-bridge circuit is used for polarity reversal, it is responsible of producing the positive and negative stepped voltage levels at the output and it consists of four switches.

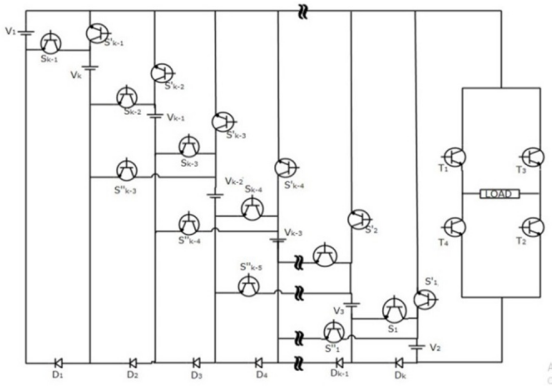

Fig. 1. Generalized structure of the proposed optimized MLI

The required number of output levels, control switches, and diodes with n_s sources for the optimized MLI with symmetrical voltages are:

- Levels generated in output with n_s sources = $(2n_s + 1)$
- Control switches required to generate n levels with n_s sources = $(3n_s -1)$, for n ≥3
- Diodes required for generating n levels = $(n_s - 1)$
- Peak output voltage = $(2n_s+1)\times V_{dc}$

The output levels, control switches, and diodes for the optimized MLI with unsymmetrical voltages are:

- Levels generated in output with n_s sources = $n_s (n_s + 1) + 1$
- Control switches required to generate n levels with n_s sources = $(3n_s -1)$, for n ≥3
- Diodes required for generating n levels = $(n_s - 1)$
- Peak output voltage = $(n_s\times(n_s + 1) +1)\times V_{dc}$

III. SYMMETRICAL AND ASYMMETRICAL OPTIMIZED MLI

To explain the operation of the MLI shown in Figure 1, two voltage sources with equal or unequal magnitude are considered (Figure 2).

A. Operation of Symmetrical Optimized MLI

With two symmetrical sources (V_1:V_2 = 1:1), the proposed MLI shown in Figure 2 is capable of generating 5 levels at the output terminals, utilizing 2 DC sources, 6 control switches, and 1 diode. When compared with the conventional and recently proposed MLIs, this topology requires a reduced number of power electronic switches, hence it is characterized by reduced size, controllability and switching losses. Among the six switches, T_1, T_2, T_3, and T_4 are H-bridge switches, also called polarity reversing switches and the switches S_1 and S_1^1 are level generating switches. The various switching states for generating 5 levels at the output are shown in its switching table (Table I). The first positive stepped (V_{dc1}=V_1) level is achieved by turning on the H-bridge switches T_1 and T_2 and the diode or level generating switch S_1^1. The second level (V_{dc2} = V_1+V_2) is obtained by turning on the H-bridge switches T_1 and T_2 and the level generating switch S_1. During this instant, the diode D will not conduct, as a negative voltage is applied to the diode.

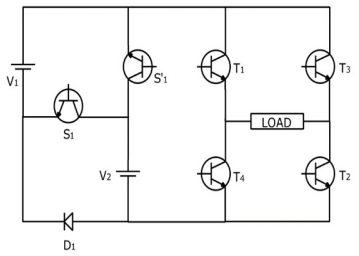

Fig. 2. The optimized MLI with two symmetrical or asymmetrical voltage sources

TABLE I. SWITCHING SEQUENCE TO GENERATE FIVE LEVELS WITH TWO SYMMETRICAL SOURCES

Output voltage	H-bridge switches				Level generating switches	
	T_1	T_2	T_3	T_4	S_1	S_1'
V_1+V_2	1	1	0	0	1	0
V_1	1	1	0	0	0	0
	1	1	0	0	0	1
0	1/0	0/1	1/0	0/1	0	0
$-V_1$	0	0	1	1	0	0
	0	0	1	1	0	1
$-(V_1+V_2)$	0	0	1	1	1	0

The zero switching states can be obtained in two ways: one is using the H-bridge switches T_1, T_3, and the load and the other is using the H-bridge switches T_2, T_4, and the load. Similarly, the negative stepped voltages are achieved by turning on the H-bridge switches T_3 and T_4 instead of T_1 and T_2 as in the case of positive voltage levels. All the gates are signaled by a simple Pulse Width Modulation (PWM) technique, in which a sinusoidal reference signal is compared

with the carrier signal for generating the gate signal. These signals or pulses are ANDed and ORed by a logical operator to obtain the required pulses. These final pulses are then given to the corresponding switches.

B. Operation of the Asymmetrical Optimized MLI

The 5-level topology shown in Figure 2 is capable of generating 7 levels at the output terminals with two asymmetrical voltage sources. The two DC sources are considered with the ratio of 1:2. The various switching states for generating a 7-level output are given in Table II. The lower level positive stepped waveform is obtained by turning on the H-bridge switches T_1 and T_2 and the diode, the positive middle level can be obtained by turning on the level generating switch S_1^1 along with H-bridge switches T_1 and T_2, and the highest level at the output is obtained by turning on the H-bridge switches T_1, T_2 and the level generating switch S_1. Similarly, the negative stepped voltages are achieved by turning on the H-bridge switches T_3 and T_4 instead of T_1 and T_2.

TABLE II. SWITCHING SEQUENCE TO GENERATE SEVEN LEVELS WITH TWO UNSYMMETRICAL SOURCES

Output voltage	H-bridge switches				Level generating switches	
	T_1	T_2	T_3	T_4	S_1	S_1'
V_1+V_2	1	1	0	0	1	0
V_2	1	1	0	0	0	1
V_1	1	1	0	0	0	0
0	1 /0	0/1	1/0	0/1	0	0
$-V_1$	0	0	1	1	0	0
$-V_2$	0	0	1	1	0	1
$-(V_1+V_2)$	0	0	1	1	1	0

IV. COMPARISON WITH EXISTING TOPOLOGIES

To show the advantages and the originality of the proposed optimized MLI, the data of conventional, recent, the proposed topologies are presented and compared in this section. The control difficulty and consistency directly depends on the number of required power electronic switches. The detailed comparison data are listed in Table III.

TABLE III. SYMMETRICAL MLI COMPARISON

	[2]	[3]	[4]	[10]	[11]	Proposed
Main switches	2(n-1)	2(n-1)	2(n-1)	2(n-1)-2	$\frac{(n+7)}{2}$	$\frac{(3n-5)}{2}$
Clamping diode	(n-1)(n-2)	0	0	(n-3)(n-2)	0	$\frac{(n-3)}{2}$
Flying capacitors	0	$\frac{(n-1)(n-2)}{2}$	0	$\frac{(n+1)}{2}$	$\frac{(n-1)}{2}$	0
DC bus capacitors	(n-1)	(n-1)	0	$\frac{(n-1)}{2}$	$\frac{(n-3)}{2}$	0
DC source	1	1	$\frac{(n-1)}{2}$	1	1	$\frac{(n-1)}{2}$
Total components	n^2	$\frac{(n^2+3n-2)}{2}$	$\frac{(5n-5)}{2}$	n^2-2n+3	$\frac{(3n+5)}{2}$	$\frac{(5n-9)}{2}$

Figure 3 represents the total devices required for generating the specific level. The proposed structure requires a comparatively very small number of switches with symmetrical or with asymmetrical voltage, and at any instant a maximum of 4 switches will conduct.

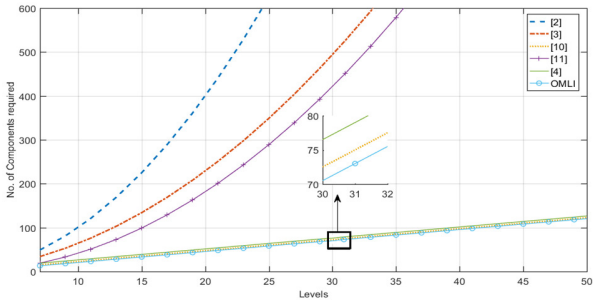

Fig. 3. Total number of required components

V. SIMULATION AND EXPERIMENTAL RESULTS

A. Simulation Results

In order to verify the performance of a proposed MLI, it was simulated in MATLAB/Simulink platform with a linear load. The simulation results of the proposed MLI with two symmetrical sources (V_1:V_2=100:100) and two asymmetrical sources (V_1:V_2 = 100:200) are discussed in this section. Figure 4 shows the Simulink model of the Optimized MLI (OMLI).

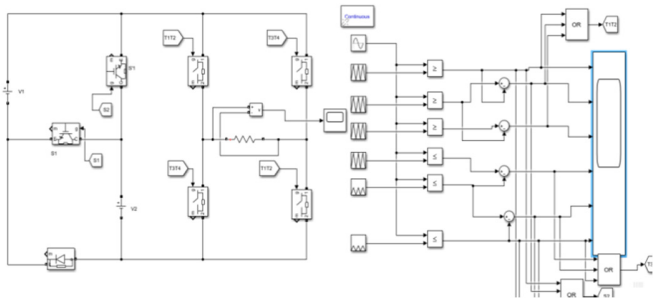

Fig. 4. Simulink model of the proposed PLI

The output voltage, output current, and THD present in the voltage of the 5-level proposed OMLI with two symmetrical DC sources are shown in Figure 5.

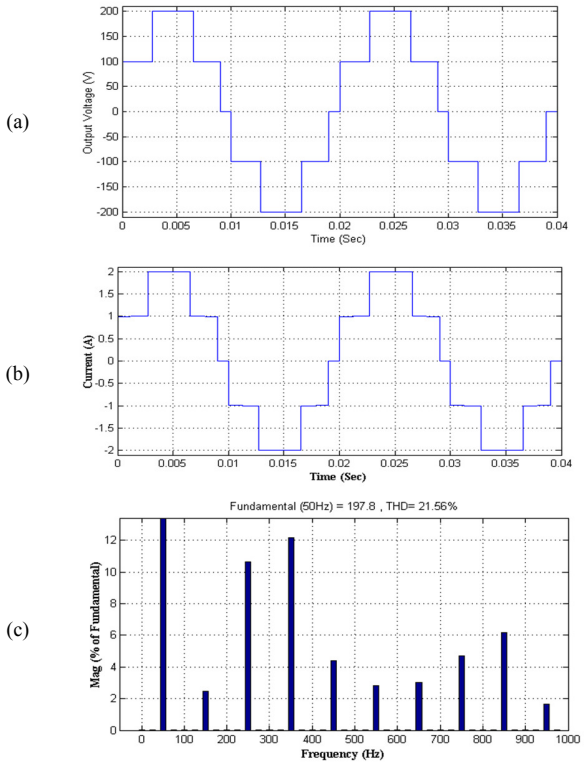

Fig. 5. (a) 5-level voltage, (b) 5-level current, (d) FFT analysis with two symmetrical sources

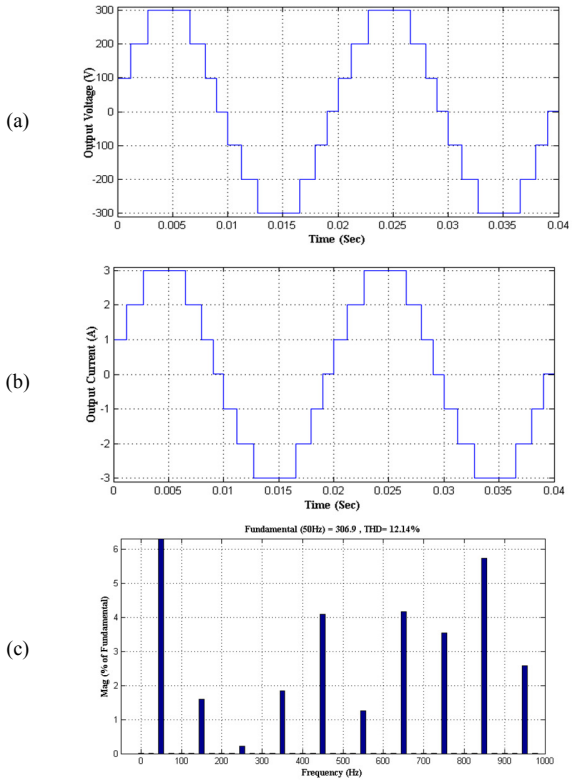

Fig. 6. (a) 7-level voltage, (b) 7-level current, (c) FFT analysis with two asymmetrical sources

To run the OMLI Simulink model, Ode 45 solver has been used with a run time of 0.04s for two cycles. Form Figure 5(a) and 5(b) it is observed that each level has a step change of 100V and 1A respectively. The %THD value of OMLI for the 5-level is 21.56% as shown in Figure 5(c). Output voltage, output current, and THD present in the voltage of the 7-level OMLI with two asymmetrical DC sources are shown in Figure 6. Form Figure 6(a)-(b) it is observed that each level has a step change of 100V and 1A respectively. The %THD in output voltage is 12.14, having reduced by 44% when compared to the 21.56%.

B. Experimental Results

The proposed OMLI with two asymmetrical DC sources was tested experimentally in order to evaluate its performance. The prototype of the OMLI is shown in Figure 7 and the experimental results in Figure 8.

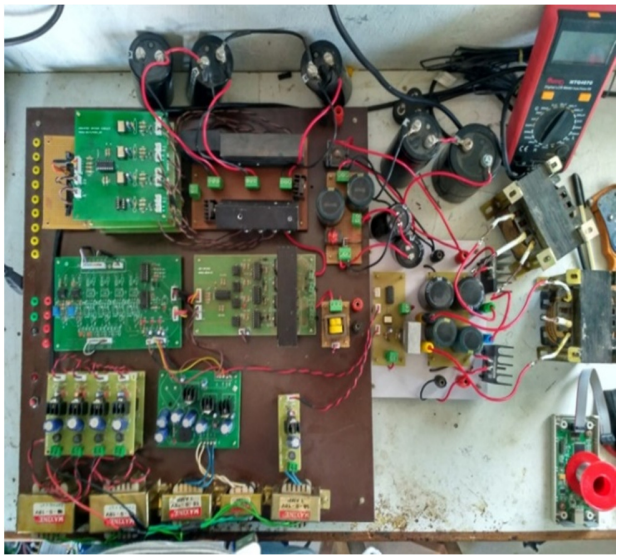

Fig. 7. Photograph of hardware setup of the proposed MLI

The implementation of the proposed MLI was carried-out by using an FPGA Spartan-6 controller, which is highly preferable to generate switching pulses in real-time implementations with an Xilinx processor as IR2110 driver module and TLP250 Opto-Couplers. The power semiconducting switches used in the experimental prototype model are 6 Nos of FGA15N120 IGBTs with anti-parallel diodes and one uncontrolled switch. The outcome waveforms were measured and recorded with key-sight DSOX2014A Oscilloscope, with a 100MHz, 4 Analog Channels. From the simulation analysis, it was observed that the OMLI output voltage THD for the 7-level inverter was 12.14%. The THD of the prototype model was measured with a FLUKE 434 series-II power-quality analyzer and the results are presented in Figure 8(a) and (b). Figure 8(a) shows the 7-level output voltage of the OMLI with asymmetrical sources and Figure 8(b) shows the corresponding %THD which was 13.1% for the 7-level OMLI. From Figure 8, it is clear that the experimental results are in close agreement with simulation and theoretic analysis with an acceptable error of ±2%.

(a)

(b)

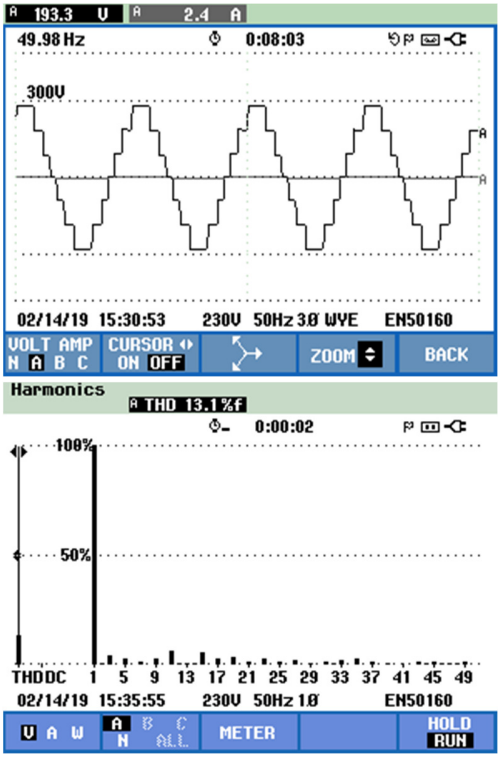

Fig. 8. (a) 7-Level voltage (b) corresponding THD

VI. CONCLUSIONS

In this work, an optimized multilevel inverter has been presented for sustainable energy applications. In comparison with the already existing and recently proposed topologies, this topology uses fewer components to produce the steps at the output side. Thereby, the proposed inverter will be compact in size and its overall complexity will be reduced. The proposed inverter was simulated in MATLAB/Simulink with the consideration of two symmetrical or asymmetrical voltage sources. It was seen that, with two symmetrical sources, the proposed inverter produces 5 levels at the output side, while with two asymmetrical sources it produces 7 levels. The simulated performance of the proposed 7-level inverter has been compared with the experimental results, which are in close agreement with the simulation results.

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COMPARATIVE STUDY OF BUCK-BOOST, ZETA AND SEPIC DC-DC CONVERTERS FOR MAXIMUM POWER POINT TRACKING APPLICATIONS IN PV SYSTEMS

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***Abstract*—The solar charge controllers which are used to charge the batteries consists of DC-DC converters which are essential components in photovoltaic systems. There are wide variety of DC-DC converters which are used for different applications depending on their characteristics, but when it comes to battery charging applications generally transformer less converters are preferred as they are compact and suitable for low power applications. In the transformer less DC-DC converters there are different topologies, generally for battery charging applications and MPPT charge controllers the converters which has low output transients and fast response are preferred.**

In this paper the design and simulation of buck-boost, zeta and SEPIC converters are done and the comparison of their transient responses are obtained based on which a particular convert is selected for the given application.

***Index Terms*—**Duty cycle, Output ripple, transient response, charge controllers, MPPT.

I. INTRODUCTION

Shortage in Power, Depleting Non- renewable resources has started a revolution towards the use of renewable energy sources. The power obtained from the photovoltaic cell varies with respect to time and environmental factors. batteries are used for storing the excess energy when available and which can be used later. since the power i.e., voltage and current varies at the output terminal of the PV cell the charge controllers are used as an interface between the PV cell and the battery.

The charge controller controls the flow of power into the battery and it also provides protection against the reverse flow of power to the PV cell. a solar charge controller essentially consists of two major units:

1 . DC-DC converters

2 . MPPT control mechanism.

The DC-DC converter is a power electronics device that converts dc power of one level(voltage) obtained at the terminals of the PV cell to the required level (voltage) for charging the battery. There are various types of DC-DC converter topology based:

1. BUCK-BOOST CONVERTER
2. ZETA CONVERTER
3. SEPIC CONVERTER

In this paper we have considered the DC-DC converters which can step-up as well as step-down the input voltage. The converters are designed for battery chargers (charge controllers) therefore the transient response of the converter is essential for the effective and efficient operation of the chargers. The converters which have minimum peak overshoot, minimum settling time and less transients are considerable for this application.

II. BUCK-BOOST CONVERTER

A buck-boost converter is a DC-DC converter which can either step-up or step down the input voltage. fig1 shows an inverting buck boost converter. as the name suggests this converter provides negative voltage at the output terminal. it is a second order converter as it uses two energy storage devices. For the simulation purpose we consider the output voltage to be same as the input voltage i.e., 18v. and the switching frequency is 10Khz.

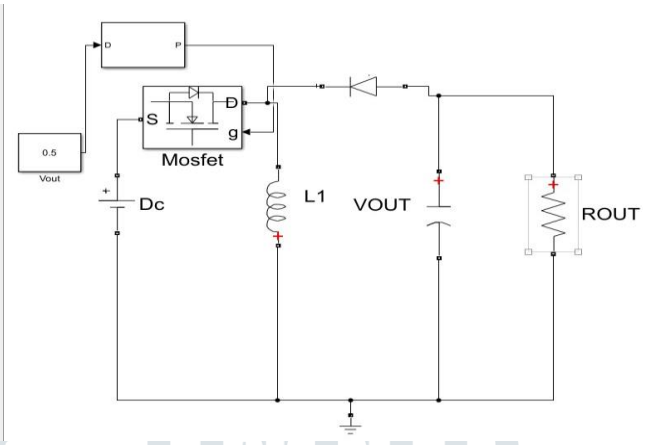

Fig.1 Simulink Model of Buck-boost converter

The design equations are given below considering the load to be 1kohm:

$Vo/Vin=-(D/(1-D))$
$L=(Vin*D)/(IL_{(pp)}*Fsw)$
$IL_{(pp)}=K*Iin$

Generally, the value of k is between 0.2 and 0.4

Table.1 Design parameters of Buck-Boost converter

INPUT VOLTAGE (V_{IN})	18V
OUTPUT VOLTAGE (V_{OUT})	-18V
DUTY CYCLE (D)	0.5
INDUCTOR (L)	170mH
CAPACITOR (C)	800µF
OUTPUT RESISTANCE	1KΩ
SWITCHING FREQUENCY Fsw	10,000 Hz

Using the design equations and considering the nominal value of capacitor Table.1 is obtained and substituting the values into the Simulink model the output response obtained is as shown in fig.2

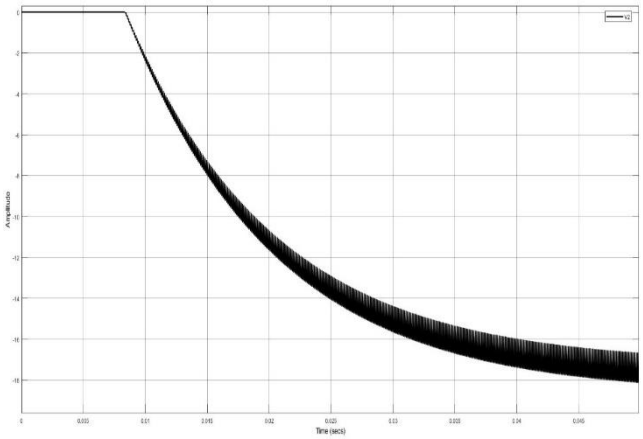

Fig.2 Output Voltage of Buck-boost converter

From fig.2 we can obtain transient response parameters of buck-boost converter and it can be compared with the response of other converters. for buck boost converter the settling time is very less but the output is inverted and also has more ripples.

III. ZETA CONVERTER

The ZETA converter topology provides a positive output voltage from an input voltage that varies above and below the output voltage. The ZETA converter needs two inductors and a series capacitor, sometimes called a flying capacitor. It is a fourth order converter as it uses four energy storage devices. Unlike the SEPIC converter, which is configured with a standard boost converter, the ZETA converter is configured from a buck controller that drives a high-side P-MOSFET. For the simulation purpose we consider the output voltage to be same as the input voltage i.e., 18v. and the switching frequency is 10Khz.

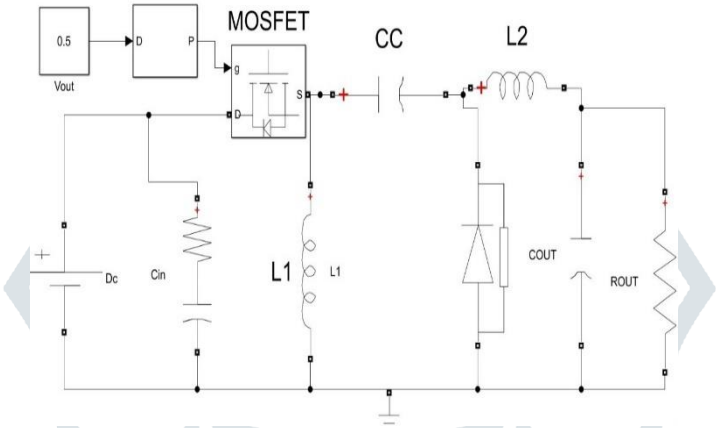

Fig.3 Simulink Model of zeta converter

The design equations are given below

$D=(Vout/(Vin+Vout))$

$L=(Vin*D)/(IL_{(pp)}*Fsw)$

$IL_{(pp)}=K*Iin$

Considering the value of k to be 0.3 for zeta converter.

Table.2 Design parameters of zeta converter

INPUT VOLTAGE (V_{IN})	18V
OUTPUT VOLTAGE (V_{OUT})	18V
DUTY CYCLE (D)	0.5
INDUCTOR (L)	170mH
CAPACITOR (C)	5μF
OUTPUT RESISTANCE	1KΩ
SWITCHING FREQUENCY Fsw	10,000 Hz

Using the design equations and considering the nominal value of capacitor Table.2 is obtained and substituting the values into the Simulink model the output response obtained is as shown in fig.4

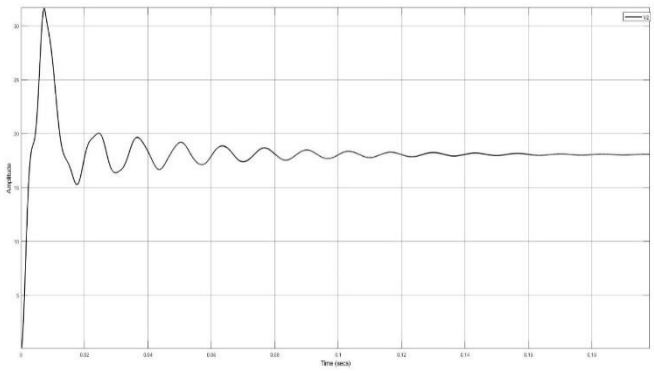

Fig.4 Output Voltage of zeta converter

From fig.4 we can obtain transient response parameters of zeta converter and it can be compared with the response of other converters. For zeta converter we can see that there are less transients in the output response.

IV. SEPIC CONVERTER

The single-ended primary-inductor converter (SEPIC) is a type of DC/DC converter that allows the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle.

A SEPIC is essentially a boost converter followed by an inverted buck-boost converter, therefore it is similar to a traditional buck-boost converter, but has advantages of having non-inverted output. For the simulation output voltage and input voltage are considered to be 18v and the switching frequency is 10khz.

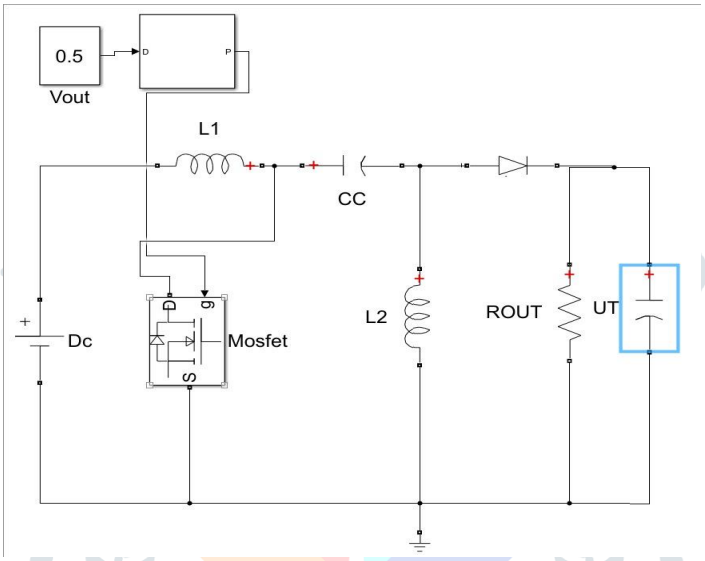

Fig.5 Simulink Model of SEPIC converter

The design equations are given below

$D=(Vout/(Vin+Vout))$
$L=(Vin*D)/(IL_{(pp)}*Fsw)$
$IL_{(pp)}=K*Iin$

Considering the value of k to be 0.25 for SEPIC converter

Table.3 Design parameters of SEPIC converter

INPUT VOLTAGE (V_{IN})	18V
OUTPUT VOLTAGE (V_{OUT})	18V
DUTY CYCLE (D)	0.5
INDUCTOR (L)	200mH
CAPACITOR (C)	1000μF
OUTPUT RESISTANCE	1KΩ
SWITCHING FREQUENCY Fsw	10,000 Hz

Using the design equations and considering the nominal value of capacitor Table.3 is obtained and substituting the values into the Simulink model the output response obtained is as shown in fig.6

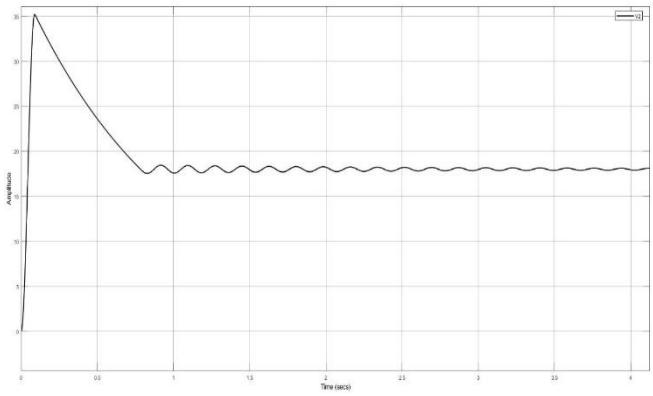

Fig.6 Output Voltage of SEPIC converter

From fig.6 we can obtain transient response parameters of SEPIC converter and it can be compared with the response of other converters. For SEPIC converter we can see that the settling time is more when compared to other converters.

V. COMPARASION

All the three converters are designed for a standard application needed and the simulation results are obtained in Simulink.

By analyzing the results obtained from the above-mentioned converter circuits, a comparison table (table 4.) is formed discussing various output parameters.

Table.4 Comparison table

Parameters	Buck-boost	zeta	SEPIC
Output voltage	Inverted	Non-Inverted	Non-Inverted
Peak overshoot	No	Moderate	High
Settling time	0.05	0.1	1.5
Output ripple	High	Low	Moderate

By referring to the above table and output response of various converters, it was seen that zeta converter proved to be the most effective for battery charging purpose since there is very low ripple in the output voltage and also it has less settling time therefore provides faster response.

Advantages of zeta converters:

1. Provides a non-inverted output.

2. Stable output response is obtained.

3. Low settling time therefore faster operation.

4. Fewer transients in the output response.

VI. CONCLUSION

The buck-boost, zeta and SEPIC DC-DC converters are designed for standard requirements and simulated in the Simulink. The results obtained are studied and compared for various parameters like settling time, output ripple etc., by which we can conclude that the zeta converter is best suited for MPPT and battery charging applications as the transient response of zeta converter is better than buck-boost and SEPIC converter.

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Design & Development of Water Management System

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Abstract:- **Undoubtedly, water is one of the most important resources on entire globe. No one including human beings, animals, plants and insects can live without water. Water is a scarce resource and it may deplete over coming years due to overuse. The bad quality, overflowing from tanks , leakage in pipes and inefficient usage of water are the main cause which leads to the wastage of water. So it is necessary to have control on water wastage and usage as well by introducing or building a system which will overcome the water wastage related issue using Internet of Things(IOT).**

Keywords:- Sensors, cloud storage, real time monitoring, microcontroller, Internet of Things (IOT).

I. INTRODUCTION

Recent development of Infrastructure, increase in population, leakage in pipes, uncontrolled usage and wastage of water, pollution, etc leading to scarcity of water is faced by human beings. So it is necessary to find the alternative system which can help to reduce the water wastage issues for which Internet of Things (IOT) is the solution which helps in building an automated system for real time water monitoring. Embedding different sensors with a micro controller we can create such a system using the cloud services for data storage.

As there is an uneven distribution of water across the city an automated system must be developed so that the water is distributed equally with equal pressure to the residents in the city. For checking the water quality the parameters like Ph, turbidity, temperature, TDS, etc. must be calculated. Level sensors are used to check the water level in tanks, pressure, flow sensors can be used to detect the leakage in pipes. The design of a water level sensor device is able to detect and control the level of water in a certain water tank. The system firstly senses the amount of water available in the tank by the level detector part and then adjusts the state of the water pump in accordance to the water level information.

There has been wastage of water daily through the pipeline leakages due to it full water were never arrived to the taps. The existing system are still lacking abilities to detect accurate estimation of water leakage in water tanks. The aims are to perform a small-scale study of existing pipeline leakage detection system, to develop a real-time prototype pipeline leakage alert system and to validate the proposed prototype through experimentation. Mobile phone can be configured as the alerts transmitter of the system to the user in case of water leaks.

II. LITERATURE REVIEW

A. Water Leakage System Using IOT [1]

In this paper, the flow of water through the domestic pipeline can be monitored, forecasted and visualize from anywhere in the world using internet through computer or smartphone. The collected data can be analyzed for making predictions to the users and also for demand management, asset management and leakage management. With the water as flowing liquid the system was tested successfully. The work can be extended to forecast data for larger communities with customer satisfaction involving low cost and better performance of the overall system.

According to the author of the paper, the proposed model to forecast and monitor the consumption of water basically consisted of flow meter, micro controller and cloud infrastructure. Hall effect based flow meter was used to measure the flow rate of the water and Arduinouno and Raspberry Pi acted as microcontroller based devices. The flow meter measured the flow rate of the water and generated a pulse signal accordingly. The flow meter was

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wired with arduino so as to sense the pulses from flow meter. The raspberry Pi which is a microcomputer receives the data from arduino microcontroller which is connected to flow meter and was programmed to read the arduino signal, process the data and store in raw data files. The raspberry Pi was programmed such that it processed the raw data and uploaded them into the web server. In order to process the request from large number of customers cloud interfacing was initialized. The end users via web interface were able to visualize the data. The data from the database would then be utilized by data prediction algorithm for making predictions as per the users. The request for the prediction comes from the users via the web interface.

So this paper provided us the result showing that the alert message would be sent after being recognized at certain level and then the user would acknowledge the message and act with actions. An experiment testing was conducted to see the results of how geophone sensor worked which was set up at the edge point of pipe which was connected to the circuit.

B. Smart Water Conservation and Management system using IOT.[2]

This paper has given a brief discussion about smart water supply across a particular area by harnessing the technological usage of IOT concept, simultaneously improving the water quality of the drinking water. This idea could be implemented by various government across the world to save water bodies from drying up caused by excess water usage. This system could also be implemented to reuse the water and also prevent water wastage. Purification and conductivity test of water also played a huge role in the welfare of public which could reduce the overall disease caused due to deficiency, thus creating a healthier society of people. This system was also further enhanced by including modules which improved the given situation further in order to prevent the excess usage of water and saving underground water. Water conductivity sensors were used in water-quality applications to measure how well a solution conducts an electrical current. This type of measurement assesses the concentration of ions in the solution. The more ions that are in the solution, the higher the conductivity, hence higher the impurities. The author also used a mineral cartridge to replenish the mineral content of the purified water from the substation. But the mineral cartridge expires due to the usage of minerals present in it. They took a survey based upon the mineral content intensity present in the tank of water and observed a constant decrease in mineral content over time and the mineral content depleted to zero after 4 months of time. Hence an intimation was sent to the user interface which warned the user to replace the mineral cartridge.

Mineral cartridges are used to control the mineral content of the purified water in substation. After the purification process, the water mineral content is reduced. This water is good enough for both commercial and industrial purposes but not apt for drinking and cooking purposes. Hence mineral cartridges are used at house level to replenish the mineral contents lost during purification processes. As said before, the use of mineralized water is way too low when compared to commercial purpose. Thus the installation of the mineral cartridge is based on specific needs and requirements. Thus by using model designed as per the author we can monitor the quantity and quality of the water as well as improve it by various controlled purification systems such as UV and RO processes and mineral replenishment.

C. An Internet of Things Based Model For Smart Water Distribution with Quality Monitoring [3]

Different sensors such as pH sensor, conductivity Sensor, temperature sensor are used for monitoring the water quality in this survey. The values from the sensor are uploaded to cloud by the raspberry PI controller through Internet channel at random interval. The reason for choosing the randomness is to avoid all the devices firing the request at the same time. These values can be monitored location wise in real time. If the supplied water is fresh and passed all the tests, even though water reaching to end points is contaminated then we can detect the source of problem e.g. if the supplied water is fresh but water reaching to end point is contaminated then we can find till which region or end point the water reaching is fresh and not contaminated, its means till that point there is no problem, the problem is thereafter.

Using this technique, we can monitor each end point for adequate water supply and immediately a necessary step can be taken for any type of problem. By this technique, we have control over each end point rather than having water valve controls society or area wise in the traditional system. The advantage of having control over each end point is that if any end point doesn't receive the water with adequate pressure, we can supply the water to that end point at a different time by turning off all other control valves within that area or society. Another advantage of this System is that we can turn off control valve when the predefined liters of water is supplied to the specific end point. In this paper, the model of smart water distribution with water quality monitoring is presented. The proposed system is created with the use of different sensors, Raspberry Pi as controller and Cloud for storing the data from Raspberry Pi and sending the command to raspberry PI for measuring water quality and controlling water distribution. The generated data can be viewed using web interface all over the world. The advantage of the system is to provide the adequate water supply with pressure and good quality water to each house, industry, and others. The proposed model can be implemented as a part of the smart city.

In future, proposed system can be made fully autonomous by embedding the artificial intelligence with some predefined set of rules and standard. With the use of Artificial intelligence, smart water distribution can be carried out automatically without human intervention. If any problem is detected in water quality, the system will automatically send a notification to remotely handled devices to carry out necessary steps by the authorized person or dedicated authorities. As per predefined interval, the proposed model generates data and sends it to cloud. Hence, proposed model generates a huge amount of data in the cloud. Therefore, some big data processing framework such as Hadoop framework will be required for analysis of

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generated data, for obtaining necessary information and generating the set of rules for training AI.

D. *Analysis, Design and Development of an IOT Based Water Management System for Residence [4]*

This paper describes a water management system design and construction details. Tank1 from the reserve tank
automatically turns the pump motor on / off. Tank 1 has two solenoid valves which automatically flows water in two ways. Go to one water filter tank and go to filter water and another tank2. Tank2 has a heater that on by pressing mobile apps button when it needs and turned off automatically, the temperature reaches 35 degrees Celsius and is displayed on the LCD display. It always gives normal water without pressing the mobile app on button. Using Arduino successfully using C / C ++ language, the program automatically allows the water level to be automatically turned on / off by sensing, stopping temperature, WiFi connected with mobile applications. As a conclusion, the system designed in this work is well performed.

There are some limitations of this system that is

(a) There are no features for water quality measurement,

(b) Water cooling properties are absent in this project.

In future, simulating this system there are several improvements can be made in order to upgrade the features such as-

(a) Temperature increment/decrement features can be added,

(b) pH meter can be used to determine the water quality.

The water level sensor in the water tank1 is submerged; it understands the high and low level of water and sends the data signal which connects the Arduino digital pin 2, 3, 4, 5. Then the water pump switch on the reserve tank based on the sensing of the water level reading which switching the relay module for the on / off switch and then switches on the relay module swing valve for water flowing on / off. Water pump connect to the ardino digital pin 12. Wifi Module's pin Arduino connectsthe digital pins 0, 1 for wireless communications. It connects the mobile app. pressing the button on the mobile app sent for the water heater which connects to the arduino digital pin 13 and the system instructions
were sent**.** An IC LM 35 is used for the temperature sensor project, which takes temperature from the current water temperature, which interacts on the Adobe board's analog pin A0, it creates an ADC that converts the reading to display in LCD which is connected to the pin with Arduino analog pin A4, A5 and then the relay module connected heat switching to 35 degrees Celsius. Open/Close the solenoid valve connect digital pin 11 which automatically in the flowing water. It always gives normal water without pressing the button on mobile applications**.** Water filter from the water tank1
and flow of the water is supplied depend on use of water.

Using the workflow author has done this project very smoothly because it is a serial process. For solving any problem or for any system development, the whole work should be handled in that segment so that accuracy can be provided. So, we have followed the workflow to increase accuracy. Due to the six-stage features and feedback scope system, this system used workflow. This workflow feature can return it to the previous step. We can return and correct the system at any time according to the requirement. In this workflow, before completing the next stage, each stage must be completed completely. Such a workflow is basically short and no uncertain requirements for the project. At each stage of determining whether the project is going on in the right direction and whether to continue or cancel the stage.

E. *An IOT Based Efficient Water Management System [5]*

In this work, an IoT based efficient water management system, measures the water levels and water quality in storage tanks. It also manages water dispensation and report generation through an user interface. The system also allows the water source at a particular location to be managed and monitored remotely avoiding water wastage and in turn, the water crisis. The whole system is tried out in a closed setup at present. The system will be implemented on a real scenario to test its whole effectiveness for the smart city setup. Internet of Things (IoT) is a happening technology which connects all objects in world to internet so that they can sense, communicate and share information interconnected over public or private network . This work aims to use IoT to develop an efficient water management system. The proposed system attempts to manage all the storage tanks and provide real time monitoring of water levels and water quality through a web application. It also integrates an alert system along with water distribution. It has sensors to sense the data, microcontroller to process the sensed data and some platform tools to store and display them. This paper describes the prototype system design, implementation and description of the tools and technologies of the IoT based efficient water management system. The next section gives a review of the existing literature.

The architecture of the proposed system consists of four layers. They are,

Physical layer: It consists of sensors to measure the water levels and water quality. At this layer, data is collected from sensors and sent to the control unit.

Network layer: It gets the sensor information and processes it using Raspberry Pi.

Administration layer: Data processed by the microcontroller is published to the cloud for storage and analysis.

Application layer: It is the client application that integrates with the cloud and helps to visually manage the system through an user interface.

The sensors are placed in all storage tanks of the city. The ultrasonic sensor measures the water levels whereas the PH sensor, turbidity sensor and conductivity sensor measure the water quality. Once the data is sensed by the sensors, it is processed and sent to the cloud. Carriots, an IoT platform streams the data from the control unit in JavaScript Object Notation (JSON) format which stores and analyses the data stream .It also allows to perform events, triggers, alarms and so on, as a response to the received data stream. All the water management activities are done through
the client web application with the help of Freeboard. It is a dashboard that acts as a data visualization tool. It receives the data stream from Carriots in JSON format by the data

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source configuration and visualizes according to its widget configuration. These widgets are automatically updated as data is streamed at Carriots using Rest API. Thus the client application allows real time monitoring and water management. Water management using the client application involves monitoring the water levels and water quality along with water dispensation. It also includes an alert system to alert the authoritative person when the water level goes beyond a certain threshold value and when there is abnormality in the water quality. Water dispensation is implemented by finding the nearest tank with available water. When there is no sufficient amount of water in the tank, the nearest tank is determined and suggestions are given to the authoritative person notifying him/her. Thereby, the system serves as an advisor during the water crisis. The system is also capable of generating various reports based on the available sensed data. They include,

A. Amount of water in each tank, thereby calculating the total
amount of water in city.

B. Amount of water consumption per area per month.

This water level monitoring, water quality monitoring, water dispensation, generation of reports together forms the IoT based efficient water management system.

The accuracy of the system is achieved using sensors. Ultrasonic sensor provides the water level measurement with millimetre precision. It also allows the water level to be updated for every millisecond. The water quality is determined accurately as a combination of PH, conductivity and turbidity sensors are used. Raspberry Pi is used as a microprocessor considering the following parameters: RAM, clock speed, input voltage required and processor. So the chosen sensors and microprocessor gives high performance to the system.

F. ***Smart Water Monitoring System Using IOT At Home [6]***

This designed smart water system can be easily applied to home, offices, and schools and at any places where water tanks are used. By placing this system in a smart building, we will be able to collect and analyze the water usage patterns of the residents and save a lot of water from wastage. This is the small contribution from our side to save and supply good quality of water. he system can monitor water quality automatically, and it is low in cost and does not require people on duty. This system is used to avoid the huge amount of water is being wasted by uncontrolled use of home/offices etc. So the water quality testing is likely to be more economical, convenient and fast.

In water tank level monitoring system for monitoring the level of tank we use the ultrasonic sensor. An ultrasonic sensor is a device that can measure the distance by using sound waves. In water level monitoring the transmitter send the sound waves and receiver receive the signal. By using following formula we calculate the distance.

*Distance =(speed of sound*time taken)/2*

In our system we consider that the height of our tank is 30cm. To avoid the wastage of water we use the automation for the motor. If the water level is less than 20 % then microcontroller send the +ve signal to the relay and relay automatically gets ON and motor will be get started. If the level of water tank is greater than or equal to 80% then microcontroller send the –ve signal to the relay and relay will be automatically gets OFF then motor also gets OFF. In this both the situations the GSM send the message to the user. If the level is less than 20% then it will send the message Alert: level is 20. If the level is greater than or equal to 80% then it will send the message like Alert: level is 80.

Water quality monitoring system is very important for measure the quality of the water. To measure the quality of water we use the pH and the temperature sensor. The pH stands for “Potential of Hydrogen,” referring to the amount of hydrogen found in water. pH is measured on a scale that runs from 0 to 14. 7 is neutral, meaning there is a balance between acid and alkalinity. A measurement below 7 means acid is present and a measurement above 7 is basic (or alkaline). The second parameter is a temperature. Temperature will also affect the equilibrium and the pH. In pure water, a decrease in pH of about 0.45 occurs as the temperature is raised by 25 °C. The pH probes were kept and temperature sensor in the water for two minute and recorded the pH value and temperature value that was displayed on the meter screen on Labview. In this water quality monitoring system if the value of pH sensor is greater than 7 then it will be send the message to the user and if the temperature is greater than 50 then also the GSM send the message to the user.

In the water pipe leakage detection system for detecting the leakage we use the flow sensor to measure the flow of the water. In our system we use the two flow sensors for measure the flow of water. If the flow measured from first flow sensor and flow measured from second flow sensor is not equal that means the leakage is present in our system. If the leakage is occurred in system then the GSM send the message to the user that is Alert: Leakage is detected.

In this system the microcontroller is the core component which controls all the devices those are connected to the microcontroller. Ultrasonic, pH, temperature, flow sensor, motor, 22 GSM is connected to the microcontroller. Microcontroller sends the data to the computer through the USB connector. Motor is used to fill the empty tank. If the tank level is below 10% then motor automatically gets ON and if tank level is greater than 80% then it will be gets OFF. The relay is used to control the functioning of motor. Relays are switches that open and close circuits electromechanically. Relay controls one electrical circuit by opening and closing contacts in another circuit. In model the coding of required component is written in Arduino IDE. In this the output can be shown on serial monitor. The author has connected microcontroller to the computer through USB cable and then measured the data measured by sensor. System runs on battery power and comprises of four sub circuits working synchronously; sensor circuit, controller circuit, SMS circuit and relay driver circuit. Sensor senses the level of the water in tank which is continuously fed to controller system. As the system encounters the empty level condition, status of load shedding is checked. Relay coil is energized and the pump operates when there is no load shedding.

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G. IOT Based Water Monitoring System: A Review [7]

This paper is presented the design and development of IoT based water monitoring & control system .For this some sensors are used. The collected data from the all the sensors are used for analysis purpose for better solution of water problems. The data is sends to the cloud server via Wi-Fi module ESP8266. So this application will be the best challenger in real time monitoring & control system and use to solve all the water related problems.This paper propose a more efficient water monitoring and control system for water utility to reduce the current water wastage problem. This approach will help utilities operators improve low cost water management systems, specially by using rising technologies and IoT is one of them. The Internet of Things (IoT) could prove to be one of the most important methods for developing more utility-proper systems and for making the consumption of water resources more efficient.

This study discusses the design and current development of system having low cost to monitor real time values and also to control the system using IoT. To measure the various parameters of the water, array of sensors are included in the system. The parameters which can be measured are like temperature, PH, turbidity of the water. Core controller can process the value measured from the sensors. The Arduino Uno model can be used to control the system. Lastly, to access the sensor data on internet, cloud computing can be used.

Relation with IOT: In past, the living of individuals has been changed due to the Internet. The IoT has been became an emerging research area because of need of an establishment for connecting things, sensors and other smart technologies. IoT is known as internet's advanced version. Information related to physical objects can be immediately accessed by IoT and results into novel system having high efficiency and outputs. In IoT, a number of main technologies are there like ubiquitous computing, RFIP, wireless sensor network, cloud computing. Cloud computing, a large-scale, low cost processing unit and also an IP based connection mostly used for calculation and storage purpose. The water quality monitoring application contains many distributed monitoring sensors' array and a wide distribution network. Separate monitoring system is also required in it as told in paper .This paper introduces cloud computing techniques for screening values on the internet.

The hardware of the proposed system consists of Arduino microcontroller development board, Ultrasonic Sensors, Turbidity sensor, pH sensor ,Wi-Fi module to collect & transfer data to cloud. Data is collected from different types of sensors mentioned above by using Arduino Uno microcontroller. Arduino is a open source hardware platform which is able to work with various sensors and communication technology. There are different types of Arduino microcontroller that are used for different purpose. It not only control devices but also can read data from all types of sensor. It is simple, low cost and easy to use. It takes 5V voltage as input speed 16 MHz .Arduino Uno contains the 14 digital i/o pins and 6 analog input pins to connect various sensors that gives analog inputs. The Raspberry Pi is a Quad-Core 64bit CPU, WiFi and Bluetooth. Raspberry Pi 3 Is the 3 Raspberry Pi[13]. It is a credit card sized board computer which is used for multiple applications. Although maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processor, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected.

This system will be built using Arduino Uno and Node MCU. Arduino Uno is connected with Water level sensor(HCSRO4), Turbidity Sensor, pH sensor, Wi-Fi module (ESP8266) that process and transfer sensed data to cloud. . And other side ultrasonic sensor connected with Node MCU. This stored data is accessed by users. This enables the user to check the level of water and if it goes full then automatic stop. Other parameters related to water like water quality can also monitored for prevent wastage of water.

H. Water Management System Using IOT [8]

This paper presents an IoT device which helps to manage and plan the usage of water. This system can be easily installed and maintained for long run. The Laser sensor is placed on the tank which continuously monitors the water level in real time. This information will be updated in the cloud and user can analyze the amount of water. According to the level of water in the tank, the motor functioning is automatically controlled. When the water level falls below the threshold level the motor will be again turned on automatically. Overflowing water tanks in residence, schools, colleges, Municipal overhead tanks, Hospitals etc. can contribute to the massive amount of water wastage. If we can control this we can save large amounts of water. Conventional water tanks can neither monitor nor control the water level in the tank. As of now, the water level has to be manually checked and refilled according to the requirements.

So in this paper, the above mention problems are solved with automatic water level detection and refilling of water storage system with the help of Internet of Things (IoT). Presented here is a Water Management System using IoT. Water level indication, automatic water pump on/off, etc are carried out by this project.

Laser sensor used in this project is VL53LOX for precise level indication. The issue of water scarcity is becoming more prevalent. The IoT enabled water management solutions like this use sensor to collect data and share data to the cloud.

The transmitter section consists of an Arduino, HC12 transmitter, laser sensor, and NodeMcu. In the automatic water level detection and refilling of water storage system, the sensor used is Laser sensor which is a replacement of ultrasonic sensor because of its accuracy and small size.

The Laser sensor is used to detect the water level. The Laser sensor is placed above the tank which continuously monitors the water level in real time. This information will be updated in the cloud and user can analyze the amount of water. These sensor values are sending to water pump via the HC12 transmitter to turn on/off the pump. The sensor values are also forwarded to NodeMCU which is used for the IoT purpose. NodeMCU connects the system to a cloud storage. Here we use Adafruit cloud platform. The platform is designed in such a way that it will show the instantaneous value of current status of water. The water level measured

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by sensors is sent continuously to NodeMcu and forwarded to Adafruit cloud, it gives a graphical representation of water level from which we can analyze our water usage.

The receiver section consists of Arduino Uno, relay, HC12 receiver and a motor. According to the value received from the sensors about water level to HC 12 receiver, the motor will automatically turn on/off to pump the water to the tank. Depending on the water levels, as described above, the status of the motor will be automatically controlled. If the water level is in between maximum and minimum level set, then the user can control the status of the motor from the Adafruit cloud platform. Buttons ON and OFF have been provided for the same.

In the automatic water level detection and refilling of water storage system, the sensor used is Laser sensor which is a replacement of ultrasonic sensor because of its accuracy and small in size. The sensor is placed on top of the tank facing downwards. The Laser sensor is used to detect the water level. Nowadays liquid level monitoring is vital in many industries too like oil, automotive etc. Using our smart system we can analyse the usage and also detect the leakage in the tanks of these industries.

I. IOT Based water Management System For Smart City [9]

This paper will demonstrate the successful implementation of an internet-based approach to measuring water quality and usage on a real-time basis. A flow sensor for measuring of quantity supplied, eliminating the drawbacks of traditional water metering systems. Future enhancements can include prepaid billing and automatic treatment of water based on the nature of contamination. Water metering system will be used for automated billing, eliminating the drawbacks of traditional water metering systems. This novel idea can be further extended to other areas like oil and natural gas monitoring systems. During the past decade, water needs have increased unpredictably in India. Increasing demand of water supply has become a major challenge for the world. Wasteful usage of water, climatic changes and Urbanization has further depleted the resource. Conservation and management of the resource must be given utmost importance. In this paper, we present an IoT design for water monitoring and control approach which supports internet based data collection on real time bases. The system addresses new challenges in the water sector -flow rate measuring and the need for a study of the supply of water in order to curb water wastage and encourage its conservation. We also measure the quality of water distributed to every household by
deploying pH and conductivity sensors. The traditional water metering systems require periodic human intervention for maintenance making it inconvenient and often least effective. For shortcoming of the existing models for a ubiquitous usage of
wireless systems for smart quality monitoring and communicate data wirelessly.

This system can be implemented on water tanks for safe and waste less consumption. Water when supplied from the reservoir to tanks then the pH level of water will be checked, if it comes in required range than the conductivity of water will be checked. If pH or conductivity of water will not be in safe range than the water will not be supplied to household tanks and valves will be closed. The Same procedure will be followed till water does not come in safe range. After the satisfactory quality check of water if the tanks are full than valves of the tank will be opened and water will be distributed. During distribution of water rate of flow is measured so that equal distribution is done. This whole data is sent from Wi-Fi to the Web page so that system can be accessed remotely from a computer. The flow of distribution and quality of water both will be monitored from the web page which can be displayed anywhere using the internet.

Electrical conductivity is also an indicator of water quality. It measures free chlorine without sample pretreatment. It does not have messy and expensive reagents needed. Conductivity data can detect contaminants, determine the concentration of solutions and determine the purity of water. It is Compact in size. Conductivity sensor measures conductivity by AC voltage applied to nickel electrodes. These electrodes are placed in a water sample and reading is obtained.

III. EXISTING SYSTEM

In the existing system, it starts with the distribution of water in the city with the help of stepper motor receiving signals from microcontroller for ON/OFF, leakage detection is carried out by pressure sensors and quality parameters like pH, temperature, turbidity are measured through using different sensors like pH sensors, temperature sensors, conductivity sensors, etc. And at the tank level of water is measured by using ultrasonic sensor and indicating the level by using the led lights.
The drawbacks of the system:
The notification is not sent to the government officials & users about the distribution of water, leakage is not effectively detected in pipes. The system is partially implemented & not that effective.

IV. CONCLUSION

This paper presents the design and development of real time water monitoring system with all the advanced methodologies. Additionally, a combination of all these advancements is not an
impossible task and can be effectively completed. Looking towards further modifications in case of more enhancements, the data stored from Smart System analysis can be used as a platform for
future plans and new strategies at any instance of time via smart terminals connected. Further changes will be made to make this system more cost effective and more firm for deploying in different areas.

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Review of Methods for Automatic Segmention of Brain Tumor in MRI Images

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***Abstract* —Efficient early detection of Brain tumors enable effective therapy thereby increasing survival rates. Even with growing progress in medical technology, brain tumor detection is an extremely complex task. The segmentation, detection, and extraction of infected tumor area manually from magnetic resonance (MR) images are effective but is a tedious and time taking task performed by radiologiest, which is based on their experience in the field. There are numerous automatic techniques which help in detection of brain tumor with higher degree of accuracy. However, the process of automatic detection and classification varies from technique to technique. Currently there is no particular reliable method widely accepted for tumor detection therefore automatic and reliable methods for tumor detection are of great need and interest. This review paper provides an overview of different methodologies practiced and the best technique adopted for higher accuracy in detecting tumors.**

Keywords—Pre-processing; Feature extraction;segmentation; Brain tumor detection; MRI image;

I. INTRODUCTION

Brain Tumor, the word tumor referred to as neoplasm, means the abnormal expansion of the tissues. Brain tumor can be an abnormal mass of tissue through which cells grow and multiply uncontrollably, unchecked by the mechanisms that control normal cells.Tumors are of two types, Benign and malignant. According to the World health organization, there are different grades(1 to 4) for these tumors. Tumors of grade 1 and 2 are low-grade tumors while the Grade 3 and 4 means the tumor is of malignant type and is high-graded tumor and this may spread to other parts of the brain and spinal cord and can be fatal. [1].

Nowadays, brain tumor is one of the main reasons for increasing mortality. As the number of patients to treat increase, tools and methods to detect, extract the tumors and also to analyze their behavior exponentially increase. Magnetic Resonance Imaging (MRI) is used to obtain high-quality images from all over the body and tissue and to ability of the MRI to detect the smallest details within the body. Through high-resolution imaging MRI, we can infer anatomical information and find out where abnormalities are. This technique has a great ability to detect differences in tissue and structures and is better than CT for the detection of the size of the tumor in the brain.

The brain images obtained using MRI are prone to noise and artifacts such as labels and intensity variations during acquisition. In addition, there are many structures in the brain image such as cerebrospinal fluid, grey matter, and white matter and skull tissues apart from the tumor. Thus, the output MRI Images need to be subjected to a few processes in order to obtain accurate location of the tumor using automatic techniques.

Figure 1 shows the stages in the brain tumor detection and they are[12]:

1. Image Preprocessing
2. Image Segmentation
3. Feature Extraction
4. Feature Selection
5. Classification Algorithms

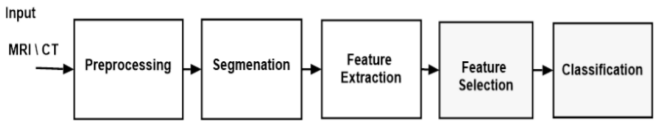

Figure 1- Stages of Brain tumor detection

Preprocessing is the primary step that is applied on MRI image. This step is implemented either to reduce the noise,to reconstruct an imagethen some morphological operations are applied to detect the tumor in the image.Image segmentation is the process of segregating a digital image into segments based on similar characteristics.A label is assigned to every pixel in an image so that pixels with the same label share certain characteristics. In feature extraction, an initial set of raw data is reduced to more manageable groups for processing.

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Feature selection is for filtering irrelevant or redundant features from the dataset.And finally, Classification is to categorize the tumors. All these stages involve different techniques which can be adopted.

II. PROPOSED METHODS

The different existing methods are studied to detect the tumor in brain using MRI image. To detect a tumor first thing is to get the MRI scanned image, then preprocessing and enhancement is done. On preprocessed image,segmentation is applied to identify the abnormal portion of the image. Then feature extraction is used to reduce set of features. At last different classifier is applied to detect and classify the tumor.

A. Image Processing and Enhancement

In pre-processing different techniques are applied such as image enhancement, scale changing, noise removal etc. Each frame of the image is converted from RGB to Gray. Gray scale image enhancement aim is to improve perception of details in images preparing the images suitable for further process. Contrast enhancement process is used to improve the visual details of the image. It has grouped into two i.e. direct and indirect methods.

Spatial resolution and contrast of the image are affected by the noise. Different filters are used to remove noise from the image such as Gaussian filter, median filter and wiener filter. Basic operation of mathematical morphology is that the process of images supported on shapes. There are four mathematical morphology, they are dilation, erosion, opening and closing[2]. An elimination of non-cerebral tissues and unwanted portions of image from the scanned image using a process called Skull striping and is based on threshold operation[3].Histogram equalization process helps in improving the contrast of the image and also which will improve the feature extraction[4]. After image is preprocessed, then the preprocessed image is segmented.

B. Image Segmentation

The aim of the image segmentation is to divide a medical image into different regions and to extract the area of interest. There are different methods used for segmentation purpose. Region based method used to get the object boundary from the image and this mainly depends on similarity of intensity of pixels in an image and watershed comes under this, it is a transformation defined on a grayscale image. In edge-based segmentation, an edge filter is applied to the image, and then pixels are categorized as edge or non-edge depending on the filter output.

Clustering is important unsupervised learning problem, so it helps in finding a structure in a collection of unlabeled data. The most frequently used clustering algorithms are K means clustering algorithm and Fuzzy clustering algorithm. K means algorithm is based on unsupervised technique and human intervention is not required in diagnosing the tumor[5].Fuzzy algorithm used in pattern recognition and fuzzy modeling, is applied for analysis based on space it takes between varieties of input data points[5].Hierarchical segmentation is the region boundaries are maintained at the full image spatial resolution for all segmentations.

Thresholding method is the most often used method. This method is used based on the threshold value to turn a gray scale image into binary image[2][4].Fast Bounding Box Technique (FBB) is an automatic algorithm which is very fast segmentation technique and can locate bounding box which is rectangle axis-parallel around the tumor on MRI image[6] .Graph based method; Region growing method andManual based are the some segmentation methods. Then the feature extraction is done from the segmented image.

C. Feature Extraction

The main objective of feature extraction is to minimize the original data set based on the specific characteristics that classify and identify different input patterns. The best-known feature extractions are local binary pattern (LBP), grey-level co-occurrence matrix (GLCM), canny edge detection, and a bag of words (Bow). A GLCM contains details about the positions of pixels having similar gray level values[1][7]. Classifications of Feature Extraction divide into three main groups i.e. Global Transformation and Series Expansion, ROI Level segmentation, GLCM Texture Features. Global transformation contains Fourier transforms and different wavelet.The discrete wavelet transforms (DWT) being a powerful tool for feature extraction was used[8][9].Discrete wavelet transform is used with extraction of texture and GLCM features in some case.

In some paper SROIs is used with the feature reduction using PCA[10]. GLCM is the most used extraction feature. Once the Feature extraction is done then that image is classified by neural networks and some algorithms.

D. Classification Technique

By automatic and semi-automatic techniques identification and separation of the brain tumors can be done. Artificial neural networks are the intelligent based systems. Some of the techniques like Fuzzy C-means, SVM algorithms, Feed Forward Neural Network, KNN algorithm, Self-organizing Map Algorithm etc. are the leading non-intelligent techniques. Better results can be achieved by combining these algorithms. Probabilistic neural network is most often used and it's a feed forward neural network. And it is employed in analysis and pattern recognition problem [1]. Statistical approach is done using ANN[7][10].To classify the detected tumor according to its malignancy level is done by SVM algorithm. SVM algorithm is best approach than KNN & other algorithm which gives a better accuracy than other. The limitations of neural networks can be overcome by SVM algorithm and the combination of SVM with different neural network gives the best result in classification [3][6].

Different methodologies are studied to detect a brain tumor. By observing we can select a best method which is most accurate and effective to detect a tumor from the MRI image.

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II. ANALYSIS OF DIFFERENT METHODOLOGIES

A. *Image Preprocessing* [11,12]

There are many techniques used to reduce noise,

1. ***Contourlet transform[13]***

This method is used to efficiently approximate images made of smooth regions separated by smooth boundaries. This method is a multi-resolution directional tight frame designed to do the same. This method has a fast implementation based on a laplacian pyramid decomposition followed by directional filterbanks to apply on each bandpass sub-band.The contourlet transform uses a double filter bank structure so as to get smooth contours of images.

In this double filter bank, the Laplacian pyramid (LP) is first used to capture the point discontinuities, after which a directional filter bank (DFB) is used to form those point discontinuities into linear structures.

Advantage

- Used to remove noise in MRI image.
- It removes Gaussian noise present in the MRI image.
- Reduces edge blurring by giving more significance to pixels near the edge.

Disadvantage

- It is rarely used because of losing required details in image.
- Time consuming[11]

2. ***Gaussian filter[13]***

Gaussian filter is a linear filter which is used to blur the images and remove unwanted noise and further detailing.

If two of them are subtracted, it can be used for "unsharp masking" (edge detection). The Gaussian filter alone can be used to blur edges and reduce contrast.The distribution is assumed to have a mean of 0.

The one advantage a Gaussian filter has over a median filter is that it's faster because multiplying and adding is probably faster than sorting.

Advantage

- Used in directionality, Multi Resolution, localization, critical sampling.
- Its basic functions are Multi-scale and multidimensional.

Disadvantage

- Highly sensitive to weak boundaries, noise, low contrast between regions, Pseudo Gradients.
- It leads to leakage of boundary or development of false gradient in heterogeneous regions.[11]

3. ***Median filter***

The median filter is normally used to reduce noise in an image, similar to the mean filter. However, it does a better job than the mean filter by often preserving useful detail in the image.

Like the mean filter, the median filter also considers each pixel in the image inturn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of replacing the pixel value with the *mean* of neighbouring pixel values, it replaces it with the *median* of those values thus being more useful than the mean filter.

The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and further replacing the pixel being considered with the middle pixel value. If in case the neighbourhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.

Advantage

- Uses nonlinear Noise from the Image that can be extracted using Digital filtering technique.
- It can preserve sharp features in an image.

Disadvantage

- It is difficult to analyze.

4. ***Anisotropic Diffusion filter***

High-frequency noise is present in magnetic resonance images and needs to be removed by a filtering process. The anisotropic diffusion filter (ADF) is proposed in various filtering applications to adaptively remove the noise, maintaining the image edges. However, when used for the first time, ADF methods still produce unsatisfactory results.

While previous ADF implementations used the gradient of the strongest edges or the standard deviation of a planar region (i.e. without any edges) for filtering, it is proposed a novel approach with improved parameter estimation based on both edge and planar region, overcoming some of ADF important limitations.

Advantage

- Widely used for MRI image enhancement.
- It retains sharp features and edges in the image.
- Reduces contours and noise in Image.

Disadvantage

- Not optimal for varying noise.

B. *Image* Segmentation[11, 12, 13]

There are many techniques used for segmentation,

1. ***K-Means Cluster Algorithm*** [11]

In most of the algorithms that are existing K-means Cluster algorithm is one of the extensively used. K-means algorithm is one of the simplest and effective ways used in the solution of clustering problems and it is a method that's supported the concept that the gravity centers of the cluster elements represent the cluster. Since this algorithm is mainly based on unsupervised technique.

Hence in this technique human intervention is not required in diagnosing the tumor. It reduces the distance of each element to centre point of the cluster.

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Once the cluster is created it upgrades itself and runs in a loop.
Hence the algorithm will be tested in domains and outcome of the test will be analyzed with standard data sets.

Advantage

- This concept will be useful to treat inputs of the data and analyze data.
- The objects will depend on a variety of data points, location and distance between them.
- Can analyze the regions effectively

Disadvantage

- Not good for noisy, non- uniform and high intensity images inputs.[11]

2. ***Fuzzy Clustering algorithm***[11,14]

Fuzzy clustering may be a sort of clustering during which each datum can belong to quite one cluster. It's a sturdy characteristic for ambiguity and may retain far more information than arduous segmentation methods. Fuzzy clustering is successfully used in pattern recognition and fuzzy modeling.
There are various common methods used to categorize classes based on the statistics and the application. Common measures for example distance connectivity and intensity are used. Its usage is in data analysis, pattern recognition and image segments. Most superior method in representing relationship between input pattern pixels and clusters naturally is by using fuzzy clustering. A hard cluster is more flexible than the other methods.
The algorithm is applied to treat annotations of the data and analyze data. The objects are based on the distance between several data points and location. Each cluster is has a center point known as centroid. For overlapping clusters this method will not be successful. Such types of clustering will come under hard clustering.

Advantage

- Can perform better for detecting tumor accurately and approximately.
- Better contrast and good brightness can be achieved.
- This algorithm is applied for analysis based on space it takes between varieties of input data sets.

Disadvantage

- Time taken is moderate

3. ***Contour and shape-based methods***

A contour and shape-based method is initially mentioned in proximity to the required boundary. Later this method adjusts the contour along with the destination edge in line with the minimization of pre-defined specification criteria. An automatic segmentation technique uses past knowledge regards to search out the form of the destination object. This technique starts with a superficial boundary shape which constitutes similar shape of a curve. To spot object boundary from an image it suggested the primary contour and shape-based method. By reducing an energy function the distortion of the contour is restrained. The energy function contains internal and external energy items. The smoothness of the contour is controlled by internal energy. The essential features like axial shape, texture -based information, gradient etc. in the image domain are extracted using contour-based technique.

Advantage

- It will control Cavities, concave-ties, convolution, splitting or merging.
- Tuning is simple and easy.

Disadvantage

- It will add unwanted information like noise in the image.
- It leads to blurring, weak boundaries, edges and reduced contrast.[11]

4. ***Region growing method***[11]

Region growing technique is mostly used and implemented technique for image segmentation. This method mainly works on the prior knowledge which is used to extracts the useful information in image region. This relies on intensity details or edges within the image. This may be done by hand selecting a seed point and joining all pixels, in order that all the pixels are connected from initial seed drew on some pre-determined criteria.
This idea is to start out with set of seed points of voxels inside the region to be segmented that are manually selected.
The pixels which are approximate have similar gray values and this approach is especially wont to exploit the important factor. This technique is to locate the input image data within the regions which are the set of connected pixels supported the factors which test the properties of the local group of pixels. The pixel are often selected neither by its properties of statistics of its neighborhood nor by its distance from the seed points. This method is free from the seed point. Region growing is also free from noise and all the pixels are interconnected without any discontinuity.

Advantage

- It removes over and under segmentation

Disadvantage

- Selection of Seed is difficult.
- Execution time is high and more

5. ***Graph- based methods***[11]

A graph may be a representation of a group of objects, where pairs of the object are connected by the links. It is a mathematical structure and is employed to model pair wise relations between objects. Graph-based method has gained more attention in image segmentation of brain MRI image.
It uses front and backend seeds to locate the brain MRI image objects and with local pixel pair wise similarities enhances the accuracy in graph-based segmentation compared to other methods. It employs many techniques, out of which Graph Cut (GC) is

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most frequently used and along with-it Random walker and Geodesics shortest path methods are some of the other frequently used methods.

Graph cuts are just a minimum cut on a given graph. The goal is to phase the main objects out of an image employing a segmentation method based on graph cuts.

This cut segments images into two regions, because the minimum cut is corresponding to the utmost flow and many graph cut algorithms actually that compute the maximum flow instead of the minimum cut.

Advantage

- It deals with both spatial information and feature features

Disadvantage

- It fails when multiple objects are used.

6. ***Thresholding method***

Threshold-based method is a simple and most effective segmentation technique. This is often the foremost used method and is used based on the threshold value to turn a gray scale image into binary image.

It is a technique for partitioning image directly region based on intensity value or property of these values like intuitive property simplicity of implementation and computational speed. The binary image should contain the information about the position and shape of ROI. By estimating a threshold value for the different regions from the intensity histogram local thresholding can be determined.

So, the edge values of local thresholding are identified by using the local statistical properties like mean intensity value, by the prior knowledge and by calculating partial volumes for each region to determine the brink for the segmentation of each component. And also, the Gaussian distribution was applied to spot the thresholds in normal MRI image.

Advantage

- Images with same intensity better performance, high contrast and different gray value among object and background.
- large computational efficiency and accuracy

Disadvantage

- Correlation of pixel is not important, because of noise present in the image. [11]

C. ***Feature Extraction [11,13,12]***

The best-known feature extractions are

1. ***Local Binary Pattern(LBP)***

It is known for its simplicity and efficiency in texture operation and it labels the pixels of image by thresholding and considers result as binary number. It has discriminative power and computational simplicity.Therefore, LBP texture operator is very popular approach in different applications.

It is considered as combination of the traditional divergent statistics and structural model of the texture analysis. The property of the LBP operator in the real applications which is an important property is that it is robust to the changes caused by monotonic gray-scale like the illumination variations. Other important property is that it is computational simple, that's what makes it to analyze the images in challenging real-time.

Advantage

- Computational simplicity
- Good performance
- High differentiating power

Disadvantage

- Less speed because of long histogram
- Miss out the structure because they do not consider effect of center pixel
- Noise sensitivity is high

2. ***Grey-level co-occurrence matrix (GLCM*) [11]**

It is a statistical method that examines the texture which considers spatial relationship of pixels and this is also known as grey –level spatial dependence matrix.

GLCM function characterizes texture of the image that calculates the frequency of occurrence of pairs of pixels with a particular value and in a particular spatial relationship in that image, creates GLCM and then it extracts the statistical measures from that matrix.

Advantage

- Excellent method for image Texture Analysis.
- Textural properties can be calculated to know the details about the image.
- It is a statistical method which is based on the gray level value of pixels

Disadvantage

- Seed selection is more difficult.
- Execution time is high and more.

3. ***Canny edge detection***

It is anoperator that uses multi-stage algorithm that detects a wide range of edges in the images. It takes gray scale image as an input and produces image as output which shows the positions of the tracked intensity discontinuities.

It works in multi-stage process. The image is smoothed by Gaussian convolution at first and then the simple 2-D first derivative operator is then applied to the smoothed image that highlights the regions of that image with first spatial derivatives.

Edge gives rise to the ridge in gradient magnitude image. The algorithm is then tracked along the top of those ridges and then it sets all the pixelsto zero that were not on the ridge top and gives a thin line in the output, this process is called as the non-maximal suppression.

The tracking process is exhibited in form of hysteresis which is controlled by the two thresholds: T1 and T2, where T1 > T2.

The tracking can only start at a point on the ridge that is higher than that of T1 and then the tracking continues in both the directions from the point until the height of the ridge falls below threshold T2. This

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hysteresis helps us to understand that the noisy edges are not broken up in to multiple edge fragments.

Advantage

- Immune to noise in environment.
- With the presence of Gaussian filter, it helps to remove noise in image.
- Effectiveness can be adjusted using parameters.

Disadvantage

- It consumes lot of time due to complex computation
- Application on real time systems is difficult.

4. ***Bag of words (Bow)***

Bag of words is a very good natural language processing [NLP] technique of text modeling. Wherever this NLP algorithm is applied, it works on numbers. So, we cannot directly feed our text into NLP algorithm. Hence, BOW model is used to preprocess the text by converting it into a bag of words, which will keep an account of total occurrences of the most frequently used words.

Advantage

- Very simple
- Easy to implement

Disadvantage

- It leads to HD vector because of large size vocabulary
- It assumes all the words are independent of each other

D. *Classification techniques [11,12,13,15]*

Some of the techniques like

1. ***Fuzzy C-means***

Fuzzy clustering is also called as soft clustering or soft k-means. It is a form of clustering where each data point will belong to more than one cluster.

It involves assigning data points to clusters so that items in the cluster are as similar as possible and items of different clusters are as dissimilar as possible.

So, clusters are identified based on similarity measures. The similarity measures may include distance, connectivity and intensity. The similarity measures may be chosen according to data or application needs.

It is one of the best and most widely used fuzzy clustering algorithm in the fuzzy C-means clustering algorithm.

Advantage

- Gives good result for overlapped data sets
- Efficiency is better than K-means algorithm

Disadvantage

- Takes more time because of more iterations involved
- Euclidean distance measures can unequally weight the factors. [11,14,15]

2. ***SVM algorithms***

SVM algorithm is also called as Support vector machine. It is a supervised learning models that analyze data using classification and regression analysis. It is a popular machine learning tool.

In SVM we plot every data item as a point in n-dimensional space, where value of each feature being the value of a particular co-ordinate. Then, the classification is done by finding out hyperplane that will differentiate two classes of data sets. So, SVM is simply the co-ordinates of individual observation.

SVM chooses the extreme points of data sets that are plotted in n-dimensional plot that will help in creating hyperplane. These extreme points are called support-vectors, so the name of the algorithm is SVM algorithm.

Advantage

- It is more effective in higher dimensional spaces
- It is more efficient
- Effective when number of dimension is more than number of samples

Disadvantage

- Not suitable for large data set
- Do not work well when there is noise in input [11]

3. ***Feed Forward Neural Network***

It is also called as Multi-Layered Network of Neurons (MLN). It is called as feed forward network because the information travels only in one direction i.e forward,from input nodes, through the hidden nodes (if any) and to the output nodes. There are no cycles or loops int the network.

It is a type of artificial neural network where connections between the nodes do not form a cycle. It was the first and simplest neural network devised.

Advantage

- Ability to solve more complex representation
- Good for making network deeper in sorting

Disadvantage

- Prone to over fitting
- Takes more time [14,15]

4. ***KNN algorithm***

K-Nearest Neighbor is one of the simplest-algorithm which is used in machine learning. It assumes the similarity between the test data set and the available cases and add the test case into the category that is most similar to the available categories.

This algorithm can be used for both classification and regression analysis but it is most likely to give better output for classification problems. It is a non-parametric algorithm which means it will not make any kind of assumptions for underlying data.

It is also called as lazy learner algorithm because it will not learn for any of the training set available, but it instead it stores the dataset and at the time of classification, it performs action on the dataset.

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This algorithm at the training phase just stores the dataset and when it gets new data, then it classifies the data into the category that is similar to the test data.

Advantage

- Simple to implement
- New set of data can be added easily to update the model
- No training period for it

Disadvantage

- Sensitive to noise and missing value
- Does not work well with large set of data
- Does not work well with High dimension data set. [11,15]

5. ***Self-organizing Map Algorithm***

Self-organizing network is a type of ANN which is trained using unsupervised learning to create a low-dimensional (usually 2D), discrete representation of the input space of training samples, which is called map, so it is the method that does dimensionality reduction.

Self-organizing map differ from other artificial neural network as it applies competitive learning but not error-correction like what different algorithm does.

So, by this SOMs are useful for visualization by creating low-dimensional views of high dimensional data.

It has two layers, i.e input and output layer (reduced map dimension layer). It does not use back-propagation for updating the layers but instead used competitive learning.

Advantage

- Easy to understand
- Easy to observe similarity in data
- They can be trained in short period of time

Disadvantage

- Requires necessary and sufficient data
- Often difficult to obtain perfect mapping [15]

III. CONCLUSION

Various pre-processing methodologies are used to reduce the imperfections in the image. Image Re-sampling, gray scale contrast enhancement, noise removal. For noise removal the median filtering technique is used , for image enhancement the edge detection is preferred for the images that have low level of contrast and then post pre processing processes like mathematical operation, skull stripping and histogram equalization are done to get the desired image from input image.

Various segmentation techniques have been explained that include fuzzy clustering means(FCM), support vector machine(SVM), artificial neural network(ANN), K means clustering, global thresholding, etc are some popular techniques which are used frequently to extract important information from medical imaging modalities. Image thresholding is preferred for the segmentation when the images have high levels of contrast.

Some papers propose BWT and SVM techniques image analysis for MRI-based brain tumor detection and classification which has accuracy of 95%. While some proposed segmentation of MRI brain images using *K*-means clustering algorithm along with morphological filtering for the detection of tumor images as its accuracy is about 95% and computational time is about 1.2636 (for k=3) &1.1232 sec (for k=4). Some proposed a methodology which included extraction of textures features with wavelet transform and SVM with an accuracy of 83%.

The textural features are extracted from gray-level co-occurrence matrix (GLCM) and statistical textural features are extracted from LL and HL sub bands wavelet decomposition and 95% of accuracy was observed.

A probabilistic neural network (PNN) is widely used in classification and pattern recognition problems because of the advantages like it is faster and more accurate than multilayer perceptron networks, they are comparatively less sensitive to outliers and generate accurate predicted target probability scores. It is considered the most accurate among all the algorithms.

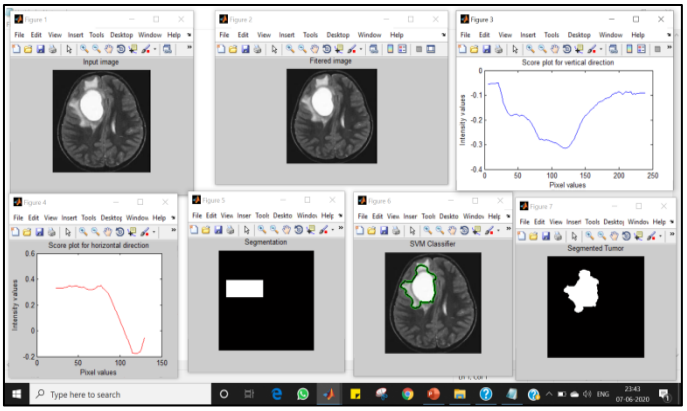

Figure 2 – Results using PNN Algorithm

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Real Time Forest Flora Monitoring System

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Abstract - *A new system to monitor the forest floor is proposed which entails the use of a UAV (Unmanned Aerial Vehicle) equipped with a dedicated set of systems and sub-systems that is used to obtain data from the forest in the form of images and other electrical signals that is later processed to infer important metrics about the same. The information obtained at the end has to be stored and constantly updated over time in the form of a database.*

Introduction:

Due to the rapid change in the modern-day world it becomes essential to monitor and analyze the attributes and compositions of one of the most important components of nature — Forests.

Fig-1: Forest area

As the world seeks to slow the pace of climate change, preserve wildlife, and support billions of people, trees inevitably hold a major part of the answer. Yet the mass destruction of trees—deforestation—continues, sacrificing the long-term benefits of standing trees for short-term gain. Forests still cover about 30 percent of the world's land area, but they are disappearing at an alarming rate. Between 1990 and 2016, the world lost 502,000 square miles (1.3 million square kilometers) of forest, according to the World Bank—an area larger than South Africa. Since humans started cutting down forests, 46 percent of trees have been filed, according to a 2015 study in the journal Nature. About 17 percent of the Amazonian rainforest has been destroyed over the past 50 years, and losses recently have been on the rise.

This calls for a reason to monitor forests so that preventative and curative measures can be implemented. To sum it up studying the forest floor can help us achieve the following agenda: (1) to maintain a huge database of different types of the trees (2) Forest fire studies (3) Invasive species mapping (4) Discovering the new species of trees (5) Biodiversity studies (6) Prevention of the extinction of rare trees by evaluating their threat level (7) Evolution/Variation in life of trees based on the changes in climate.

When we look into the existing methods that are used for such purposes we can understand what they lack and come up with a more effective solution (1). The survey of the forest was manually done by the Department of Forest Survey of India (FSI).This consumes a lot of manual labor and takes a plethora of time in order to get adequate information about the forest floor in the least (2). VHR Satellite imaging is the more nominally opted-for method as it is easier to maintain and hyperspectral image of a very large area can be obtained. However, even such a method finds its flaws when it demands a huge seed capital and the information obtained is approximated thereby reducing its precision. It also makes it impossible to control and revisit places as the satellite is in orbit in any case of emergency (3). Outdated statistical techniques that were predominantly used tend to have a lot of error in the predictions and are also harder to apply for a large real-time dataset. On the contrary, the newer methods introduced are not only more accurate but can also deduce more information and can be modeled on a computing machine (4). Database is updated less frequently and on paper which is harder to access and maintain. These issues can be overcome by using a software database which has a large memory, can be processed easily and much simpler to integrate in an autonomous system.

The solution that we would like to propose is using a UAV (Unmanned aerial vehicle or drone) as a fully/semi-automated tree cover reconnaissance device. This UAV is equipped with the following sub-systems.

1. Raw Data Acquisition
2. Feature Extraction
3. Composite Database
4. Statistical Data Analysis
5. End user interface

1. Raw Data Acquisition:

The UAV is the main part of this part of the proposed monitoring system which consists of parts such as flight controller, subsystem controller, sensors, communication modules, Power supply system etc. The main job of the drone is to navigate the desired area under study whilst carrying the camera and other physical parameter sensors that are used to obtain the raw data.

In our case we will be using a quadcopter as our designated UAV equipped with Arduino as the primary subsystem controller.

The quadcopter consists of propellers equipped with brushless dc motors connected to electronic speed controllers on each wing. The UAV will be powered using lithium polymer / lithium ion rechargeable batteries. To distribute the right amount of power to both the Arduino controller and the drone, we are using a power distribution board.

Fig-2 Unmanned aerial vehicle

Our main controller is connected with required sensors such as GPS, Gyroscope, Accelerometer, Temperature and Pressure sensors. A high definition camera is fixed onto the drone to take clear pictures for further processing. For the purpose of communication and transmission the data obtained from sensors and the camera we use a radio frequency trans-receiver. A thermocouple is used to measure the surrounding temperature. A humidity sensor is also integrated to obtain the corresponding and instantaneous humidity value of the surrounding.

The Next step for us in solving this problem is automating the drone. Keeping in mind the vast geographical area a forest would cover, it is ideal that we use an automated drone with a predetermined / pre-planned flight plan which would effectively reduce our manpower and resources burned.

Here we have used a drone to monitor an area of, let's say 1km x 1km. We use the CC3D flight controller as it is powerful and affordable and has a small form factor. If we use this along with a GPS module, we can even design a waypoint based flight.

We use a small complex circuit board. It gets an input and drives it to the RPM of each motor. As pilots, we can drive the motors accordingly.

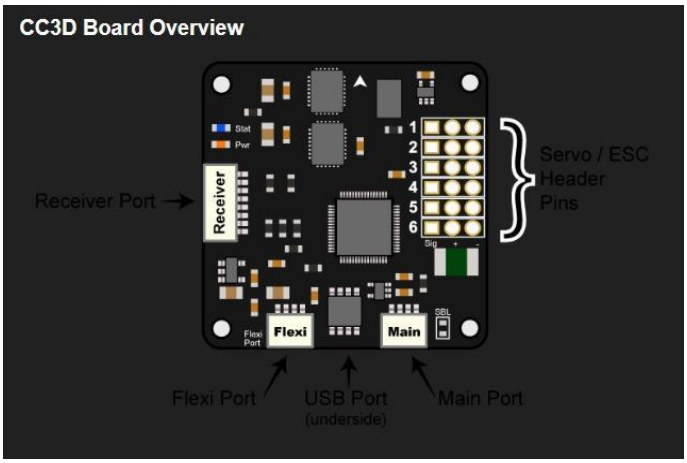

Fig-3 Flight controller

Quite a lot of flight controllers make use of sensors to aid their results. GPS can also be used for auto-pilot. To elaborate the previous statement: (1). Accelerometer is used to provide the vibration, acceleration force which the drone is subjected to in all three axes X, Y and Z, the tilt angle and the triple axes linear acceleration which can be used to calculate velocity, direction and even rate of change of altitude of the drone. These parameters play an important role in the flight navigation (2). Gyroscope is used to detect the angular velocity in three axis, meaning it can detect rate of change of angle in pitch, roll and yaw which can provide stability to the drone and prevents it from wobbling (3). Magnetic compass gives the sense of direction to the throne (4). Barometer detects the atmospheric pressure and gives altitude (5). Ultrasound is used to detect and avoid objects (6). GPS module- The comparison of the actual position of the drone with its destination (both of which are obtained using the GPS module) using the PID controller, the drone can be instructed to move as intended.

Any good UAV designed or built for the purpose of flora monitoring should comprise of the following features (ideally):

- Good stability.
- Precision in terms of covering certain distance, velocity, acceleration, direction, altitude.
- Resistance to external factors such as rain, heat, etc.
- Should conserve power/maximum efficiency.
- Low power to weight and volume ratio.
- Good capability of maneuvering.
- Position hold, which lets the drone maintain a fixed location at a set altitude.
- Return-to-home navigation, wherein a drone returns automatically on the press of a button based on its take-off location.
- Autonomous flight, where the flight path is set based on GPS/GNSS waypoints which the drone will follow using autopilot functions.

2. Feature Extraction:

The feature extraction module is essentially a program that can obtain meaningful data with respect to the parameters under study from the raw data images obtained from the camera. For this purpose, a Convolutional Neural Network (CNN) Algorithm can be implemented, which has theoretically been proven to predict and classify image data to a high accuracy. The same application can be seen in our plant species recognition which can then be mapped to other parameters such as the geographic co-ordinates etc.

CNNs are technically made up of "neurons" with learnable weights and biases. Each specific neuron receives numerous inputs and then takes a weighted sum over them, where it passes it through an activation function and responds back with an output. Here the input corresponds to the pixel value of the image data array. The process of self-updating of these weights is usually hidden and occurs through a process called learning. To train a CNN model we need to supply it with standard known dataset which consists of many images with different orientations and variety. A CNN model is theorized to improve its prediction accuracy over time as it is a self-learning algorithm. This method of learning is usually referred as supervised learning as we know the parameters that are under study beforehand. The CNN model also consists of a lot of hidden layers through each of which a convolution operation is performed.

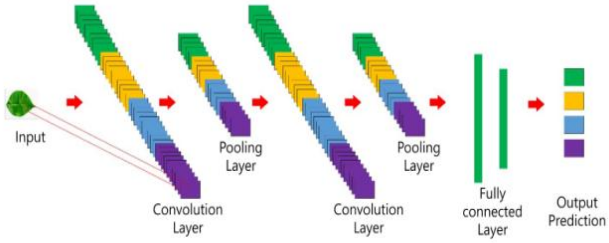

Fig-4 CNN model

Features such as contour, color, orientation, etc. are obtained by the CNN model which it uses to determine the species of the tree. This is the end output of the CNN that is given to the database for further processing. A small unsupervised model can also be implemented to detect any abnormality in the image data. The remaining raw data parameters that are obtained are from the sensors which might need certain preprocessing steps such as filtering, thresholding, correcting, scaling etc.

3. Composite Database:

A composite and flexible digital database needs to be created in order to store all the data required for the survey which can be analysed and also whose output can be stored in the same.

3.1 Maintaining the data:

All the data which is received by different sensors as well as the camera images which are processed by the feature extraction module are stored in a database automatically with respective date and time. This database keeps the all logs of all the retrieved and processed information. We are implementing an SQL database in our case.

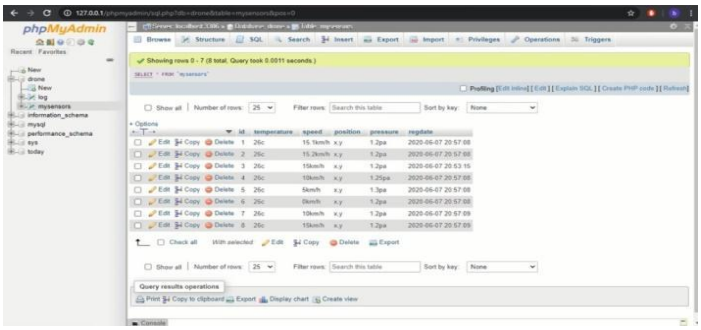

Fig-5 Database

3.2 Retrieving the data:

Once the data is stored in the database, we can retrieve the same at any time on a web page as demonstrated in the figure. This web page was created for this purpose exclusively and can be accessed universally with a single click, but presently we are running it on a local host which restricts us from doing so. The data stored varies by parameters and across time that ranges from the end to end cycle of operation of the drone.

Fig-6 Data retrieved from database

4. Statistical Data Analysis:

Statistical data analysis is the science of collecting, exploring and presenting large data sets to detect patterns and trends. The large amount of data is to be collected by the end user interface such as name of the species, scientific name, and number of trees, height, width, temperature, humidity and other atmospheric conditions. This data is then analyzed using different nonlinear regression algorithms to understand the behavior of the species with their respective habitat.

This analysis also helps us to understand the correlation between the different atmospheric conditions and the flora conditions also allows us to understand why tree canopy density is high in certain parts of the world. This analysis involves the use of neural networks, where we use back propagation techniques to predict the growth of certain kinds of trees with respects to changing atmospheric conditions. The data collected from the study is plotted. From the graphs we can interpret the kind of trees which grow in different seasons and those trees which are evergreen. The data collected by the drone is to be updated frequently to the database in order to have efficient analysis of the area under study.

4.1 Forest cover:

One of the major reasons for the survey is to monitor deforestation. This can be done by analyzing the forest cover over a given area. Forest cover is basically a density of tree canopy in a given plot. Forest cover can be classified in terms of density of tree canopy as,

*Very Dense Forest (VDF): tree canopy density greater than 70 percent.
*Moderately Dense Forest (MDF): tree canopy density greater than 40 percent less than 70 percent.
*Open Forest (OF): tree canopy density greater 10 percent and less than *40 percent.
*Scrub: forest land canopy density less than 10 percent
*Non-Forest: areas not included in above classes (e.g.- water).

Class	**Area (Sq. km)**	**Percentage of Geographic area**
Very Dense Forest	418	7.4
Moderately Dense Forest	782	13.8
Open Forrest	512	9.06
Total Forest Cover*	1712	30.31
Scrubs	252	4.46
Non-Forest	3684	65.22
Total	5648	100

Table-1: Classification of forest area

4.2 Graphical analysis & Prevention of the extinction of rare tree:

Consider a sample data for demonstration. The following table represents the forest cover analysis over an area. A sample data was considered for this demonstration. The tree population density data obtained is plotted and shown in the graph. We can infer the species that are headed towards, or below the endangered threat threshold line. It can also be declared that species has been extinct if the curve touches the x axis of the graph in that area of study. In the following graph Banyan tree is on the verge of extinction which is now marked and protected.

	coconut	sandalwood	teak	peepal tree	banyan tree
1985	100	35	40	87	10
1990	120	30	45	85	8
1995	90	38	50	81	6
2000	105	40	38	90	6
2005	106	32	42	95	6
2010	80	34	45	80	6

Table-2: Count of trees in different years

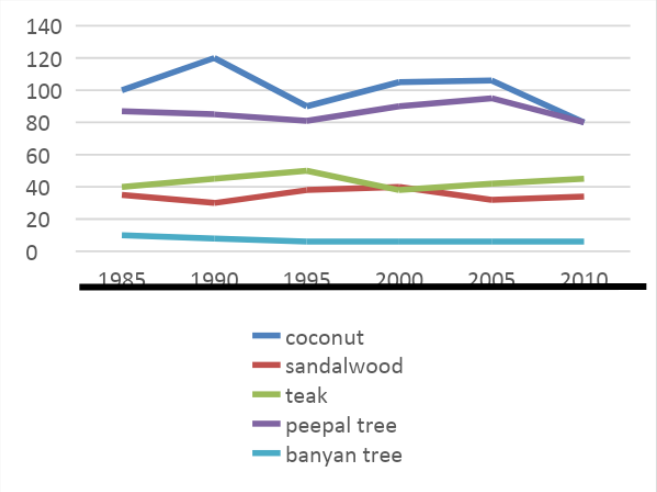

Chart-1: Endangered species trends

5. End User Interface:

We propose the idea of developing a GUI based software that:

- Aids in the overall operation/ control/ maintenance of the drone.
- Runs the CNN model and collects its output predictions.
- Performs statistical analysis.
- Provides Graphic Output.
- Maintains a solid database of all the acquired data.

SCOPE:

This proposed solution to monitor forests can be adopted by the agencies and organizations that study and survey forest flora respectively, independent researchers who cannot afford means like satellite imaging, farmers who own extremely large plots for agricultural purposes, forest department as a preventative measure of forest fires etc. The same implementation can be improved in the following way:

- Optimized drone operation (power efficiency, greater load carrying, more physical endurance, fully automated flight navigation).
- A neural network that functions more accurately for tree classification.
- End user interface enhancements.
- Budget cut down from all information acquired from the R & D phase.

CONCLUSION:

The act of conserving nature is a fundamental duty bestowed upon whoever takes aid from it and as humans we should do everything in our power to make sure the millions of years of evolution it took for these beautiful forests to spawn not to get destroyed in vain. Integrating an autonomous survey system into a forest flora ecosystem can harbour a lot of good by preserving and improving the natural state of the forest. One of the biggest areas of change can quickly be observed in the species extinction threat analysis which can be corrected by taking the required measures by the respective authorities. We can also prevent undesirable effects of nature such as forest fires, species invasion, climate change etc. By analysing the data from our proposed solution.

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BIOGRAPHIES:

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Govardhan is currently pursuing a Bachelor of Engineering degree majoring in Electrical and Electronics and is in his final year at BMS Institute of Technology. He is a member of the civil defence committee. His interests are electrical motors, embedded systems, coding. He is also a person caring for nature and preserving. which was one of the main reasons which motivated us to initiate this project.

Comparative Study of Different Sleep Monitoring Methods

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Abstract : World Sleep Society statistics show that disorders such as insomnia, sleep apnea, and narcolepsy affect up to 45 per cent of people, creating increased demand for home-based sleep monitoring system. These disorders mean that people do not get enough rest, or have a generally poor quality of sleep, raising the risk of heart diseases, high blood pressure, diabetes and stress. Lot of efforts has been made in the advancement of Sleep Monitoring systems. Various techniques have been implemented and attempts have been made in order to increase the precision and accuracy of sleep data, which can be further analyzed to produce a sleep score or efficiency.

In this paper, different sleep monitoring methods have been analyzed and their comparison has been done on the basis of their complexity, accuracy, output etc.

Index Terms **– Non- Invasive, REM- sleep, Non-REM sleep.**

I. INTRODUCTION

Sleep is a type of "brain activity" and this activity has the purpose of recovering from brain fatigue. Sleep plays a significant part in relieving tension and recovery. Sleeplessness takes a toll not just physically but also emotionally. A decent amount of sleep is pointless when the brain is restless all along the time. Quality plays an equal role in the maintenance of sound mental health.

Good sleep quality can lead to many beneficial outcomes including improved physical health, decreased daytime sleepiness and improved psychological wellbeing. Deprivation of sleep can cause memory issues, depression, increase pain perception and weaken your immune system.

It is a fact that humans are spending one-third of their lives in sleeping. Therefore, sleep monitoring is important because sleep accounts for a third of our lives and also affects the remaining two-thirds. Sleep monitoring and tracking plays an important part in the diagnosis and treatment of sleep disorders. It also helps to maintain a healthy lifestyle, and to recognize sleep patterns and sleep cycle. Deep Sleep parameters such as NREM and REM sleep detection play a vital role in monitoring sleep and measuring quality of sleep. Other parameters such as Breathing Rate, Pulse, Brain waves also give better insight into sleep surveillance.

Numerous researchers have proposed various approaches to monitor sleep, some of them are:

1. Polysomnography
2. Using Motion Sensing Mattresses
3. Ubiquitous Sensor System
4. Using Seismometer
5. Infrared Cameras
6. Sleep Masks
7. 3-D Cameras

Such approaches, however, are expensive and often require overnight treatment in clinics. And not all methods use all the parameters required to satisfy those conditions. This can result in different performance from one method to another. Therefore, in recent times, technology has developed a lot of state-of-the-art concepts such as machine learning can improve monitoring techniques.

In this paper we are comparing different sleep monitoring methods comprehensively based on the parameters and devices used, availability, complexity of system, use of technology and feasibility for daily life use.

II. DIFFERENT SLEEP MONITORING METHODS

Different Sleep monitoring methods that have been analyzed are as follows: -

1. POLYSOMNOGRAPHY

Polysomnography is the gold standard method for sleep tracking. This is a screening procedure for sleep disorders. Polysomnography is typically performed at a sleep disorders unit within a hospital or at a sleep center. The test tracks patterns in your sleep.

The doctor will measure the following during a PSG to help graph a person's sleep cycles:

- Brain Waves
- Skeletal Muscle Activity
- Blood Oxygen Levels
- Heart Rate
- Breathing Rate
- Eye Movement

To record this data, the technician will position small sensors called “electrodes” on:

- Scalp
- Temples
- Chest
- Legs

It is a non-invasive, painless test but because of the adhesive used to attach sensors to the skin, it can cause skin irritation. Elastic belts around chest and stomach will record breathing patterns and chest movements. A small clip on finger will monitor the oxygen level of the blood. The sensors installed on small, flexible wires transmit the data to a computer. Technicians will set-up equipments for making a video recording at certain sleep centers. This will allow the doctor to check the night-time changes in your body position. You are probably not going to be as comfortable in the sleep center as you would be in your own bed, so you may not fall asleep or sleep as easily as you are at home, but the output does not differ much.

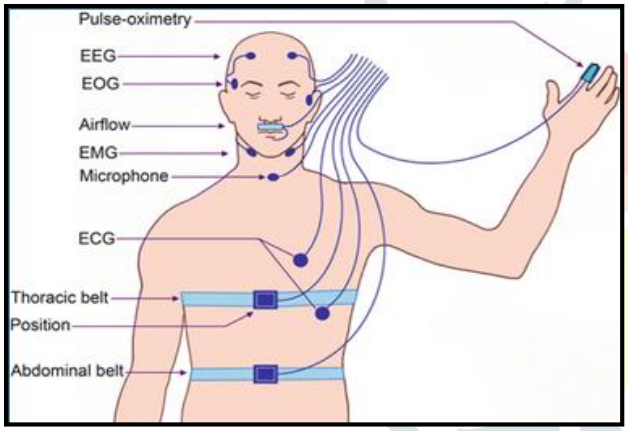

Fig.1.1: Connections in Polysomnography

MEASUREMENTS	NO. OF CHANNELS
EEG	Minimum 3
Air Flow	1 or 2
Chin muscle tone	1 or 2
Leg movements	1 or more
Eye movements	2
Heart Rate & Rhythm	1 or 2
Oxygen Saturation	1

Fig.1.2: Measurements and Channels required

Fig.1 shows the connections that are done in Polysomnography. It typically records at least 12 channels, and at least 22 wire attachments. Fig.2 illustrates the channels required for measuring various body elements. Wires lead from the patient into a central box for each channel of registered data, which in turn is linked to a computer network to capture, store and view the data.

PSG results can take up to about 3 weeks to obtain. A technician must compile the data to calculate sleep cycles from the night of the sleep test.

Polysomnography is a very complex test. It is a costly and uncomfortable sleep tracking test but its accuracy is high. It is also inaccessible, as the test can only be performed in hospitals or sleep centers and therefore does not give people the option to use it at home for sleep monitoring. It is a time-consuming test too.

2. Sleep Monitoring using a 3-D Camera

This non-invasive approach uses a 3D time-of - flight (TOF) camera to detect sleep stages from the respiratory motion recorded. After the patient sleeps his / her muscles relax and the degree of relaxation in each sleep stage is different. Abdominal muscle relaxation leads to slight variations in the movement of the abdomen in some regions. The signal of respiratory movement from all visible regions is extracted from 3D video recordings. It extracts the characteristic features of various sleep periods, comparing the correlation (coefficients) between different signals. Likewise, cases of obstructive sleep apnea are also observed.

The muscles become more and more relaxed during the various stages of sleep, and muscle tone is weakest during the Rapid Eye Movement (REM) stage. REM sleep is distinct from non-REM sleep, because at this stage the EEG is similar to the awakening stage, but at this point the body appears paralyzed. REM sleep also features the usual rapid eye movements recorded by the EOG. The 3D image recorded is broken down into twelve zones, shown in Fig. 2.1 and the average distance from the distance image to each zone is collected. The recorded signals are the variation of the mean distance to the chosen zones in time.

Fig.2.1: The distance image of the patient's body is divided into twelve zones;
Zone [1, 1] is darkened in the figure.

The measured distances change a lot when the body moves during the sleep period compared with respiratory motion. These body motions of high amplitude are greatly mitigated by filtering the signals.

A non-invasive diagnostic method is the sleep monitoring method, which is based on a 3D camera. The most significant result is the feature that establishes the transition from waking to sleeping. In general, belts with accelerometer sensors are used in PSG to monitor chest and abdomen respiratory effort. This 3D camera will be cheap and affordable for everyone in large scale production. The OSA algorithm for event detection is simple, and can be easily implemented. This can be enhanced by tracking the patient's movements during sleep. This method may also be used to screen for respiratory sleep disorders.

3. Sleep Monitoring using Pressure Sensor Mat

This method of sleep monitoring uses a low cost, disposable pressure sensor mat to monitor the user's sleep and movement. Fig. 3.1 shows Pressure mat tile. The design of the sensor mat is based on compressible foam sandwiched between two orthogonal conducting Paper (or C-paper) capacitance sensor arrays. C-paper is non-woven material where the loading of carbon fiber into matrix achieves electrical conductivity. The dielectric medium used between C-papers is foam. The combination of both is used as electrodes for the Capacitor sensor. A low-cost C-paper was designed for use as the electrode of the capacitance sensor. Typical mat design uses 3 mm thick foam with a 5 mm row / column grid pattern reveals it has a 0.1 PSI pressure measurement resolution. Both the changing properties of the conductive paper and the foam will control resolution.

Fig.3.1: Pressure Mat Tile

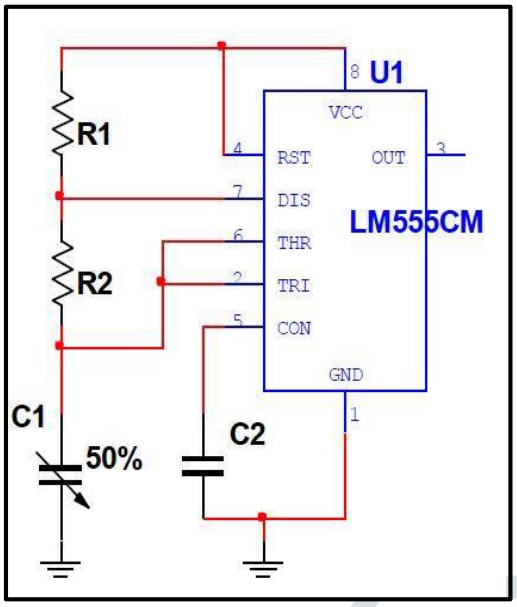

Fig.3.2: Astable Multivibrator Circuit

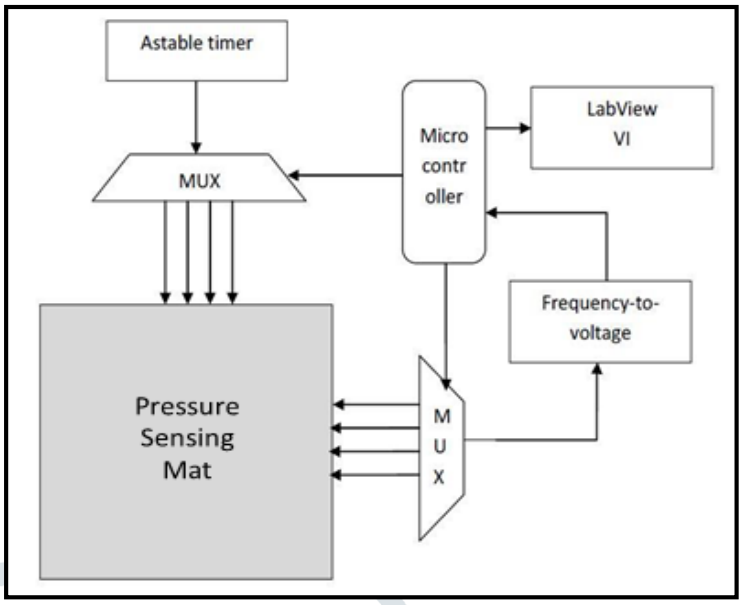

Fig.3.3: Block Diagram of the circuitry

Fig. 3.2 shows Astable Multivibrator Circuit and C_1 capacitance is the capacitance inside pressure sensing mat. When external pressure is applied, the foam compresses and capacitance changes due to electrode displacement at any point in the mat. Astable multivibrator output frequency changes due to capacitance change. The signal is amplified from an astable multivibrator and given to frequency to voltage converter. The micro-controller reads DC voltages and uses graphical interface to display outputs. Multiplexer scans with 20 Hz scanning frequency on rows / columns. Fig. 3.3 shows the block diagram of the circuitry of the sleep monitoring system.

This non-invasive sensor enables clinicians to collect data from in-home and community settings without disrupting the subject's routine sleep. The advantage of using C-Paper pressure sensors to monitor in-home sleep is that it can be used as a disposable mat that improves overall hygiene. Making large mats is easy by tiling different C-Paper mats, which is cost-effective, too. Usable and low-cost pressure sensors may also be used for imaging applications and general healthcare applications. This method uses only the pressure sensor and, therefore, only monitors the person's movement during sleep, so it is not an accurate method. In this process, only graphical analysis of sleep is performed, and output is not given in terms of sleep performance.

4. An Ubiquitous Sensor System for Sleep Monitoring

This design focused on reducing the number of sensors required, and utilizing non-invasive, feasible technologies. This approach presents ubiquitous architecture based on portability and interoperability principles in which a Smart Watch and a Smart phone are combined to incorporate a sleep monitoring system. This device incorporates heart rate, accelerometer, and sound signals into Smart watch. Smartwatch & Smartphone uses API to share data.

Audio signal is used to extract snore events during the sleep period. Heart Rate sensor is used to determine the heart beat rate of the user, which can be used further to predict sleep stages. Accelerometer is used to detect motion of the user during the sleep. The App provides graphical interface on the collected data including motion diagram including information on deep and light sleep period.

This study contributes to the concept of the sleep monitoring system architecture based on ubiquitous tools, i.e. Smartwatch & Smart phone, shown in Fig. 4.1. Smartphone includes a mobile app & a persistent database, while smartwatch includes a wear app for sensor data collection. Audio, ECG and accelerometer combine to sense simple sleep patterns such as amount of sleep hours, number of awakenings, and snore events etc. Fig. 4.2 shows the layers of the framework of API for communication and data exchange between the Smartwatch and the Smartphone .

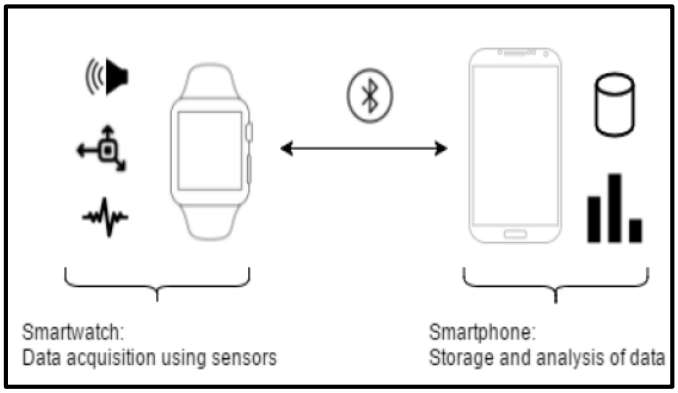

Fig.4.1: Ubisleep System Architecture

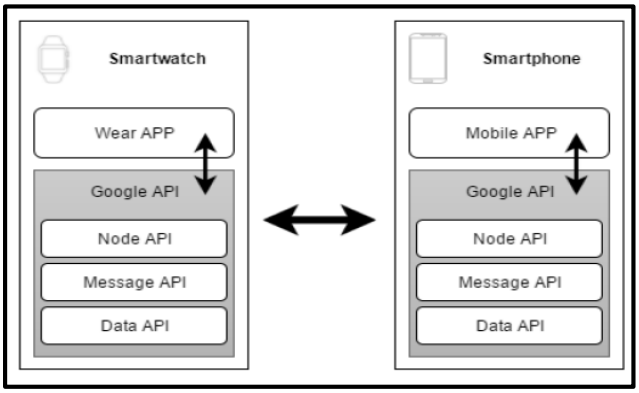

Fig.4.2: Framework Layers

However, some difficulties were observed, namely in designing and implementing the multi-tiered framework, mainly due to the challenge of putting all the different methods and concepts together. In addition , the development of both the wear app and the smartphone app posed many challenges not only in terms of system requirements, but also in terms of usability and user

interaction due to the smartwatch's small screen dimension. This indicates the sleep monitoring system is very complex. Certain concerns that need to be discussed are: data transmission protection policies, the summary and/or optimization of storage data, and usability principles with a special emphasis on the user-friendliness of the smartwatch interface due to its reduced dimension. Such challenges and difficulties make this approach quite expensive.

5. Sleep monitoring system using infrared cameras and motion sensor

This approach includes developing and implementing a novel sleep monitoring device that analyzes respiration, head position and body posture at the same time. The system consists exclusively of cost-effective vision-based devices, operating in a quiet and non-contact manner with little natural sleep disturbance. Specifically, the sleep process is recorded via an infrared camera. The region of breathing motion is automatically determined from the infrared video, and the intensity is calculated, resulting in a waveform showing respiratory rhythms. Five additional infrared cameras are used to record the face of the subject from multiple orientations, and the matching of models is used to conduct head tracking. A Kinect motion sensor is often used to obtain skeleton description of body posture that is resilient to self-occlusion, and machine learning techniques are applied for classification of body posture after the noise is filtered.

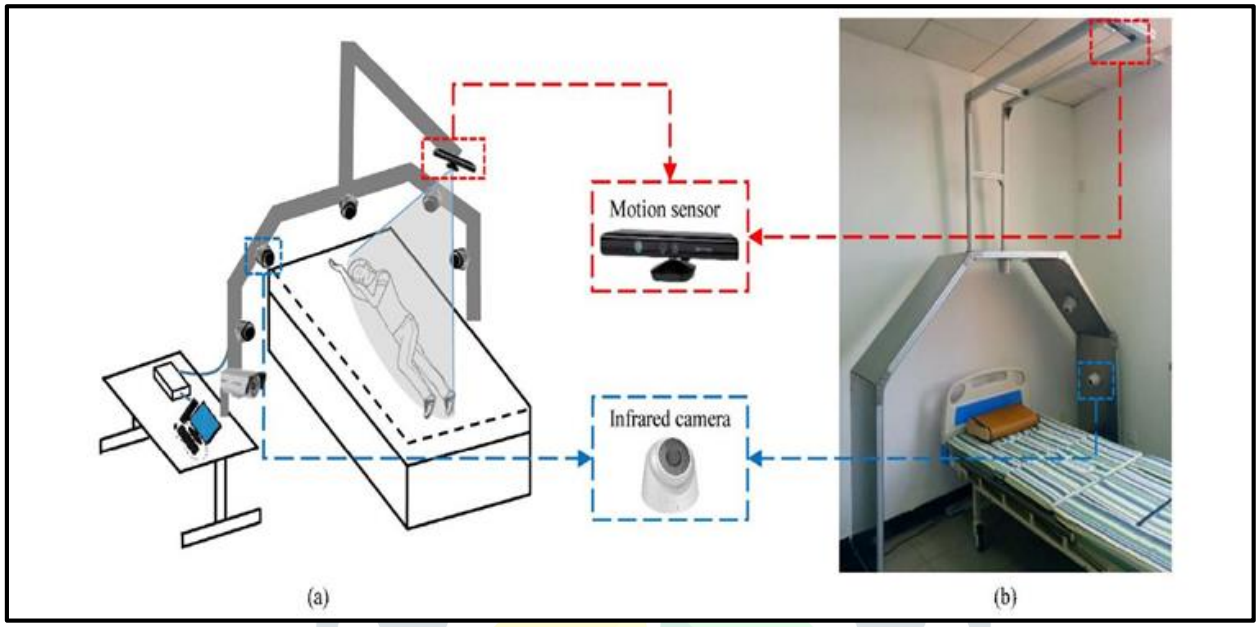

Fig.5.1: Overall Architecture of the monitoring system. (a) Blueprint of the system hardware. (b) Real scene.
The infared camera of the monitoring system is shown in blue rectangle, and the motion sensor Kinect is shown in the red one.

Fig. 5.1 shows the overall architecture of the sleep monitoring system. Blueprint of the system hardware is shown in Fig. 5.1(a). An arrangement of the infrared camera and Kinect motion sensor in real scenario is shown in Fig. 5.1(b).
Breathing and Body and Head Posture Analysis algorithms have been implemented in this method and data analysis software has also been used. Simulation Data set has also been collected from subjects in order to apply analysis algorithms.

This simple and efficient architecture allows the device to work properly and stably. Since no physical contact between the sensor and the subject is required and no precise targeting is assumed, the system is robust to the unconscious movements of the subject during sleep, and can be deployed in a regular home environment. Therefore, the subject can sleep peacefully and naturally without interruption from the monitoring device thanks to its peaceful and non-contact mode of activity.
True breathing anomalies with complex properties would require more sophisticated detection algorithms, however. The device will also fail if a thick blanket completely covers the subject. The breathing action under such condition would be too subtle for the algorithm to detect. The Kinect sensor also can not acquire accurate data about the skeleton. The system proposed is not cost-effective and the setting of apparatuses is very complicated. As visual assistance is needed, there is a lighting necessity that can cause disruption in sleeping for the patient.

6. Sleep Monitoring with bed-mounted Seismometer

During the sleep, a bed-mounted seismometer system was used to monitor heart and respiratory rates, and body movement and posture. An groundbreaking local maxima statistics approach and instantaneous property-based method for estimating heart and respiratory rates have been developed to efficiently monitor sleep status.

The body motions and movement can be registered and analyzed for determination of sleep quality by using Amplitude Abnormalities in the seismometer. The seismometer was mounted to the frame of the bed, which is non-intrusive and non-contact to the body. Raspberry Pi 3 was connected to the seismometer to process the data in real time. The bed-mounted seismometer is non-intrusive and non-contact, showing great potential for tracking sleep quality and status. Viewing the respiration and heartbeat are different human body rhythms; oscillatory components were extracted to estimate those body parameters. Instant property analysis method based on oscillatory analysis technique Synchro Squeezed Wavelet Packet Transform (SSWPT) and novel local maxima statistics was designed to estimate heart and respiratory rate.

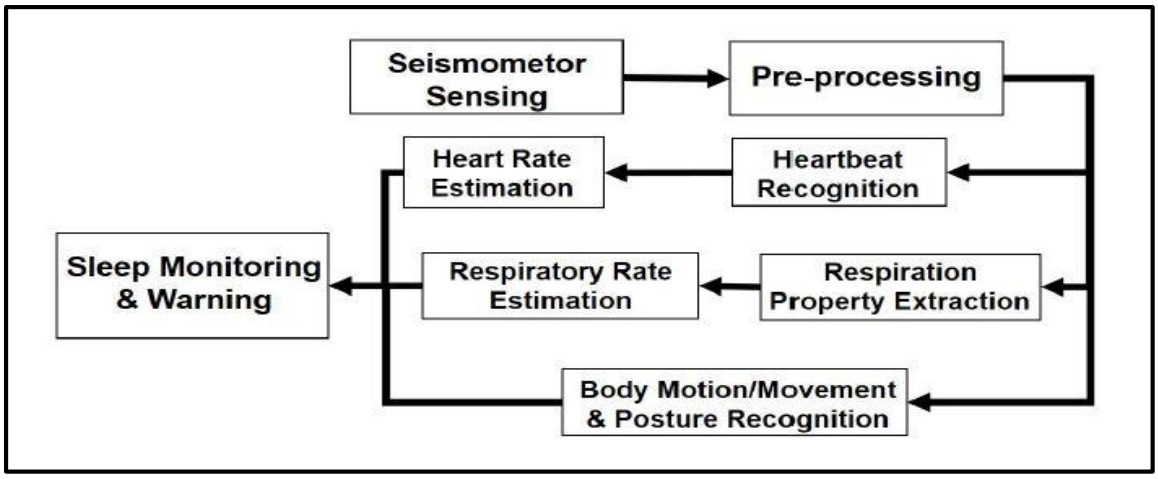

Fig.6.1: Sleep Monitoring system workflow

Fig.6.1 shows the workflow of the Seismometer based Sleep monitoring system. This method is more robust than others because it uses only one device i.e. seismometer for sensing heart and respiratory rate, as well as body movement and posture. This approach is relatively costly, though. To make the present program more sophisticated, Machine Learning & Deep Learning can be introduced.

7. Graphene-Based Sleep Mask for Sleep Tracking

This method has been basically devised to measure eye movements during sleep. In this method, Sensing electrode is placed into a commercially available eye Mask. To prepare the conductive material, a sending material is coated with Graphene Oxide and reduced. Conductive textiles are on a scoured and bleached nylon knitted fabric. The first step in this process is reducing a solution of Graphene oxide, functionalizing the solution, and then coating the textile material with this. Electrodes are created by sewing processed nylon fabric into a standard, off-the-shelf eye mask using non conductive polyester thread.

To investigate the output, two masks (Mask A and Mask B) were made. For horizontal movements, the second mask (mask B) uses two larger electrodes sewn on either side of the eyes, and one smaller reference electrode. Mask A has a hole cut into it to allow the participant to see a screen to follow the instructions given in the experiment, while the second one has been left as received. Fig. 7.1 shows the picture of prepared masks A & B.

Fig. 7.1: Sleep masks with grapheme-based nylon sensors sewn in, showing the view from back of the mask.

Electrical tape has been used to prevent the metal back of the snap connectors touching the skin.

(a) Mask A (note V+ and V- electrodes were not used in this paper) (b) Mask B

Using Unity, an eye-tracking experiment is set up on a PC to test the device. The program instructed the user to perform a series of voluntary blinks, as well as smooth eye pursuit movements that are accomplished by instructing the user to follow a moving ball with their eyes on the screen. The program also manages the timing of each of these acts to enable repeatable participant measurements.

This device can be used for EOG tests, and can detect eye blinks with a high SNR above 16 dB consistently. It has also shown that in certain situations, it can detect smooth eye movements of the pursuit. It has been found that the smooth pursuit eye movements were difficult to detect in many situations, possibly due to the difference in tightness of the mask strap between participants with different head diameters. Such electrodes, however, are only held in place with a regular elastic band, as opposed to conventional electrodes which are held on with an adhesive pad, providing greater comfort and ease of use for masks. The findings suggest that this material could be much more convenient than traditional methods for monitoring eye movements in REM sleep.

8. Machine Learning Based Sleep-Status Discrimination Using a Motion Sensing Mattress

This approach introduces a new paradigm of sleep-status discrimination by introducing a motion-sensing mattress that senses the movements of the user on the bed including the movement of head, arms, legs and feet. Unlike conventional methods such as Polysomnography (PSG) requiring user-connected electrical equipment, or like wrist actigraphy requiring user contact, the proposed system distinguishes sleep states in an unconscious and non-contact manner. The proposed system is developed in offline stage using a machine learning method, and by using designed sleep-status discrimination algorithm, it distinguishes sleep states in the online level. The experimental findings show that the proposed approach effectively differentiates sleep status without using a monitoring interface communication with the body or using hospital treatment of PSG.

Fig. 8.1: The test bed for field measurement

Fig.8.1 shows the test bed arrangement for sleep monitoring. Motion sensing mattress is adopted and called WhizPad, which is imbedded with 4 pressure sensing units to monitor the user 's movements on bed including head, arms, legs and feet movement. Once WhizPad senses a movement, it registers the event and outputs digital value ranging from 0 to 30 where 0 & 30 represents the lowest and highest values, respectively. Operation of the four parts is registered every 30 seconds and then transmitted to the server. PSG is often used to track the brain waves of the patient to differentiate between two sleep states: "Wake up and Sleep."

WEKA (Waikato Environment for Knowledge Analysis), is the machine learning tool used in this process. The proposed system of sleep discrimination can be divided into two levels, Offline and Online.
The priori awareness of user activities (recorded by WhizPad) and sleep states (identified by PSG) passes in the J48 Decision Tree (J48-DT) classifier for training and testing in the Offline process. In the online process, the findings in the offline stage from the machine learning framework are used to develop our algorithm for sleep discrimination. The output of J48-DT is used in the algorithm for compiling the table of decisions. The program must analyze the decision points in order to achieve the sleep condition "Awake" and "Sleep", according to the compiled decision table. In the online process, the activity signals reported by WhizPad are going through the mechanism of sleep discrimination to discern the present sleep state of the user.

The system's accuracy is high, but because it uses PSG to discern users' sleep cycles, this process is very costly and people may find it difficult to use this tool, because the whole system is not readily available. For rigorous performance field research , the proposed scheme will be applied with various machine learning techniques, such as Hidden Markov Model (HMM) and Long Short-Term Memory (LSTM), in future.

III. COMPARISON

All the sleep monitoring methods mentioned above have been analyzed on the basis of parameters and devices used, availability, complexity of system, use of technology and feasibility for daily life use etc.
A comparison table (Table 1) is formed discussing all the parameters stated above.

Table -1: Comparison Table

Parameters	Output Response	Complexity	Accuracy	Technology	Manufacturing Cost	Reliability	Feasibility	User Comfort during Sleep
Poly-somnography (PSG)	Graphical Output, Needs Experts analysis	Very High	High	Invasive / Non-Invasive	Very High	Very High	Low	Low
3-D Camera	Graphical Output	Low	Very Low	Non-Invasive	Low	Low	High	Moderate
Pressure Sensor Mat	Graphical Output	Moderate	Moderate	Non-Invasive	Moderate	Moderate	High	High
Ubiquitous Sensor System	Graphical & Numerical Output	High	High	Non-Invasive	High	Moderate	High	High
Infrared Cameras & Motion Sensor	Graphical Output	Moderate	Low	Non-Invasive	Moderate	Moderate	Moderate	High
Bed-mounted Seismometer	Graphical Output	High	High	Non-Invasive	High	High	Low	High
Graphene based Sleep Mask	Graphical Output	Moderate	Low	Non-Invasive	Moderate	Low	Moderate	Moderate
Machine Learning Based Motion Sensing Mattress & PSG	Graphical & Numerical Output	High	High	Non-Invasive	Very High	High	Low	Low

By referring to the parameters in the above table, it was seen that every method has some advantages and disadvantages. Hence, in order to get a user-friendly, feasible, reliable and cost-effective system, trade-off should have to be done between reliability, ease of access and manufacturing cost. It is also concluded that Machine Learning algorithms can definitely increase the accuracy of the system.

IV. RESULTS AND DISCUSSION

Different methods of Sleep monitoring have been studied and a comprehensive comparison of these methods was made. The conclusions from these methods are framed in a Table of Comparison. Comparison has been made on various parameters such as output response, complexity, accuracy, technology, manufacturing cost, etc.

Sleep monitoring is a very important part of human life, as sleep is a very important part of human life and accounts for one third of our lives. Such forms of tracking certainly benefited the current mankind. Nonetheless, Research is being conducted in the area of sleep monitoring, and in the near future, we will receive the best possible solutions.

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SOLAR POWERED PORTABLE ELECTRICAL VEHICLE CHARGING STATION

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Abstract - *Electrical vehicles (EV) are actually need of the hour in this drastically degrading environment.*

By 2030, the Government of India plans to have only EV in India. Fast charging of EVs and Charging Infrastructure is required to make EVs widely acceptable as the charging time is the key barrier standing in the way of widespread acceptance of EV. Thus, important enabler of the transformation will be – Smart Infrastructure for charging the EV. This will empower futuristic vision of the Nation.

One of the important aspects of this transformation is having an approving charging infrastructure. The present power system could face huge instabilities with wide spread of EVs. This project named 'Solar Powered Portable Electrical Vehicle charging station' uses hybrid power system. The solar energy is converted to electrical and used to charge the lead acid battery, which in turn charges the battery of the EVs connected to this station. When the energy from solar panels is not sufficient to meet the demands, electricity from power grid is utilized. Electric Vehicle battery charger is a business of imminent potential. Currently its worth is of billions of dollars, and supports millions of vehicles worldwide and is expected to grow exponentially in coming years. In such a scenario, it is crucial to provide public charging service. In order to make this more user-friendly a set of facilities are attached along with this station like user authentication, LCD display, audio interaction, WIFI connectivity, cloud storage and thingspeak platform. They could be installed at: Hotels, clubs, Retail stores, railway stations, Shopping malls, Universities, Colleges, Airports etc.

Key Words: *Dual power supply charging station, ESP32 MCU, cloud storage, user-friendly facilities, RFID, Smart infrastructure.*

1. INTRODUCTION

The widespread introduction of electric vehicles (EVs) is a major goal amongst policy makers because of their potential to significantly reduce the CO2-emissions of the transportation sector and thus the reliance on fossil fuels for transportation. Especially interesting fields of application for EVs are urban areas, where benefits such as virtually no local exhaust and noise emissions by far outweigh their currently limited available range. Hence, many cities such as Amsterdam introduce strong incentive programs to support the introduction of EVs. However, EVs are expensive due to high battery costs and limited in their usability compared to conventional vehicles.

Commercial success for EVs will require installing charging infrastructure that is accessible, easy to use, and relatively inexpensive—whether at home or in public locations. The form this infrastructure will take is still uncertain, with a range of charging technologies currently available and more expected to emerge over the next five years. The current range of equipment spans slower alternating current (AC) chargers best suited to home or office locations and short trips (Level 1-2 in this paper), and much faster direct current fast chargers (DCFC) for rapid refuelling in public locations, best suited for recharging on longer journeys (Level 3-5). The time taken to add 100 miles of range varies from 26 hours for the slowest AC charger, to six minutes for the fastest DCFC charger—still far slower than the 300 miles-per-minute enjoyed by a 30 mile-per-gallon ICE.

The vehicle battery charging station using hybrid power system developed in this work provides a unique service to the traveller who wishes to travel for a long distance using electric vehicle. For such users in between over the highways there should be an electric charging station to recharge their vehicle. The vehicle battery charging station can be quickly and easily installed outside any business premises.

1.1 Basic assumptions

The design of RF ID based Solar Powered Portable Electrical Vehicle charging station relies on the following assumptions:

- Maximum solar energy is used for charging the lead acid battery inside the vehicle battery charger to keep it charged fully all the time
- The charging current is up to 1 amp @ 48vDC
- A single solar panel of size 635 x 550 x 38 mm, 37WP capable of supplying up to 5 amp is used.
- Provision to charge maximum 1 vehicle is provided.

2. METHODOLOGY

The proposed protype uses AC supply from grid. Transformer is used to step down(220v/54v) the voltage from the distribution grid voltage level to EVs battery voltage levels. AC/DC converter transforms the ac power into dc power and forms a dc bus. EVs are connected to the DC bus for charging via DC-DC converters.

The DC bus makes it possible to connect Renewable Energy Sources (RESs) generation systems directly through a simple DC-DC converter, that is DC supply from solar panel is passed via solar charge converter and DC-DC converter to be stored in Lead Acid (PbA) battery through a suitable battery charger.

The prototype focuses on building an electric charging station which fills in the cavity that acts as obstruction in the penetration EVs globally. Thus, few user-friendly facilities are added and enabled with microcontroller unit to enhance the overall consumer experience.

Few other facilities attached are, for example, the RF ID reader and card enables easy authentication of every user. LCD display shows the charging time selected and the amount of money deducted/ left. Voice recorded memory chip enables recorded audio instructions to the user. With help of WIFI mod all the data is stored in thingspeak platform, which can be analysed and processed for further advancement.

3. MAJOR SUBSYTEMS

1) Hybrid Source Management Module
2) Station Management Module
3) Charging Point
4) Vehicle Side Subsystem
5) User Management Module

3.1HYBRID SOURCE MANAGEMENT MODULE

The hybrid source management module consists of two sources i.e., solar panel source and an electric grid source. The power drawn from the power grid is converted from AC to DC and the noise from both of the sources in the supply is reduced using a DC-DC converter. This power is then stored in a battery. In this project, we used a lead-acid battery of 48V rating.

3.2STATION MANAGEMENT MODULE

The station management module consists of the ESP 32 microcontroller. Various peripherals such as the keyboard for input, LCD display for output and a voice memory chip for an audio output is connected to it. The module is given a 12 V input from the battery and the charging of the vehicle is monitored through the charging regulator. A charging point is connected to the charging regulator.

3.3CHARGING POINT

To charge the lead acid battery of the car, a battery charger is required which can increase the charge of the battery. For this project, a 12V, 2A battery charger is used which can be used to charge the battery of the electric vehicle.

3.4VEHICLE SIDE SUBSYSTEM

The vehicle side subsystem is used to verify the results of the charging system. The vehicle side subsystem consists of an ESP32 microcontroller, a 48 V power supply, an LCD display and a voltage sensor. The 48V is given through the lead acid battery which is used to run the vehicle. The voltage level is detected by using voltage sensor which is then sent to the ESP and the output is then displayed through the LCD display.

3.5USER MANAGEMENT MODULE

The ensure that the user of the charging station is verified and receives timely updates about the charging condition of the vehicle, a user management module is used. It consists of an RFID sensor unit for user verification and a server on Thinkspeak cloud platform to retrieve the data about the various details of the battery.

4. SIGNIFICANT COMPONENTS

4.1 SOLAR PANEL (PHOTOVOLTAIC (PV) MODULE):

A solar panel (Photovoltaic (PV) module) is a device that produces a flow of electricity under sunlight. This electricity is accustomed charge batteries and, with the help of an inverter, it can power normal household electrical devices or loads.

Solar cells can either be monocrystalline (cut from one silicon source) or polycrystalline (from multiple sources). Let's look at the differences between the two options. Amongst the few types available Monolithic Solar Panels are used for this project.

Fig 01: Monocrystalline solar panels

Monocrystalline solar panels contain cells that are cut from one crystalline silicon ingot. The composition of those cells is purer because each cell is formed from one piece of silicon[4].

Solar panel specifications

• Total number of panels- 3 nos

• Maximum Power (Pmax) = 5 Watts * 3 = 15 Watts

• Maximum Power Voltage = 18 Volts * 3= 54Volts

• Open Circuit Voltage (Voc) = 18 Volts

• Short Circuit Current (Isc) = 1 Amp

• Temp coefficient of ISC = 0.08x102 A/C°

• Cells - 36

• Cell Technology - Monocrystalline Cell Shape – Rectangular

Therefore, the intensity of each solar panel = 5 watts

4.2 DC – DC CONVERTER:

DC-DC converters are also known as Choppers. Here we will have a look at Buck Boost converter which can operate as a DC-DC Step-Down converter or a DC-DC Step-Up converter depending upon the duty cycle (D)[3].

In this project the dc output from solar panels which bear voltage in the range of 46V to 54V is fed into the input of the Buck Boost converter, which produces a constant DC voltage of 48V.

When the sunlight is sufficient or more than necessary then voltage produced by PV solar panels is approx. 54 V for the given specifications of the PV modules.in that case the DC-DC converter bucks the input, that is lowers the input value to give constant 48V output.

Similarly, when it's a cloudy day or when there's no sunlight (at night) the voltage produced by PV solar panels is approx. 46 V for again for given specifications.in such case the DC-DC converter boosts the input, that is apprehends the input value to give constant 48V output. The DC-dc converter uses PID converter to provide constant sensitive output. the simulation of DC-DC Buck Boost converter is shown below, done using MATLAB along with the circuit diagram.

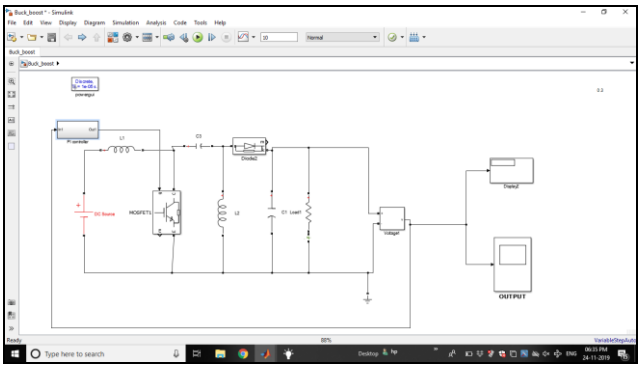

Fig 02: Block diagram of DC-DC Buck Boost Converter

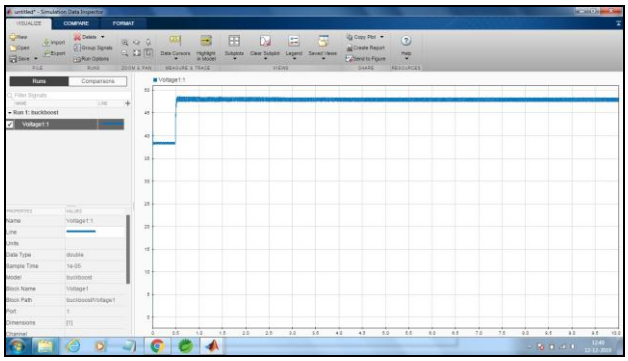

Fig 03: Simulation of DC-DC Buck Boost converter using MATLAB

4.3 RECTIFIER

An electrical device that is used to convert alternating current into direct current is called as rectifier. Every electronics system which is made of embedded systems-based circuit or project consists of micro-controller as major component [2].

The power from the grid is of AC form, at the customer end it is of magnitude 220V -230V. Now when the EV is connected to the charging station, the power conversion of suitable form happens like this. First an AC transformer steps down the voltage from 220V to 54V keeping the frequency and power same. Then this 54V is converted from its AC form to DC form with the help of a Bridge rectifier. The output of bridge rectifier is 54V variable DC, which is then sent to DC-DC converter to obtain stable, constant DC.

4.4 BATTERY

The Lead Acid battery which uses sponge lead and lead peroxide for the conversion of the energy into electric power, such style of battery is termed a lead acid battery. The lead acid battery is most generally employed in the power stations and substations because it's higher cell voltage and lower cost.

Some general specifications of the standard Lead Acid Battery
Nominal cell voltage: 2.1 V
Charge/discharge efficiency: 50–95%
Charge temperature interval: Min. −35 °C, max. 45 °C
Self-discharge rate: 3–20%/month
Specific energy: 35–40 Wh/kg
Energy density: 80–90 Wh/L
Specific power: 180 W/kg
In this project we aim at using 4 nos of 12V, 1Ah capacity.so that makes the total capacity as:
If connected in series: 4*12=48 V, 1Ah capacity.
If connected in Parallel: 12V, 4Ah capacity.
Since the optimum voltage to be fed in to the battery is 48 V we'll choose series connection of the Lead Acid batteries for the project.

4.5 RADIO-FREQUENCY (RF):

Radio frequency Identification (RFID) is termed as wireless identification technology that uses radio waves to spot the presence of RFID tags. Just like Universal Product Code reader, RFID technology is employed for identification of individuals, object etc. presence.

RFID based system has two basic elements:

1. RFID Tag: RFID tag has microchip with radio antenna mounted on the substrate which carries 12 Byte unique Identification number.
2. RFID Reader- It reads unique ID from RFID tags. Whenever RFID tags comes in range of the RFID reader, it detects the unique ID on from the RFID tad and communicates it serially to the microcontroller or PC. RFID reader has transceiver and an antenna mounted upon it. It is mostly fixed in stationary position.

4.6 LCD DISPLAY:

A liquid-crystal display (LCD) is a smooth panel display, electronic video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly.

LCDs are utilized in a good range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage.

In this project the LCD shown in the above figure is used .it is of configuration 16 X 2.

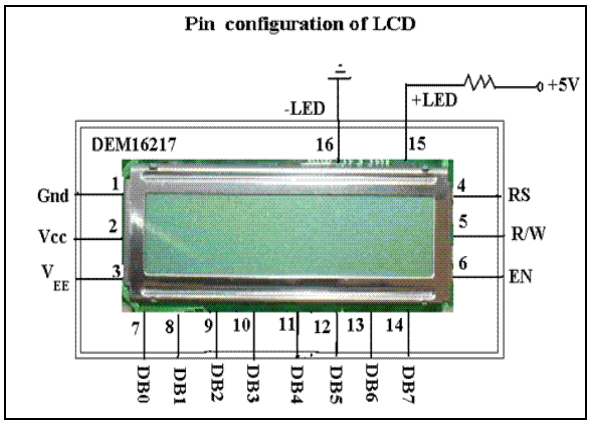

Fig 04: LCD

It basically facilitates monitoring and shows various selected parameters such as

- Voltage of solar panels
- Time left/selected for charge
- Balance left/ deducted from the user account

4.7 ESP 32 - NODE MCU

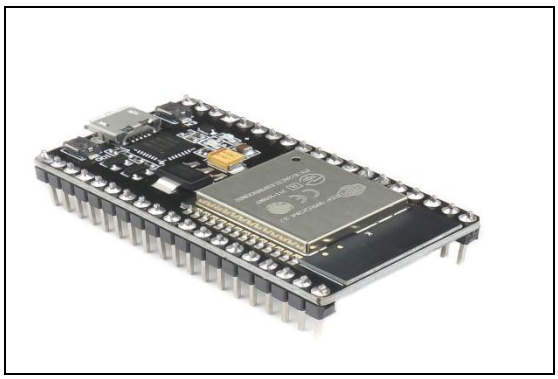

Fig 05: ESP 32

The ESP WROOM 32 is a great, generic module that has WIFI-BLUETOOTH-LOW ENERGY as its prominent features. It targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as audio encoding, MP3 streaming and decoding.

At the core of this module is a ESP32S chip, which is meant to be scalable and adaptive. There are 2 CPU cores which will be individually controlled or powered, and therefore the clock frequency is adjustable from 80 MHz to 240 MHz . The main use of the Node MCU in this project is to transfer the data over WIFI and store it in cloud for storage and analysis.

Its another important task here is to convert the Analog data to digital data that can be displayed on LCD.

4.8 I2C

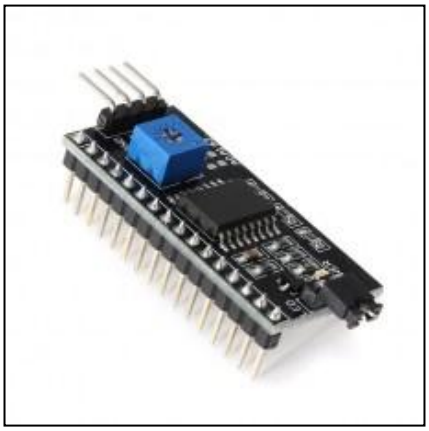

Fig 06: I2C Module

I2C combines the best features of serial peripheral interface (SPI)and universal asynchronous receivers - transmitters (UARTs). With I2C, you'll be able to connect multiple slaves to one master (like SPI) and you'll have multiple masters controlling single, or multiple slaves. This is used because here in this project we have more than one displaying text to a single LCD.

4.9 CLOUD COMPUTING (THING SPEAK)

The data visualization and storing will be done in MathWorks's Thingspeak platform.

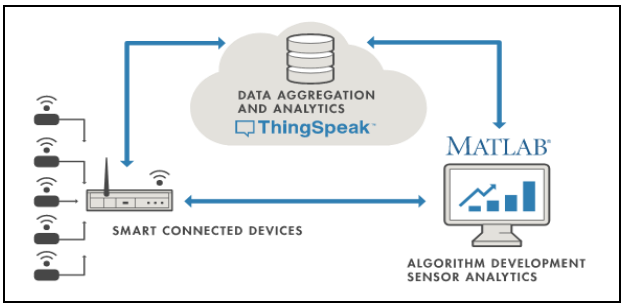

Fig 07: use of Thinkspeak

The data collected over thingspeak can be viewed on PC or mobile application. this project aims at collecting

1. user end credentials for authentication
2. Time selected for charging the vehicle
3. Frequency of usage/charging etc.

All of this data can be analysed to draw study various aspects like the frequency of a particular customer, time he/she usually selects for charging, money spent, type/ company of automobile etc.

4.10. SOLAR CHARGE CONTROLLER

A solar charge controller is basically a voltage or current controller used to charge the battery and keep electric cells from overcharging [1].

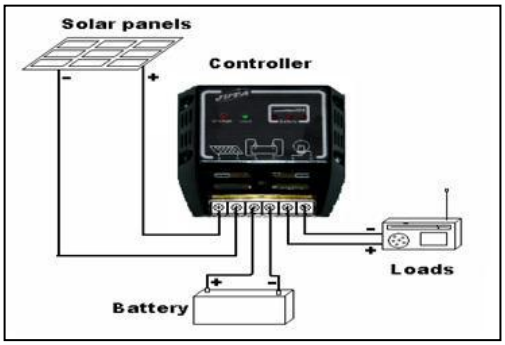

Fig 08: Solar charge controller

It directs the voltage and current hailing from the solar panels setting off to the electrical cell. Generally, 12V boards/panels put call at the ballpark of 16 to 20V, so if there's no regulation the electrical cells will damage from overcharging.

4.11 BATTERY CHARGER:

When the Lead Acid battery discharges, it is charged again Like every device which needs its charger to gain back the lost charge, lead acid battery requires on of its kind to recharge. this is what battery charger is meant for.

Fig 09: A Solar battery charger

A simple 12V, 2A battery charger is shown in the above figure.

4.12 TRANSFORMER:

A transformer is defined as a passive device that transfers power from one circuit to secondary through the method of electromagnetic induction. It is most typically utilized increase ('step up') or decrease ('step down') voltage levels between circuits[5].

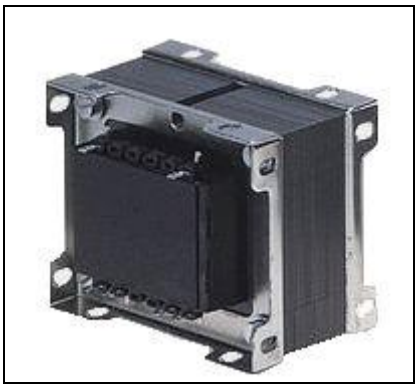

Fig 10: Voltage transformer

The power supply from the grid at the consumer end is in terms of 220V-230V, to convert this voltage to usable form , it is stepped down to 54V.using a small voltage transformer as above.

4.13 PUSH BUTTON/ KEYBOARD

Push-Buttons are normally-open tactile switches. Push buttons allow us to power the circuit or make any particular connection only we press the button. Simply, it completes the circuit connected when pressed and breaks when released. A push button is additionally used for triggering of the SCR by gate terminal.

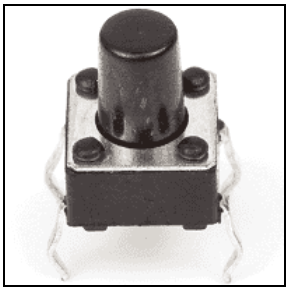

Fig. 11: A push button

A push button as shown above is used to take inputs from the consumer, while selecting the time and amount for charging the vehicles, based on the instructions displayed in the LCD.

5. CONCLUSION

The charging station prototype is implemented with a hybrid power supply to charge electric vehicles efficiently, keeping in mind the need to switch to renewable sources for energy supply. With the recent advancement of the sustainable transportation industry, this will be used to charge vehicles in an eco-friendly way. The proposed prototype can charge an electric scooter at the least. Since this is just a prototype, it may to be able to charge the e-scooter within desirable time.

In order to speed up the charging time necessary changes has to be made with respect to the battery capacity. Battery of higher ampere -hour specifications must be used. The current has few limitations, like it is not that efficient during cloudy and rainy days, there is loss of solar energy in the transfer of power, loss of solar energy in the transfer of power and the charging current is up to 1 amp @ 48vDC.

Futuristic approach or advancement could be- being able to charge a variety of EVs; use of solar tracking system for max output from solar panels; increase in the range of journey over one charge thus to establish the real time charging station.

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ROBOTICS FOR INSPECTION OF HIGH VOLTAGE TRANSMISSION LINES

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Abstract: Transmission line inspection has usually been a high risk and expensive work. Hazardous works so as to damage operator as properly as recurring that require specific handling. India relies mostly on electric energy structures for commercial as properly as home utilization. Unfortunately, the electrical energy distribution structures are inefficient causing wastage of about 30% at some stage in transmission from power plant to the end users. Our paper describes the introduction of a mobile tool designed to move alongside the high-strength transmission lines continuously analysing various parameters including energy loss at some stage in transmission of power from the generation sites to the houses of the consumers. In case of any malfunctioning or abnormality, the tool intimates the people responsible through IOT. Parameters like GPS, temperature and distance are measured and solar panel is employed by coupling with the battery making the tool environment-friendly. The content supplied over here gives the improvement of a tele-operated Expliner robot designed for preventive renovation of high-voltage electric powered transmission. Automated transmission line examination and fault revealing is proposed to perform through image processing, and sensory data acquisition.

Index Terms: **Tele-Operated, IOT (Internet of things), Expliner.**

I. INTRODUCTION

In India, the intake of electric powered energy has extended to a startling amount due to a growth in users, and a boom in commercial power intake. Despite how carefully the designing of the circuit is carried out, losses do exists in the transmission strains. External elements or internal factors results in the increase of electrical power losses, and thus, the wastage of electricity. To call a few, some strength losses encompass losses because of ohmic resistance, atmospheric conditions, miscalculations, etc. all through transmission between assets of supply to the consumers (or load centre). Technical survey carried over the years delineate that around 35-40% of the entire power generated inside the power plant life makes their manner to the end-user. Rest all will be lost in the shape of power loss. This will curtail the financial and electrical stand of our land. High voltage transmission traces connecting the power plants and sub-stations positioned near the load (How electricity is brought to consumers, n.D.) form a vital a part of delivering electricity from the source to the customer. It is one of the key factors in determining the reliability of the energy infrastructure in a country. Various components are involved in the transmission system. They should be well maintained consistently with given protection and reliability standards below a harsh environmental condition. The feasible damages and degradation as a result of poor weather and long-term use could result in the unfinished functioning of the components (Overhead Distribution Manual, n.D.), which could result in power loss and poor carrier to the customers. Hence, we have come up with a concept of designing a robot to travel alongside the high strength transmission traces where the day to day guide inspection cannot be completed frequently. The device keeps track of environmental situations along with temperature and transmission line parameters.

II. CONVENTIONAL METHODS OF INSPECTION

Fig 1: Ground inspection

Fig 2: Manual inspection

Fig 3:visual inspection by helicopters

Fig 4: Sensors method

Ground inspection: Ground inspection is the oldest and maximum intuitive transmission line inspection technique. A crew of service employees is dispatched out on the field to look into an electricity line. The personnel carry gadget to assist them of their task, but in the end depend on their senses to perform the inspection. If the electricity line is on the point of roads or passable waterways, this method is used. In locations with heavy snow-fall, snowmobiles may be used. If no further convenient choice is out there, the provider employees have to traverse the length of the line on foot. Once under the energy line, the service personnel have to check the status of it. The primary method of doing this is to visually asses the structures, the usage of binoculars, cameras, or plain eyesight. Visual assessment is a sufficient way for plenty inspections of vegetation, insulators, towers, and cables.

Manual inspection: To inspect the traces, people ought to walk on the cables, in many cases suspended few hundred meters above the ground. Special gondolas may also be employed, permitting the operator to "slide" at the cables. These methods imply the interruption of transmission of electricity, require professional people, and disclose the people to unusual levels of risk and stress.

Visual inspection via helicopters: This technique is to perform visible inspection of the cables by way of helicopter with video cameras. Pattern-recognition algorithms can be used to enhance the performance of inspection by means of video. However, those inspection tasks have a tendency to be expensive, and frequently offer just partial photographs of the cables. Flying helicopters close to the transmission traces and towers additionally involves risks that need to be avoided. Some of these dangers may be reduced by means of using unmanned helicopters.

Sensors technique: As alternatives to visible inspection, thermal sensing, X-ray and electric powered sensing may be used to stumble on damage within the transmission traces, however the sensors need to be located adjacent to the cables.

Fixed sensor technique: A constant sensor is set up at the power line device and stays there throughout its carrier life. Data from any such sensor is transmitted by means of cable or by RF-communication. The requirement of power in present day sensor structures is often made, so tiny that a battery is sufficient for years of operation. Other energy supply alternatives in use these days are solar cells, and equipment established on the conductor itself can be through induction that gathers energy from the varying magnetic field of the live line.

III. LITERATURE SURVEY

Expliner robot by Paulo Debenest, Michele Guarnieri, Kensuke Takita, Edwardo F. Fukushima, Shigeo Hirose, Kiyoshi Tamura, Akihiro Kimura, Hiroshi Kubokawa, Narumi Iwama and Fuminori Shiga employs pulleys to move on the transmission lines, and has a carbon-fibre structure with a T-shaped base and a 2- DOF manipulator [1].

A Remotely Operated Vehicle (ROV) prototype was implemented to test the proposed approach in a single transmission line span by Thamashi Malaviarachchi, Thadeesha Perera, Supun Perera, Pasika Ranaweera [2]. The intended functions of the proposed ROV are positioning, live video transmission and the sag template indication of the transmission line which are being explicated in this paper. But the proposed design is supposed to be operated in a single span. But for the industrial applications, span to span operation is a compulsory requirement. Therefore, an enhanced structure should be designed which consists of three wheels to successfully operate on multiple spans. The ground clearance is expected to be in a standard range of 15-20 m. Hence, a sensor with more than 20 m is required. Currently, the prototype operates with an ultrasonic sensor which has a maximum range of 5 m. Therefore, to achieve the required range with actual transmission lines, high precision LIDAR system can be implemented.

Autonomous inspection robot by Ayush Kumar pandey developed cable car for navigating on the wires. A set of wheel-claw mechanism is mounted on the end of each arm. The robot can hop on the wires with its arms and claws. The control system and the inspection devices are installed within the control box which is suspended under the body of the robot. Each arm has 4 DOF. The rotary joint on the arm can regulate the claws for grasping object accurately. The screw and nut mechanisms are applied to drive the claws and wheels upward and downward. This prototype failed to operate in different climatic conditions and was inadequate to maintain a proper centre of mass on the inclined cables. This failed to implement the protection of robot from EMF effects [3].

LINESCOUT, developed by MONTAMBAULT and POULIOT addresses [4] these issues elegantly by moving on the live lines with enough mobility to overcome suspender clamps and other obstacles, while performing simple maintenance, and repair tasks. However, the sensing of live lines especially of multiple cables simultaneously — still represents a challenge.

The LineRover, developed by MONTAMBAULT was perhaps the first practical robot for the inspection of lines, but was not able to cross large obstacles. In order to overcome this limitation, SAWADA developed [5] a robot with several degrees of freedom that uses a rail to cross suspender clamps, in a rather heavy and complex configuration.

In CHINA, TANG, ZHU and others have worked on a robot that moves on the ground wire, above the live line. The ground wire has few obstacles and is easier to navigate. However, this brings additional limitations regarding the quality of the data acquired from the live lines, since the robot can obtain only partial images of the cables [6]. By moving the position of its centre by moving the position of its centre of mass, Expliner actively controls its posture and overcomes obstacles. But the current prototype could confirm its mobility concept on horizontal lines, but not on inclined cables. Therefore, its overall mass must be reduced, while concentrating mass in the counter-weight, so that the motion units can be lifted more and perform obstacle avoidance even on inclined cables. Expliner was able to climb cables with an inclination of up to 30 degrees. However; the motion units were dragging more electric current than the recommended limit to operate continuously. In addition, overcoming spacers on inclined cables require Expliner to change its centre of mass. One type of spacer could not be overcome [7].

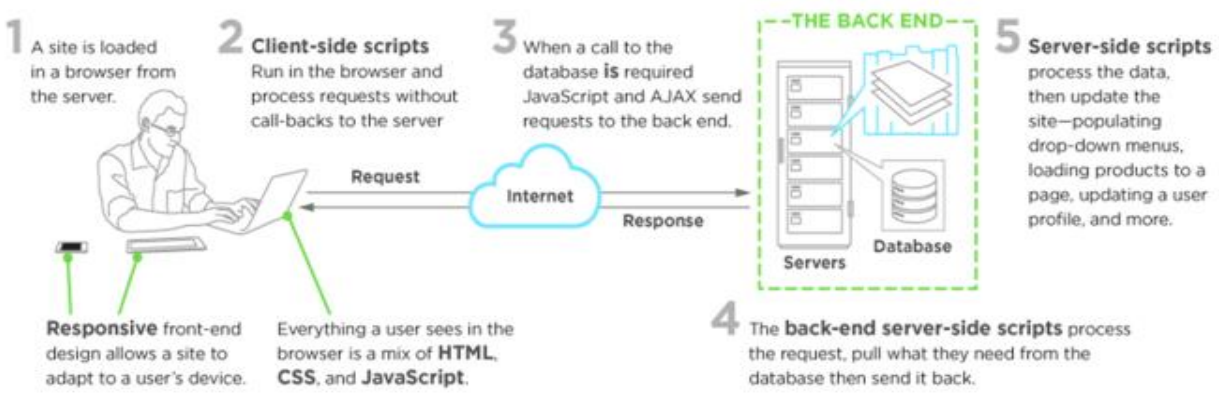
P. S. Ranaweera_, D. C. Alahakoony, K. S. S. Prabhashwaray and A. M. G. V. I. Lakmaly proposes a method being tested by a prototype for traversing alone the transmission conductor, inspecting the line through a real time video streaming, detecting faults and pinpointing them through Geo Tagging. This technology will expand the remotely operating distance of the ROV. Furthermore, a mechanism was developed to enable the robot to cross over from one span to another in the transmission network which includes suspension type insulators. However, the operating time of the prototype ROV is considerably low due to its high energy consumption [8].

IV. OBJECTIVE

- This project revolves around the creation of a mobile tool designed to move alongside the high-voltage transmission lines constantly analysing various parameters including rate of electricity loss throughout transmission from the power plants to the houses of the consumers.
- Conventional methods require manual inspections which can be dangerous because of the high electricity inside the transmission lines. Through these devices, periodical check-ups can be avoided.
- Any damage in the transmission lines can be detected most effectively after conditions like low voltage or power cuts occur. By the usage of these robots, future mishaps can be effectively prevented.
- In case of any malfunctioning or abnormality, the tool intimates the people responsible through IOT.
- Parameters like GPS, temperature and distance are measured and solar panel is utilized by coupling with the battery making the robot environment-friendly.
- To provide safety, unlimited and uninterrupted power for all.

V. DEVELOPMENT PLATFORMS

Front End development:



Web Interface Design:

Fig 5: Authentication page

The main web interface of this robot contains the real time image capturing of a fault, GPS plot and the type of fault which are obtained by the acquired sensor data from the robot. This interface is developed using HTML, CSS, PHP and JavaScript. First a user has to login with the username and password which is issued by the system administrator to get access to the interface. The authentication page is shown in the fig 5. Authorization depends only on the administration except the user cannot get access himself to the web page. Here the extracted faulty images of HV cables, type of faults and GPS plot of fault lines are saved in different folders.

Hardware components:

Raspberry pi 3: This fruit-named computer is a precious tool for students, artists, and of course hobbyists and hackers. With features for developing things in several areas, it's not a surprise to possess many on-board 5V regulators, so if your supply voltage is up to 12V you can also source 5V from the board. In this model Raspberry pi is configured to work as a server for wireless data transmission.

Lithium polymer battery: A 11.1V lithium Polymer battery to power the whole Robot.

Voltage regulator: A regulator like LM7805 can convert 11.1 V of battery to 5V (for Raspberry Pi).

DC geared motion: Geared DC motors can be defined as an extension of DC motor. A geared DC Motor incorporates a gear assembly attached to the motor. The speed of motor is measured using metric rotation/minute typically is in thousands if not million rotations/minute.

LC293D driver: L293D is a Motor Driver IC which allows DC motor to drive on either direction. L293D may be a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It implies that you can control two DC motor with a single L293D IC.

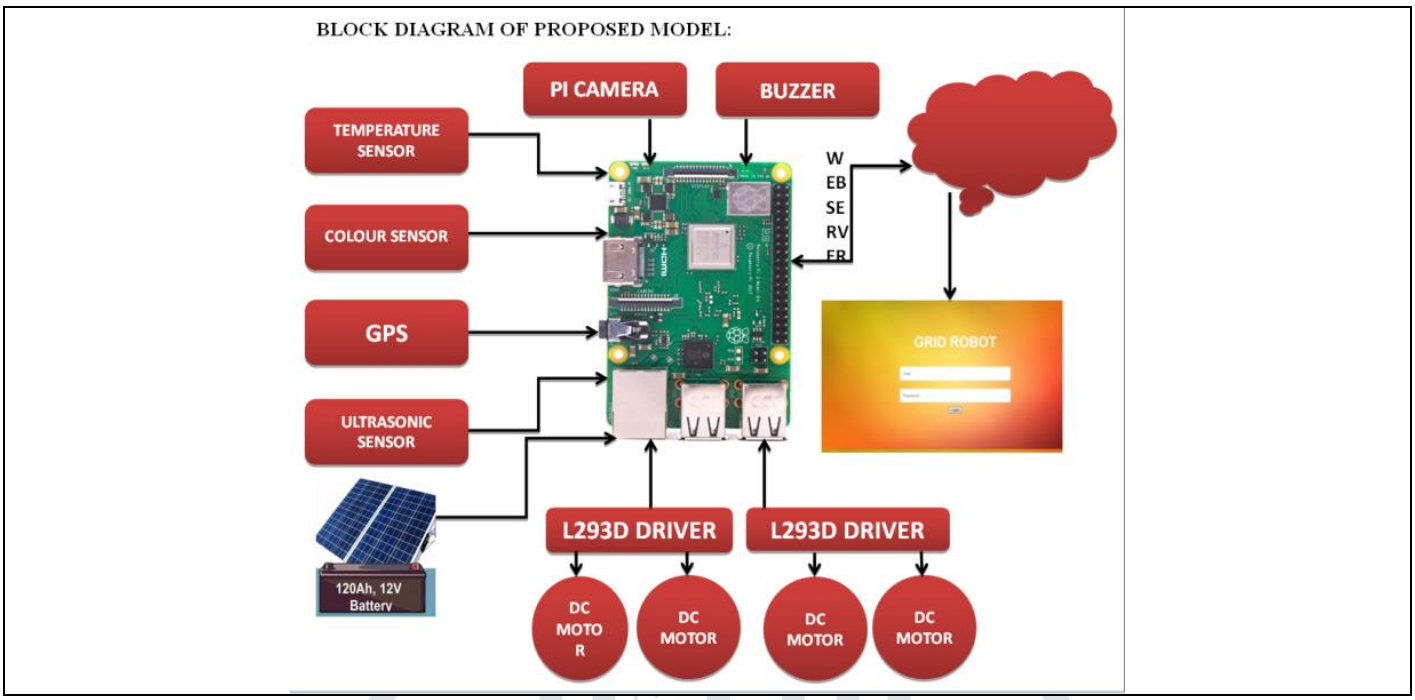
Pi camera: This is a portable lightweight camera that supports Raspberry Pi. It communicates with Pi using the MIPI camera serial interface protocol. It is normally employed in image processing, machine learning or in surveillance projects.

Buzzer: This is a small yet efficient component to add sound features in our project for fault detection in remote places.

GPS module: GPS receivers use a constellation of satellites and ground stations to compute position and time almost anywhere on earth. It detects the exact location of the faults on HV cables for preventive measures.

Sensors: An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear).colour sensor is used to detect the conductor colour during faults. Temperature sensors are used to detect the temperature of conductor during short circuits or increase in current level in conductors during faults..

Block diagram of proposed model:



VI. WORKPLAN

- Smart power line robots are hung along the HV lines for inspection and rectification. The robot is powered up employing a 12V battery which is being continuously recharged using an environment-friendly solar panel. The power is distributed to the voltage regulator which successively steps down, and forwards the voltage to the relevant low- power components.
- Dc Motors are attached to the driver circuit (L293D) for to and fro motion of the robot along the transmission line
- Sensors like ultrasonic, current, temperature and colour are used for smart metering which ensures accuracy and reliability.
- Ultrasonic sensors are used for obstacle detection within the specified range.
- The expedience of the current limit and therefore, the upswing in temperature can be sensed using temperature sensor
- The damage to the wire just in case of humidity, moisture which results in colour change is detected using colour sensor.
- The internet connection is used to plot data obtained from sensors online. The significant aspect of the robot involves the utilization of GPS module which provides the exact location of fault. The Raspberry pi is configured to work as a server, in order that GPS data is hosted as HTML data to the user end. Distance measuring data is obtained by Raspberry pi through GPIO pins.
- Analysis of the above- mentioned parameters are controlled using raspberry pi which acts as a server using python programming and data can be accessed through a web page.
- Wireless transmission of the measured parameters which intimate the concerned authority to rectify the problem before it becomes an issue.
- Real time monitoring is carried out using pi camera.

VII. FUTURE SCOPE

The magnetic field energy harvesting unit is capable of recharging the battery employed in the robot and provides a low cost solution than renewable energy sources.

To beat the difficulties appeared in the presence of magnetic and electrical fields of high voltage lines, a well-insulated enclosure box is constructed. This enclosure consists of a magnetic shield, an electrical shield (Faraday's cage) along with a roof to withstand the climatic conditions.

Future enhancements include building a mechanical structure which can move to different transmission lines bypassing the repeaters, and transformers between them.

VIII. CONCLUSION

The project is intended in a way to improve efficiency and to be as much user-friendly is as possible. Simplicity of component use also works as an element for low power consumption and simple maintainability. These power line inspection smart robots are going to be considerably effective and we hope, will bring forth a revolution in the Power and Electricity Board of our nation leading to a greener future and unlimited, uninterrupted power for all.

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TWO AXIS MOTION CONTROL WITH INTERPOLATION USING PLC

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Abstract: This paper is designed to implement of a two-axis motion control with interpolation using PLC (Programmable Logic Controllers). Linear motion is one of the fundamental movements and an absolute necessity for any motion controller. High precision, repeatability and direction-independent are the three important factors to evaluate the performance of two axis motion control with Interpolation. To achieve this, PLC based algorithm is implemented, which avoids complex on-the-motion computation with skillful combination of the accumulator and multiplier-based hardware structure. In addition to employ high speed and high precision equipment such as linear motor-driven stages, the precision of the machined contours is highly dependent on the capabilities of the servo controllers or stepper motor controllers. In this paper, the design of a precise controller for a two-axis LMDS has been investigated for interpolating applications.

Index Terms - Motion control, Two axis motion control, PLC, Linear Motion, Interpolation, Stepper Motor

I. INTRODUCTION

Many times, because of human errors lots of accidents occur. Improper lifting/overexertion is one of them. Industrial accidents occur when there is a failure to follow proper procedures, including taking shortcuts, improper handling of materials, misuse of equipment, fatigue and over confidence about abilities. This project is dedicated to adding extra facilities with the existing system of motion control. Decreasing settling time allows the controller to move more rapidly from one position to the next position where the further process will begin. All multi axis motion control involves coordinated motion. In reality, coordinated motion is very specific subset of motion control. Control schemes that involve multiple axes operating independently to position the load are much simpler to execute than those requires very fast control loops with high-resolution feedback.

A PLC is an industrial computer control system that continuously monitors the state of input devices and makes decision based upon a custom program to control the state of output devices. Most of the production line, machine or process can be greatly enhanced using this type of control system. However, the biggest benefit in using a PLC is the ability to change and replicate the operation or process while collecting and communicating vital information. Another advantage of a PLC system is that it is modular. That is, we can mix and match the types of Input and Output devices to best suit for application. Because of the move and settle nature of the process, this type of equipment has traditionally used stepper motors. Now, that is changing. “One of the big trends we are seeing is a move from stepper motor technology to servo motor technology.

II. Introduction to motion control

Motion control is an exciting automation technology that has become the cornerstone of modern industrial machinery design. It is about making a mechanism move under complete control, how you want, when you want. It incorporates the finer elements of motor control and requires careful mechanical design. Motion technology is advancing to provide improved performance and increased ease of use, enabling servo and motion controls to be applied more widely than ever before. Motion control can provide greater accuracy, performance and efficiency in many production machine applications. Motion control technology can be applied to rotary servo motors, asynchronous AC and DC motors and various linear motor technologies, to provide ever more flexible and dynamic production systems. The result is that every automation engineer should now have some background knowledge of motion control systems and their mechanical requirements.

Two Axis Motion Control

The term "axis of motion" refers to one degree of freedom, or forward and backward motion along one direction. It may be linear or rotary motion, and may take the form of a conveyer belt, a rotary knife, or many other types. When two or more axes of motion are involved on a single machine, that machine is employing multi-axis motion. The axes may be working independently, or moving together. The need for multi-axis synchronization arises whenever the axes must move together, and the relationship between their respective motion is important.

The most familiar example of a multi-axis application requiring synchronization is that of an X-Y plotter. Here there are two axes, the X direction and the Y direction. Each may move independently of each other, but if a two-dimensional figure is to be drawn accurately, their motion must be coordinated. The figure below illustrates what happens to a 45-degree line if the X axis starts and ends later than the Y axis.

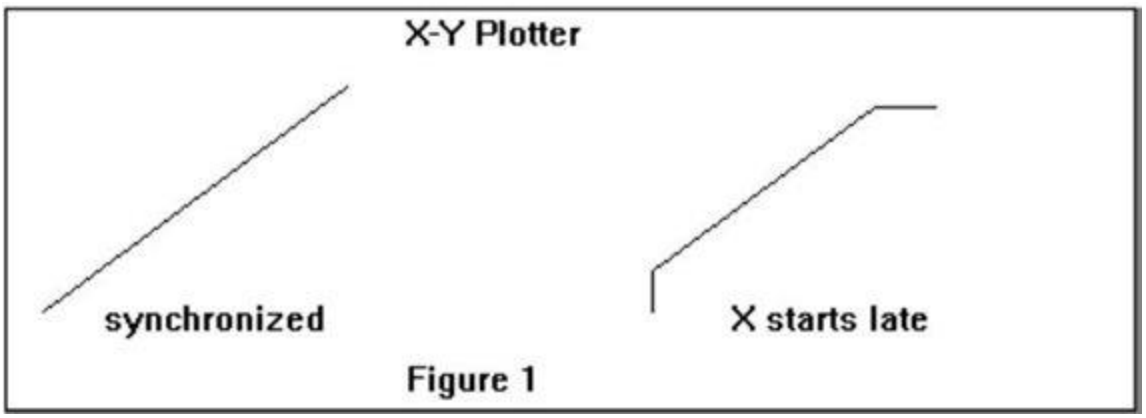


Fig: Example of XY Plotter

III. Stepper and Servo Motion Control Systems

The availability of electronic motion control has brought solutions to the problems inherent with the mechanical approach to synchronization. To understand how these solutions are achieved, it is helpful to review basic electronic motion control systems. One axis of electronic motion control consists of the motor, the motor drive, and the controller. The controller accepts motion commands from a host computer or an internally stored program. These commands are interpreted by the controller to generate continuously updated position commands (motion profiles) to the drive. The motor drive controls the current to the motor which will result in the commanded position. In a multi-axis system, one controller can control several motor and drive combinations.

The motion control system may be a **stepper or servo system**. Stepper systems tend to be less expensive than servo systems, but have less speed and power for a given size of motor. In stepper systems, the drive receives position commands in the form of low voltage pulses (steps), and adjusts the *phase* of the current in two sets of motor coils to align the motor shaft. Each new step received corresponds to an additional increment of rotation on the shaft. Current is maintained in the motor coils, even when the motor shaft is in the correct position. Common step motor resolutions range from 200 steps per revolution (full stepping) to 50,000 steps per revolution (micro-stepping).

Servo systems employ motor shaft position feedback, either from an incremental encoder or from a resolver. The actual position and velocity derived from the feedback is compared to that commanded in the motion profile to result in a torque command to the drive. In servo motors, the phase of the current is adjusted according to the actual position of the shaft. It is continuously adjusted to produce maximum torque for a given current amplitude. This process is called commutation, and is done mechanically in brushed motors, and electronically in brushless motors. The drive controls the amplitude of the current to the motor in proportion to the torque command. In analog servo systems, the feedback goes to the controller, and the controller's output is an analog torque command. In digital servo systems, the drive accepts steps as the position commands, and the shaft feedback goes only to the drive. Servo systems must be tuned to match the load they are moving for the best performance. A properly tuned system results in powerful and precise positioning of the load. The choice of motion control system will depend on the particular application

IV. PLC (PROGRAMMABLE LOGIC CONTROL)

A Programmable Logic Controller, or PLC, is a ruggedized computer used for industrial automation. These controllers can automate a specific process, machine function, or even an entire production line.

How does a PLC work?

The PLC receives information from connected sensors or input devices, processes the data, and triggers outputs based on pre-programmed parameters. Depending on the inputs and outputs, a PLC can monitor and record run-time data such as machine productivity or operating temperature, automatically start and stop processes, generate alarms if a machine malfunctions, and more. Programmable Logic Controllers are a flexible and robust control solution, adaptable to almost any application.

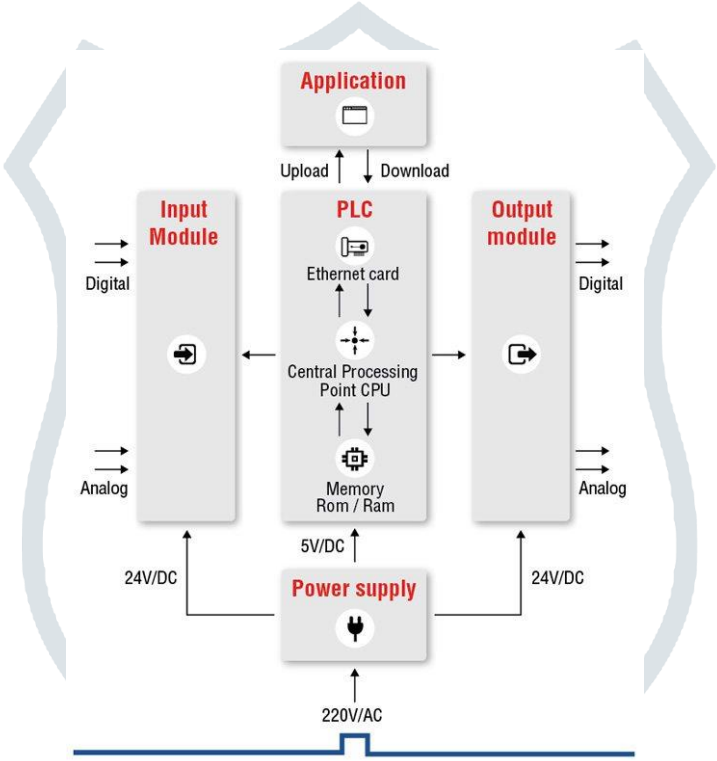
There are few key features that set PLC'S apart from industrial PC'S, Microcontrollers and other Industrial control solutions:

I.I/O – The PLC's CPU stores and processes program data, but input and output modules connect the PLC to the rest of the machine; these I/O modules are what provide information to the CPU and trigger specific results. I/O can be either analog or digital; input devices might include sensors,

switches, and meters, while outputs might include relays, lights, valves, and drives. Users can mix and match a PLC's I/O in order to get the right configuration for their application.

II.Communications – In addition to input and output devices, a PLC might also need to connect with other kinds of systems; for example, users might want to export application data recorded by the PLC to a supervisory control and data acquisition (SCADA) system, which monitors multiple connected devices. PLCs offer a range of ports and communication protocols to ensure that the PLC can communicate with these other systems.

III.HMI – In order to interact with the PLC in real time, users need an HMI, or Human Machine Interface. These operator interfaces can be simple displays, with a text-readout and keypad, or large touchscreen panels more similar to consumer electronics, but either way, they enable users to review and input information to the PLC in real time.



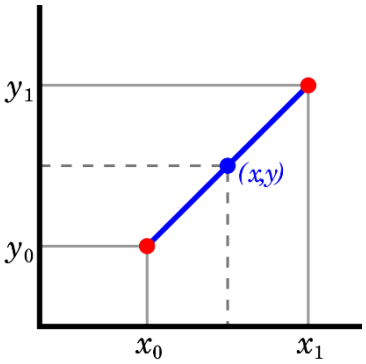
V. CIRCULAR AND LINEAR INTERPOLATION WITH PLC MOTION CONTROL

Interpolation : Is a type of estimation a method of constructing new data points within the range of a discrete set of known data points. The interpolation is either linear or circular, but we consider linear interpolation.

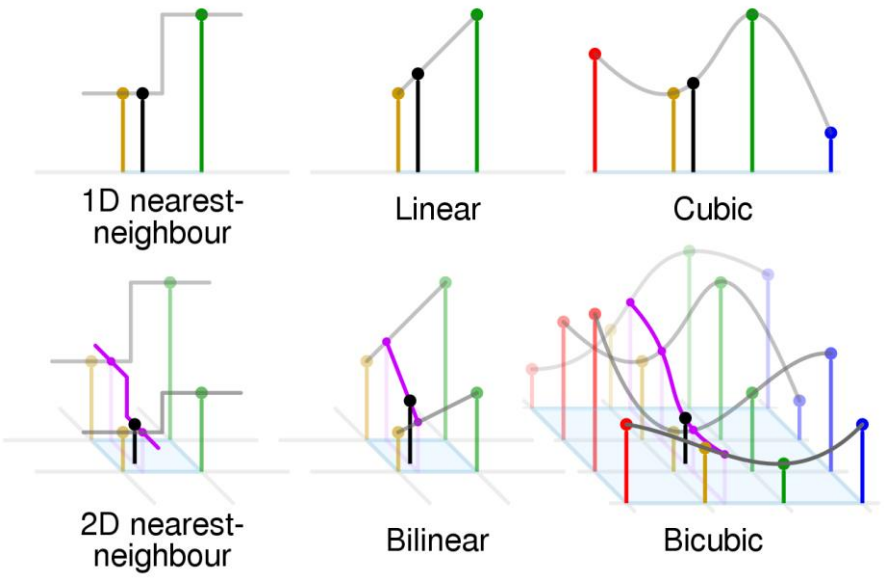
Linear interpolation: Is a method of curve fitting using linear polynomials to construct new data points within the range of a discrete set of known data points.

Circular interpolation: Since not all parts are made of flat surfaces, end mills will invariably need to move in a non-linear path. In the case of machining circular tool paths, the path of the end mill's centerline is circular. This is referred to as Circular Interpolation.

Linear interpolation between two known points:



Given the two red points, the blue line is the linear interpolant between the points, and the value *y* at *x* may be found by linear interpolation.



Comparison of linear and bilinear interpolation some 1- and 2-dimensional interpolations. Black and red/yellow/green/blue dots correspond to the interpolated point and neighboring samples, respectively. Their heights above the ground correspond to their values.

Circular Interpolation:

All rotating end mills have their own angular velocity at the outside diameter. But when the tool path is circular, there is an additional component that is introduced, resulting in a compound angular velocity. Basically, this means the velocity of the outside diameter is travelling at a substantially different velocity than originally expected. The cause of the compound angular velocity is seen in the disparity between the tool path lengths.

When G02 (clockwise circle, CW) or G03 (counter-clockwise circle, CCW) is selected, the programmed path is traversed with a feedrate given by the F-word, on a circular movement to the target position. Circular movements can be run in the three main planes of the spatial coordinate system (X-Y, Z-X, Y-Z). The selection of the main plane is done using the functions G17, G18, G19.All programmed tracking axes are moved with linear velocity in such a manner that the start and the end of their movement take place simultaneously to that of the main axes.

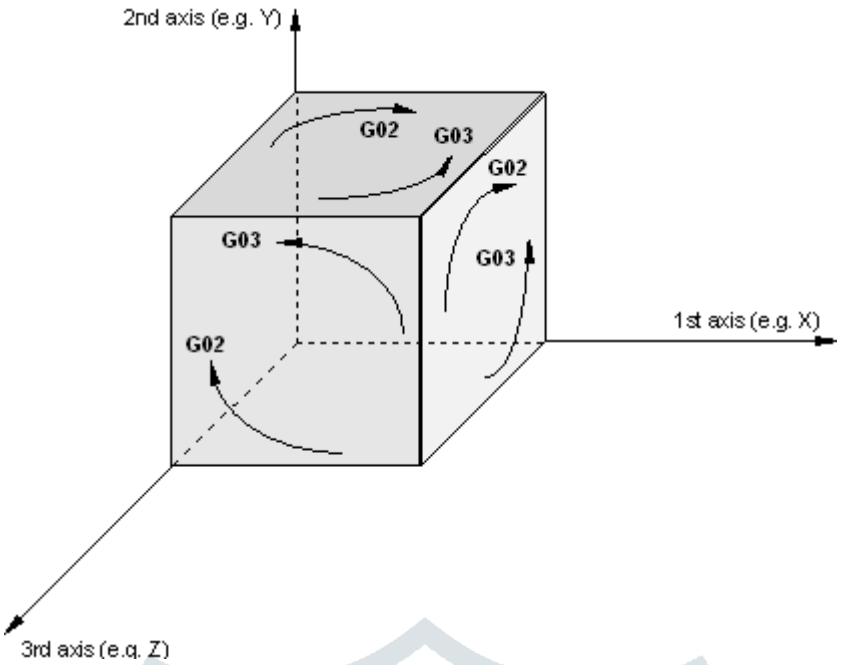


Fig: Elucidation of circle functions G02 and G03

G02 Circular interpolation clockwise circle (CW) (modal)

G03 Circular interpolation counter-clockwise circle (CCW)

INTERPOLATION ALGORITHMRESEARCH

In all curves, straight line is the most fundamental curve; any complex curve can be approximated by a mass of short lines, so the linear interpolation is very important in motion controller.

Generally, linear interpolation methods include Plus-minus Method, Point-to-point Comparison Method, and Differential Analytical Method, etc. All of those interpolation methods, usually implemented by software in MCU or PC, are classified as Incremental Method which needs interpolation calculation, error/destination judgment, and pluses feeding in every interpolation process . With this implementation mode, plenty of software resource is occupied, which result in slow speed in drawing picture and time-consuming in CPU, so one CPU sometimes may be not competent for burdensome tasks such as drawing management and drawing execution, etc. To enhance the drawing speed, linear interpolation method implemented by hardware circuit such as FPGA is sought, and the particular structure of FPGA make it have an excellent time performance in interpolation calculation. This method suits to apply in machining and drawing instrument under numerical control. At the same time, a novel linear interpolation algorithm is employed, and this interpolation algorithm does not require a large amount of complex mathematical calculation, so it is fast enough to be used in real-time applications.

3-D line movement inspace

Line movement in space can be decomposed into line movement in plane through mapping transformation, as shown in figure 3. In the figure, space line from O to P hasthree decomposition methods: OB and OC, or OB and OA, or OA and OC. It is an example for pulse output of the linear interpolation driving. We define the longest distance movement in interpolation as “long axis”. the othertwo axes are called “short axis”. Long axis decides the decomposition method of the space movement, for example, if Z axis is the long axis, the linear movement OP should decompose into OB in XOZ plane and OC in YOZ plane.

When the interpolation begins, Z-AMM outputs an average pulse train, whose frequency is set firstly by CPU, to LIM, the driving pulse of two short axes depends on the long axis and the relationship of this axis with the long axis. At last, the linear interpolation of 2-D line movement OB and OC implements the 3-D line movementOP.

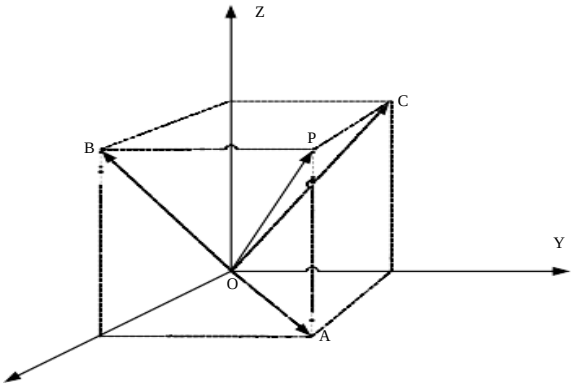


Fig: Decomposition of 3-D Line movement in XYZ space

VI. SPECIFICATIONS:

1. PLC and Supporting Function (DVP-SA2, PLC)

❖ A PLC is a computer, or more precisely an industrial computer. PLC's are designed to withstand harsh environments; assembly lines, food-processing plants, automotive plants and more. Most PLC's are modular; they can be scaled up or down as needed. Inputs cards, output cards, communication cards, motion control cards all can be added or removed to satisfy most engineering needs.

❖ They are designed for a very specific purpose, machine control. The PLC is the brain of any intelligent control system. Just as the integrated circuit chip replaced multiple transistor circuits in electronics, the PLC replaced multiple electromechanical relays in industrial circuits. Complex machines contained thousands of relays. Today a single PLC can replace all the logical relays, timers, and other peripheral devices common in the machines of the past.

PLC (DVP SA2)

- ❖ Adopt 32-bit CPU
- ❖ Program capacity: 16K steps/Data register:10K words
- ❖ Execution speed: LD: 0.35us,MOV:3.4us
- ❖ Built-in 1 RS-232 and 2 RS-485 port (Master/slave)

2.Stepper Motor

GENERAL SPECIFICATION

Stepper Motor Model	EMM57HS51-605
Step Angle	1.8 Degrees per step
Optimum motor Temperature	80 Degrees C Maximum
Operating Ambient Temperature	-20'C TO +50' C
Storage Temperature	-20'C TO +60'C
Operating Ambient Humidity	90% RH ,40' MAX (no condensation)
Insulation Resistance	100M OHM MIN,500V DC Megger at normal room temperature and humidity

Dielectric Strength	At normal room temperature and humidity motor can with stand 1500V AC applied between winding and motor body for 1 minute
Shaft Radial Play	0.02mm Maximum (450 Gms – Load)
Shaft Axial Play	0.08mm Maximum (450Gms – Load)
Maximum Radial Force	75N (20mm from the flange)
Maximum Axial Force	15 N-M
Thermal Class	CLASS B (+130 Degree C)
Protection Grade	IP40
Mounting Direction	Can be mounted in both horizontal and vertical direction

ELECTRICALSPECIFICATION

No of Phase	2 Phase
Stepping Angle	1.8 Degrees per step
Voltage Per Phase	3.3. Volts
Current Per Phase	1 Amps
Resistance Per Phase	6.6 Ohms
Inductance Per Phase	5.5m H
No of Leads	4 Wire

MECHANICAL SPECIFICATION

Holding Torque	10 Kg-Cm
Detent Torque	300 Gm-Cm
Rotor Inertia	230 Gm-cm
Motor Mass	0.59 Kg

VII.PROPOSED METHODOLOGY:

This project is designed using PLC (Programmable Logic Controllers). In practice, two-axis motion control systems are typically applied to processes with slow contour motion such as fine machining. In a typical motion control system, there are three basic components: the controller, the drive and the motor. The path planning is performed in the controller, which sends low-voltage command signals to the drive, which in turn applies the necessary voltage and current to the motor, resulting in the desired motion. Servo systems operate in a closed loop fashion and vary output torque to move into/stay at the command position. The classic 'pulse and direction' signals that are widely used with PLCs provide an inexpensive, noise free method for precision motion control. While typically limited to a few axes of control and where coordination between axes is limited, PLC controllers with pulse and direction capability are an excellent fit for many motion applications.

VIII.Conclusion

This paper introduces the implementation of linear interpolation module in 2-axis PLC controller. High performance and configurable stepper motor drive is implemented in two axis motion control drive using interpolation. The implementation of 2-axis linear interpolation module is discussed. By practical analysis of linear interpolation, has excellent performance and can be used for practical motion control.

Future Scope

1. Two axis motion control applications can be used for controlling applications by using PLC.
2. Used in controlling applications such as Movement of Docking doors, Sortation and placement machines, Bagging Machines etc
3. PLC with interpolation can be used in Art and Craft industries.
4. Can be implemented in Packing industries.

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Comparative study of Variable frequency drive to run an AC Induction motor using synchronized and unsynchronized PWM generator, with and without filter

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Abstract: **This comparative study has been performed to check the most efficient and smooth working of an AC induction motor by reducing the total harmonic distortion by using different methods in variable frequency drive. Hence the results are obtained using the simulation of various methods and observed the best technique for direct torque control (DTC) of the machine.**

This paper is presented based on the results obtained using MATLAB simulation software.

Index Terms **– PWM generator, Asynchronous machine.**

I. INTRODUCTION

Every waveform of voltage or current or flux are desired to be sinusoidal under ideal condition. Under practical conditions tend to become non-sinusoidal. A waveform becoming non-sinusoidal means along with the fundamental, harmonic component must be induced within the system. The harmonic information can be obtained by writing the Fourier series of non-sinusoidal periodic waveform.

AC motors are used for converting electrical energy to mechanical energy. They are used in various applications in different industries, factories and automobiles as locomotives. These motors need controlled power to control the speed and torque. Hence, we use variable frequency drive (VFD) [4] to have a direct torque control(DTC) over machines . Variable frequency drive consists of power electronic circuit combined with a controlling circuit which are used to vary the speed and torque of the machine [1]. In general,VFD converts DC to variable frequency AC or AC(fixed frequency) to AC(variable frequency).

This project has been done to show the comparative study of various methods to decrease total harmonic distortion (THD) [3]. We have seen that the total harmonic distortion has been reduced as we approach different methods. To verify our generated input to the machine, we have considered a 3-phase, 5.4Hp (4kW),400V,50Hz, 1430RPM asynchronous machine operated as a motor. By supplying the available DC input through the drive into the 3-phase asynchronous machine, we verify characteristics of Speed, Stator current, and Electromagnetic torque with respect to time at the motor [2].

II. METHODOLOGY

a. 3-phase, 2-Level variable frequency drive.
b. 3-phase, 3-Level variable frequency drive with unsynchronized mode of operation of PWM generator.
c. 3-phase, 3-Level variable frequency drive with synchronized mode of operation of PWM generator.

(a) 3-PHASE, 2-LEVEL VARIABLE FREQUENCY DRIVE.

Figure 1, shows the 3-phase, 2-Level variable frequency drive along with its output connected to the input of themotor. Here a 2-level PWM generator and a universal bridge as a part of a drive, convert available 400V DC to 3-phase 2-level AC. The input voltage to the motor is measured with the voltage measuring instrument. Parameters of PWM generator and universal bridge are mentioned in Table 1.

Table 1: Parameters of PWM generator and universal bridge.

Blocks	**Parameters**	**Value**
PWM generator	Generator type	Three-phase bridge (6 pulses)
	Mode of operation	Unsynchronized
	Frequency	27*50Hz
	Initial Phase	0 degrees
	Minimum and maximum values	[-1, 1]
	Sampling technique	Natural
	Internal generation of reference signal	Selected
	Modulation index	0.9
	Reference signal frequency	50Hz
	Reference signal phase	0 degrees
	Sample time	10e-6 s
Universal bridge	Number of bridge arms	3
	Power Electronic device	IGBT/Diodes

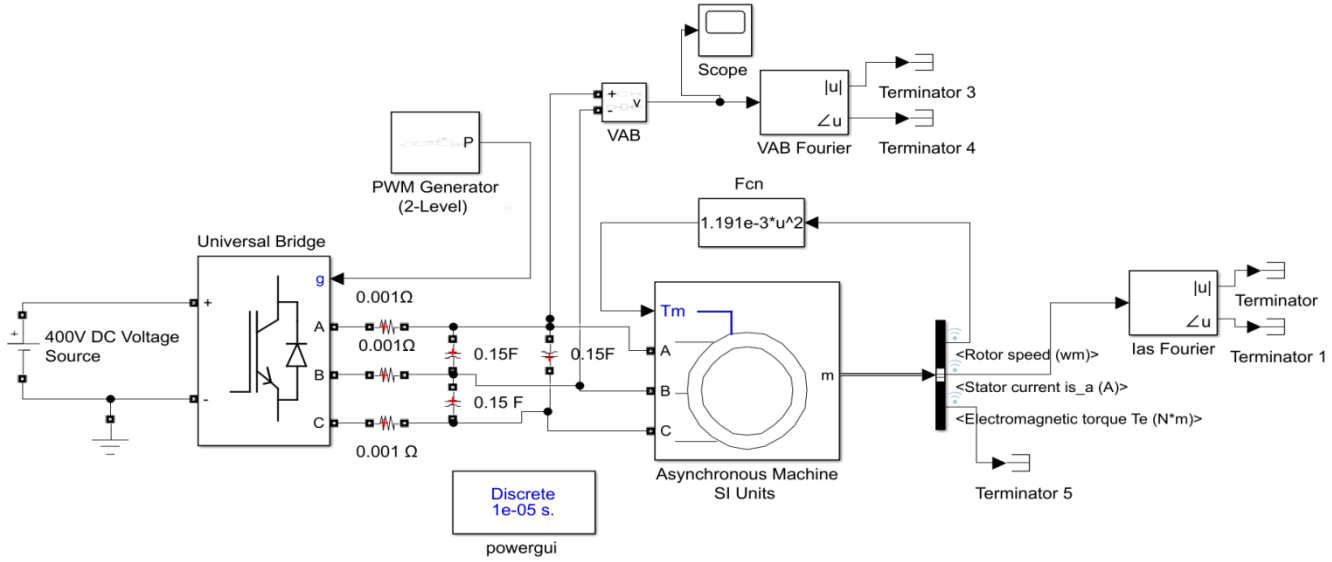

Figure 1: circuit diagram of 3-phase, 2-Level variable frequency drive.

Figure 2, shows characteristics of Speed, Stator current, and Electromagnetic torque with respect to time at the motor. The motor starts rotating and reaches its steady-state speed of 133rad/s (1270rpm) after 0.16s. At starting, the magnitude of the 50 Hz current reaches 41.5A peak (29A RMS) whereas its steady-state value is 17.5A (12.37A RMS).With the average torque value equal to 21Nm.

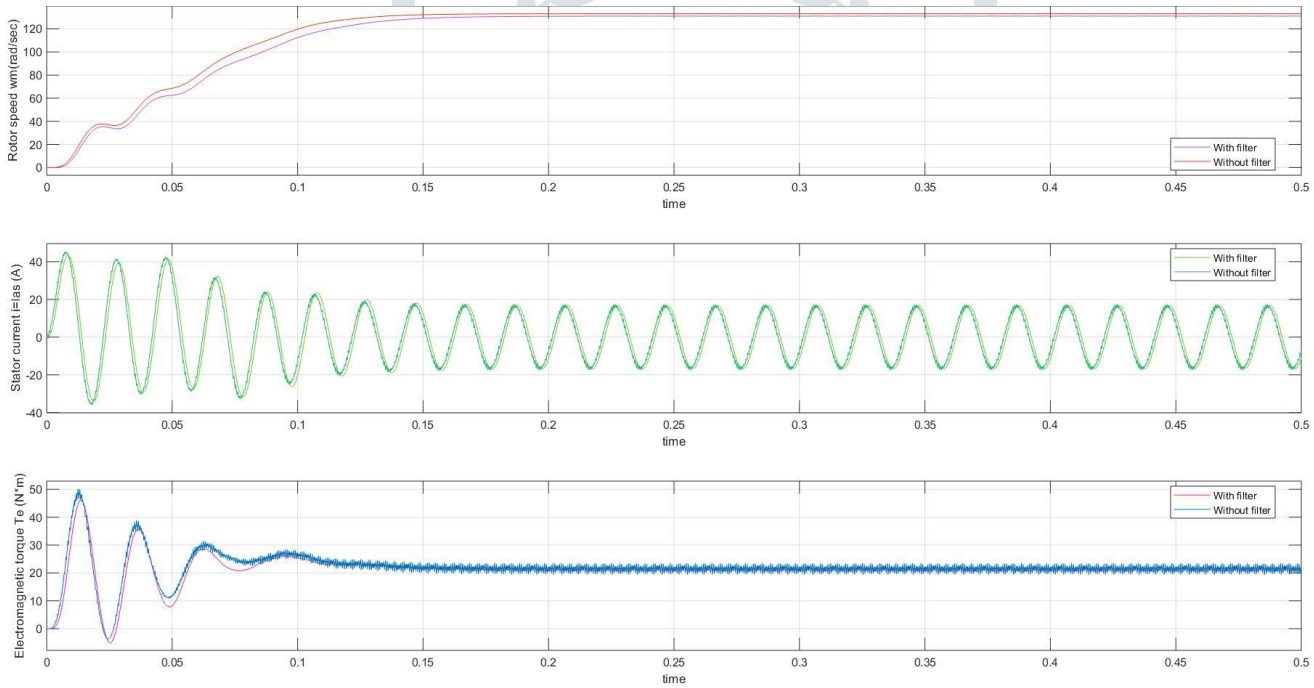

Figure 2: characteristics of Speed, Stator current, and Electromagnetic torque with respect to time of method (a) with and without filter.

Powergui FFT analysis tool is used to perform harmonic analysis, to obtain the fundamental component and THD of theV_{ab} voltage. Figure 3 is the spectrum window showing the fundamental component and THD of the V_{ab} voltage without filter. We can observe that theinverter voltage being 400V for modulation index equal to0.9.This signal being 2-level oscillates between 0 and +/-400V gives a THD magnitude of 79.87%. The highest harmonic of 30% occurs around the multiple of carrier frequency, at 25th harmonic (27-2) and 29th harmonic (27+2). Similarly, Fig.4 shows the same signal after adding filter, which gives the THD magnitude of 6.96%. FFT settings are shown in Table 2. In this tableexcept start time all the parameter values are same for all the remaining methods.

Table 2: FFT settings.

Parameters	**Value**
Start time (s)	0
Number of cycles	5
Fundamental frequency	50Hz
Max frequency	5000Hz
Max frequency for THD computation	Nyquist frequency

Display style	Bar (Related to fundamental)
Base value	1.0
Frequency axis	Harmonic order

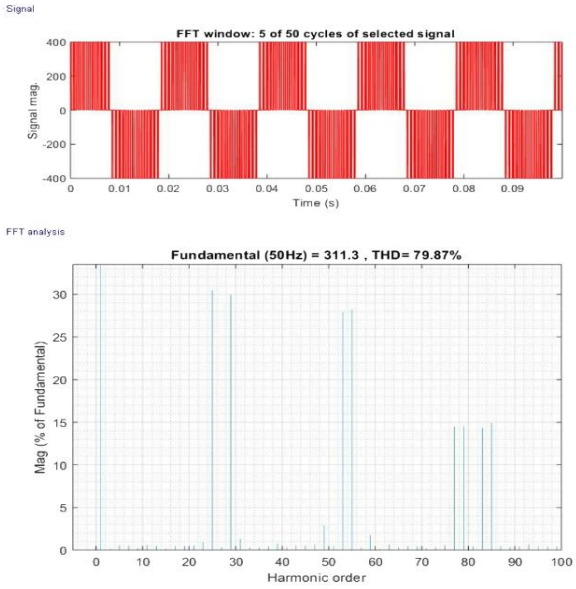

Figure 3: FFT analysis of 3-phase 2-level line voltage V_{ab} without filter.

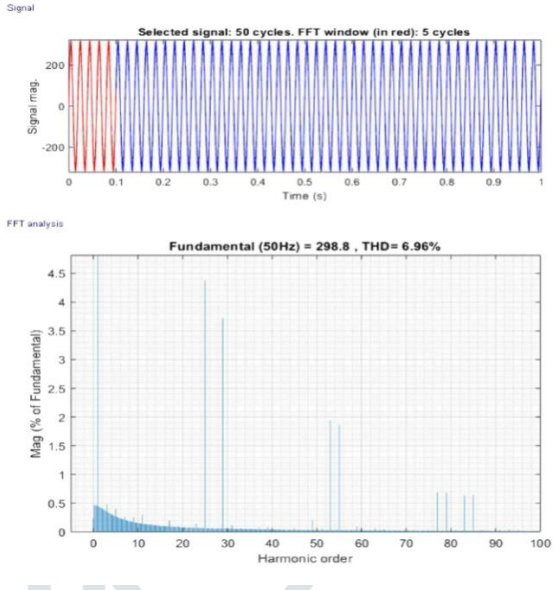

Figure 4: FFT analysis of 3-phase 2-level line voltage V_{ab} with filter.

(b) 3-PHASE, 3-LEVEL VARIABLE FREQUENCY DRIVE WITH UNSYNCHRONIZED MODE OF OPERATION OF PWM GENERATOR.

Figure 5, shows the 3-phase, 3-Level variable frequency drive along with its output connected to the inputof themotor. Here a 3-level PWM generator and a 3-level bridge as a part of a drive, convert available 400V DC and 200V DC to 3-phase 3-level AC with the circuit as shown in Fig.5. Rest of the circuit being same as Fig.1, parameters of 3-level PWM generator and 3-level bridge is mentioned in table 3.

Table 3: Parameters of 3-level PWM generator and three-level bridge.

Blocks	**Parameters**	**Value**
PWM generator	Generator type	Three-phase bridge (12 pulses)
	Mode of operation	Unsynchronized
	Frequency	27*50Hz
	Internal generation of reference signal	Selected
	Modulation index	0.9
	Output voltage frequency	50Hz
	Outputvoltage phase	0 degrees
	Sample time	10e-6 s
Three-level bridge	Number of bridge arms	3
	Power Electronic device	IGBT/Diodes

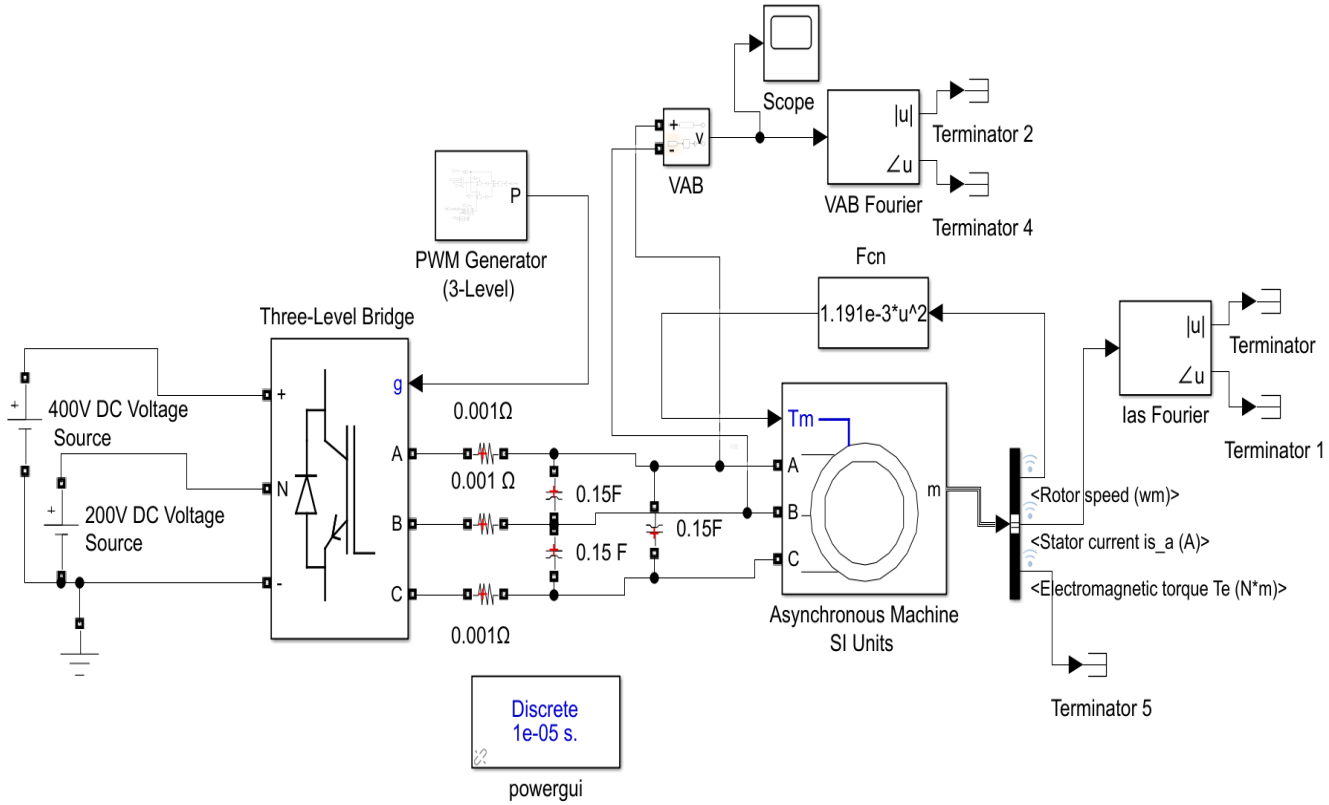

Figure 5: Three-Phase, Three-Level variable frequency drive with unsynchronized mode of operation of PWMgenerator.

Comparison of Fig.6with all the methods is carried out in Table 5 and harmonic analysis for input voltage signal is been carried out and compared with all the methods in Table6.

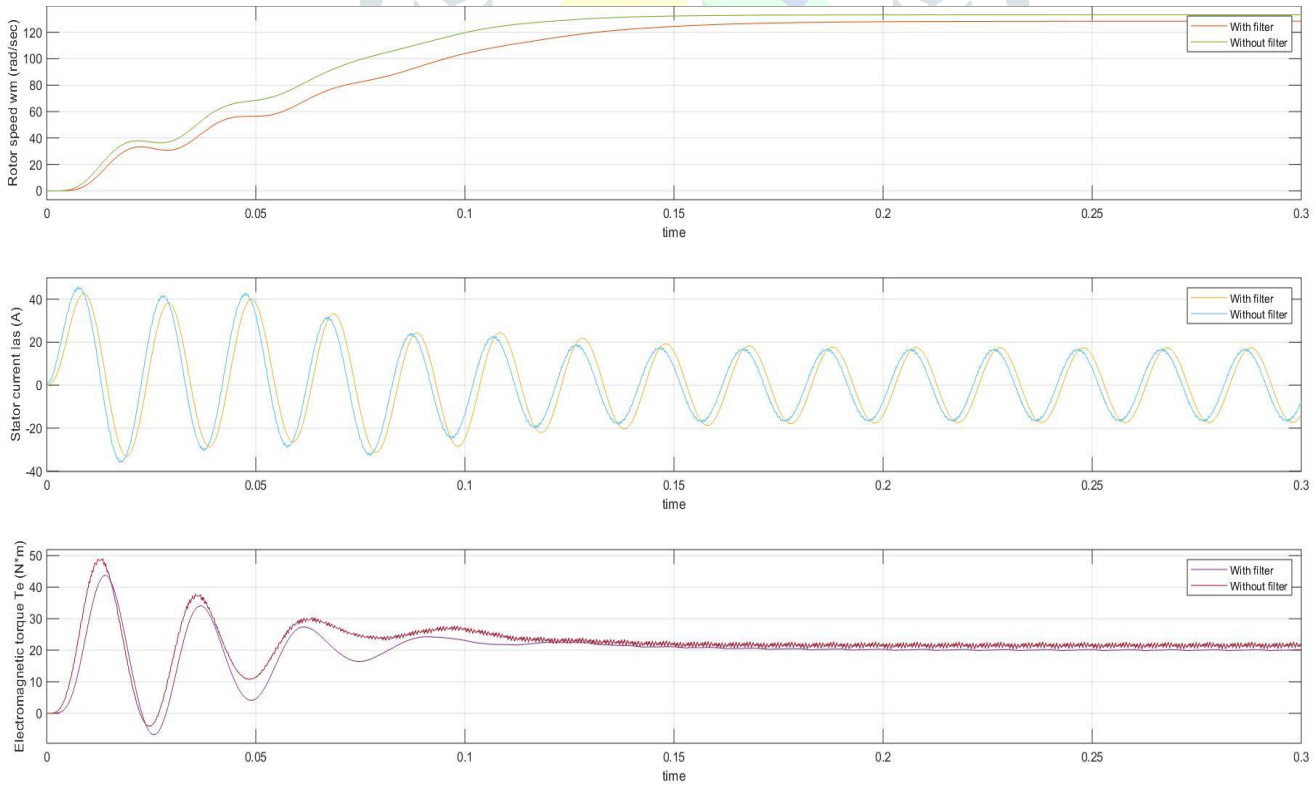

Figure 6: Characteristics of rotor speed, stator current, and electromagnetic torque of method (b) with and without filter.

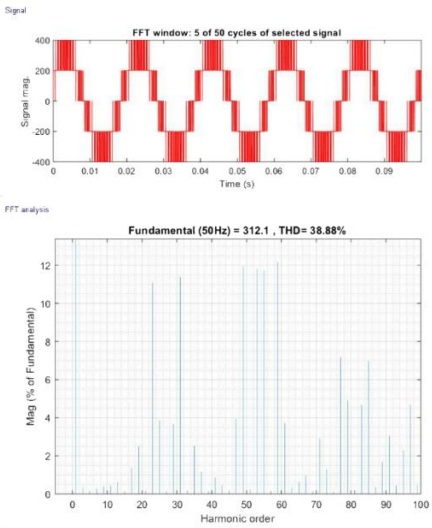

Figure 7: FFT analysis of unsynchronized 3-phase 3-level line voltage V_{ab} without filter.

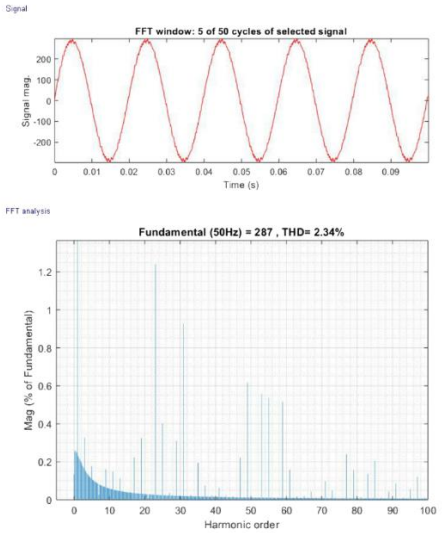

Figure 8: FFT analysis of unsynchronized 3-phase 3-level line voltage V_{ab} with filter.

(c) 3-PHASE, 3-LEVEL VARIABLE FREQUENCY DRIVE WITH SYNCHRONIZED MODE OF OPERATION OF PWM GENERATOR.

Figure 6, shows the 3-phase, 3-Level variable frequency drive along with its output connected to the input of themotor.Here, PWM generated under the synchronous mode of operation, expect the carrier signal (Uref) synchronized to an external reference signal (wt). Rest of the circuit being same as Fig.5, parameters of 3-level PWM generator, 3-phase programmable generator and sine wave blocksare mentioned in table 4.

Table 4: Parameters of 3-level PWM generator, 3-phase programmable generator and stair generator.

Blocks	**Parameters**	**Value**
PWM generator	Generator type	Three-phase bridge (12 pulses)
	Mode of operation	synchronized
	Switching ratio (carrier frequency / output frequency)	10,000Hz
	Sample time	10e-6 s
Three-phase programmable generator	Positive-sequence [Amplitude, Phase (degrees), Freq. (Hz)]	[1,0,50]
	Time variation of	Amplitude
	Type of variation	Modulation
	Sample time	10e-6 s
Sine	Amplitude	1
	Frequency	2*pi*50
	Phase	0
	Sample time	0 s

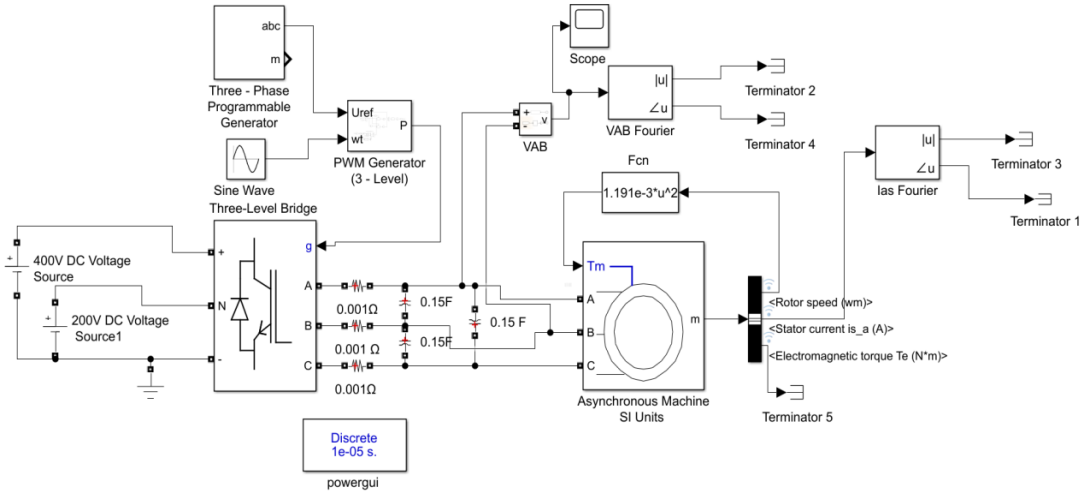

Figure 9: Three-Phase, Three-Level variable frequency drive with synchronized mode of operation of PWM generator.

Comparison of Fig.10 all the methods is carried out in Table 5 and harmonic analysis for input voltage signal is been carried out and compared with all the methods in Table 6.

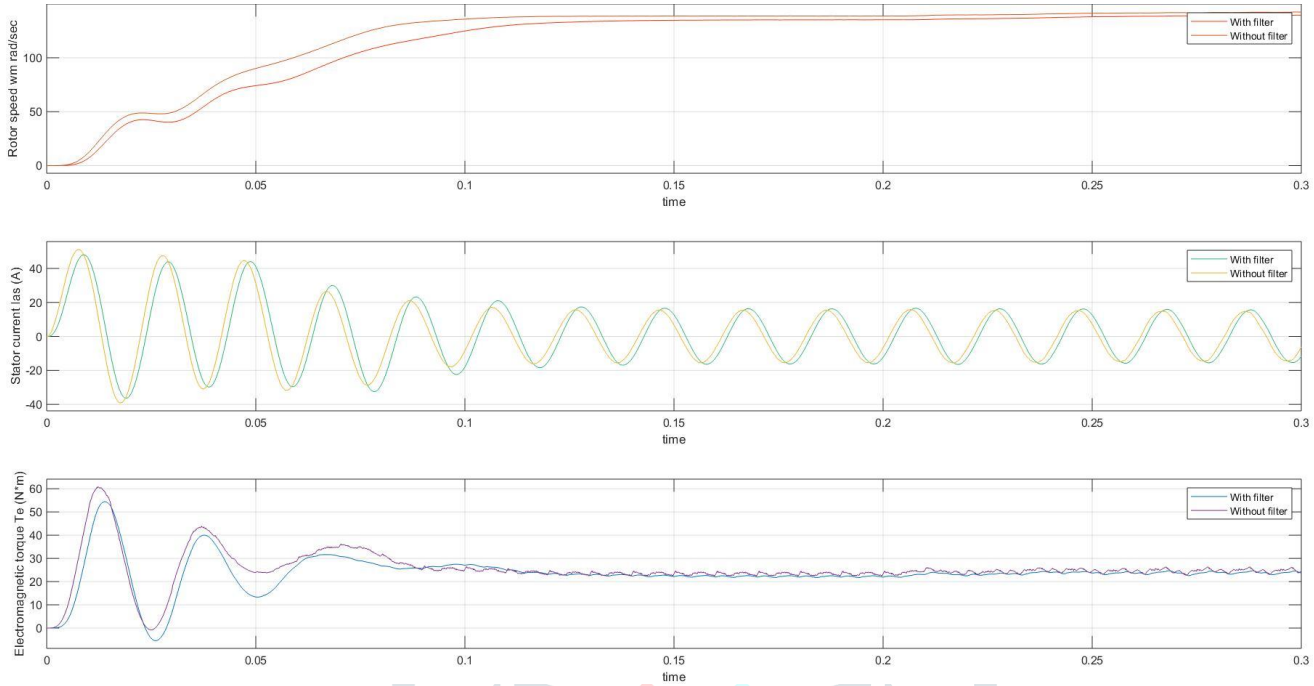

Figure 10: Characteristics of rotor speed, stator current, and electromagnetic torque of method (c) with and without filter.

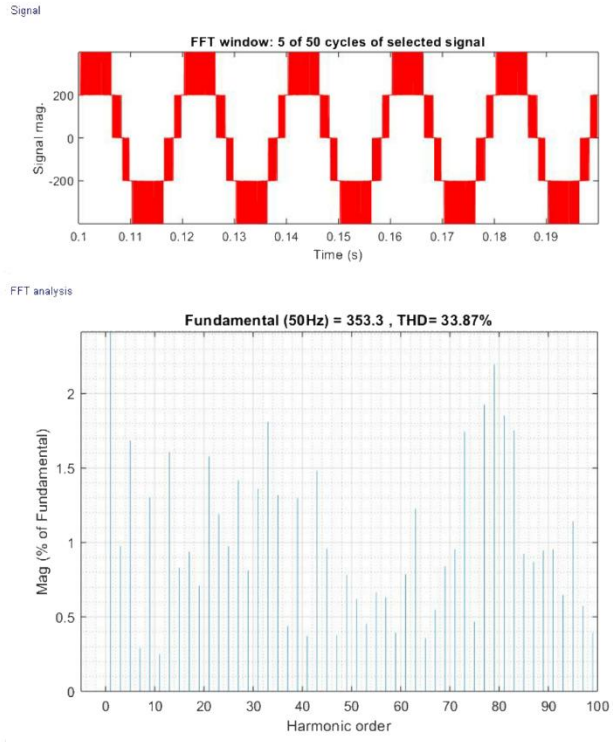

Figure 11: FFT analysis of synchronized 3-phase 3-levelline voltage V_{ab} without filter.

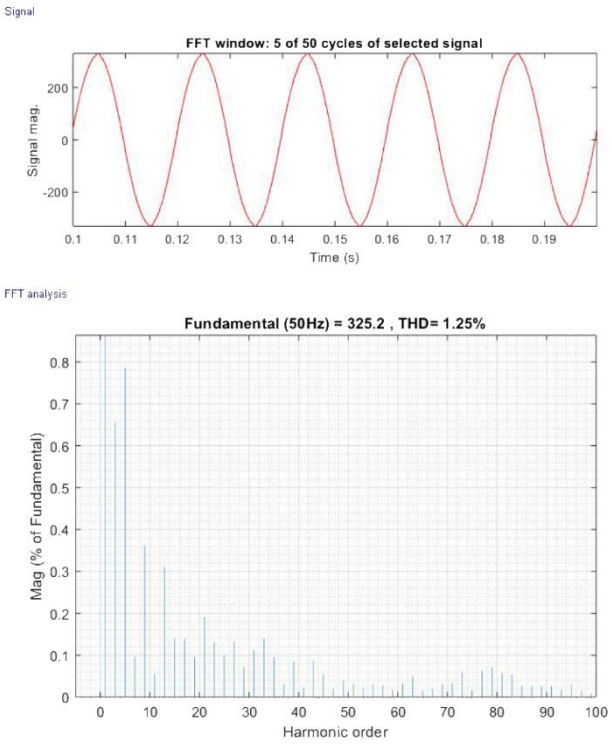

Figure 12: FFT analysis ofsynchronized 3-phase 3-level line voltage V_{ab} with filter.

III. SPEED CURVE

To obtain variable speed at the output of the motor, the fundamental frequency at the PWM generator is changed in the steps of 5 from 40Hz to 50Hz. The variations in the rotor speed of asynchronous motor can be observed from the fig.13. We can also observe that, as the frequency increases the motor speed increases.

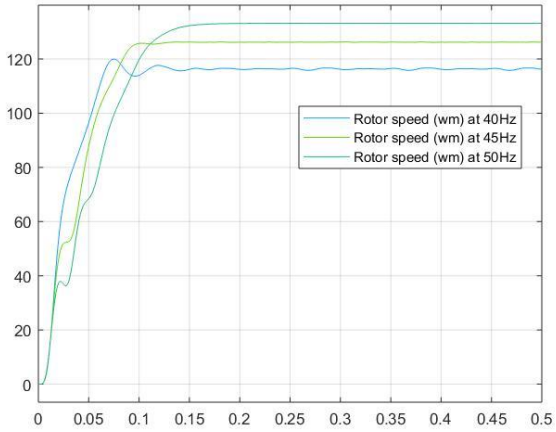

Figure 13: Rotor speed at various frequencies.

IV. RESULTS AND DISCUSSION

From table 5, we can observe that three level synchronized method provides better torque and speed characteristics with lesser settling time. With torque and speed value being more for the same input the efficiency of this design is high compared to other two methods.

Table 5: Comparison ofcharacteristics of rotor speed, stator current, and electromagnetic torque between all three methods without filter.

Methods	**Rotor speed (rad/sec)**	**Stator current (RMS)**	**Average Te(Nm)**	**Settling timein seconds.**
Two level	133	12.37A	21	0.16
Three level unsynchronized	133	11.80A	22	0.17
Three level synchronized	138.8	11.52A	23.5	0.12

The filter that is used contains a series resistor (0.001Ω) in all 3 lines and a capacitor (.15F) in parallel between every line to line. By using the same filter designed in all three methods the THD obtained are tabulated in the table 6. From table 6 we can observe that three level synchronized drive method generates less harmonics in the generated AC voltage signal.

Table 6: Comparison of THD of voltage signal generatedfrom all three methods.

Methods	**THD without filter**	**THD with filter**
Two level	79.87%	6.96%
Three level unsynchronized	38.88%	2.34%
Three level synchronized	33.87%	1.25%

V. CONCLUSION

The comparative study has been carried out with the output obtained from the MATLAB simulation results andcomparing the data from the simulation results we found out theFFT analysis of synchronized 3-phase 3-level with filter,one can achieve better results in the design of variable frequency drive.

VI. REFERENCES

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HOME SECURITY SYSTEM BASED ON FINGER PRINT AND FACE RECOGNITION

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ABSTRACT *:* Smart security system has become indispensable in modern daily life. The proposed security system has been developed to prevent robbery in highly secure areas like home environment with lesser power consumption and more reliable standalone security device for both Intruder detection and for door security. The door access control is implemented by using face recognition and finger print technology, which grants access to only authorized people to enter that area. The face recognition and detection process is implemented by principal component analysis (PCA) approach and instead of using sensor devices intruder detection is achieved by performing image processing on captured video frames of data, and calculating the difference between the previously captured frame with the running frames in terms of pixels in the captured frames. This is the stand alone security device has been developed by using Raspberry Pi electronic development board and finger print , operated on Battery power supply, wireless internet connectivity by using USB modem. Auto Police e-Complaint registration has been achieved by sending security breach alert mails to the nearby police station e-mail id. This proposed is more effective, reliable, and this system consumes very less data and power compared to the other existing systems.

1. INTRODUCTION

An efficient and accurate home security and access control to the doors system which is based on face recognition is very important for wide range of security application. Security is an important aspect or feature in the smart home applications [5]. Most of the countries are gradually adopting smart door security system. The most important major part of any door security systems are identifying accurately the persons who enter through the door. Face recognition is probably the most natural way to perform authentication between human beings. Additionally, it is the most popular biometric authentication trait, after fingerprint technology. Most of the security system was implementing a principle component analysis (PCA) algorithm for face recognition on hardware platform for its dimensionality reduction and simplicity. Wireless technologies for example and ZigBee, radio frequency identification (RFID) and etc are used in access control systems. This proposed system also act as home security system for both Intruder detection and provide security for door access control by using facial recognition for home environment.

Human body is identified as an intruder within a home environment achieved by capturing live video from web camera and processing will be done on captured video frames to identify the motion detection of the intruder. The web camera to capture the series of images as soon as the intruder motion is detected in certain area of the home premises and also it is having sending automatic e-Mail alerts along with captured images and other contact details to the nearby police station control room e-Mail id about the intruder detection to take further immediate necessary actions.

The advantage of this system is for accessing the door is that face detection and recognition is performed by using face detection technique and the entire face recognition is completed by pressing single and tiny push button switch. Face recognition includes feature extraction from the facial image, recognition or classification and feature reduction. PCA is an effective feature extraction method used based on face as a global feature. It effectively reduces the dimension of captured images and at the same time holds the primary information. In this project, face recognition system is implemented based on standard PCA (Principle component analysis) algorithm. Classification or Recognition is done by the measure method such as Euclidean distance technique, which is used to classify the feature of images stored in the database and captured test images

2. IMPLEMENTATION

There are two parts in this section. The first is the implementation of Door lock access by using Face Recognition and the second is the implementation of Intruder detection along with auto alert sending.

1. Implementation of Door Lock Access by using Face Recognition

This project work proposes an idea of for face reorganization concept for accessing the door lock system and it implemented with the help of OpenCV [7] which is a popular computer vision library. Face recognition is an important application of image processing owing to its use in many fields. An effective face recognition system based on OpenCV is developed in the project. Face recognition has been a best choice after problem of biometrics and it has a various type of applications in our present life. An efficient face recognition system can be of great help in forensic sciences, identification for law enforcement, authentication for banking and security system, and giving preferential access to authorized users i.e. access control for secured areas etc.
A real time door lock access system by face recognition system based on PCA is presented in the project. The technique used here involves generating the 'Eigen faces' then projecting training data into face space and evaluation of a projected test element by projecting it into face space and comparing to training data. The face recognition systems presented here can extract the features of face and compare this
with the existing facial images of database. The faces considered here for comparison are still faces.

2. Implementation of Intruder Detection along with Auto Alert Sending.

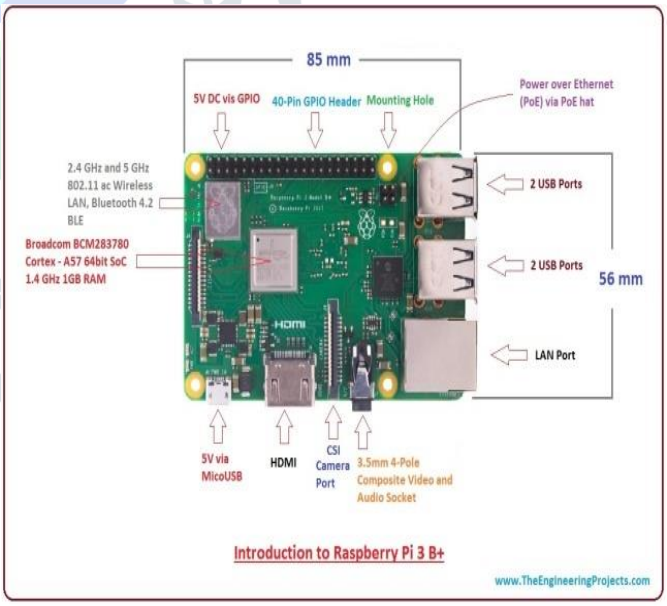
The proposed home security system (i.e. Intruder detection Module) builds up on the frame subtraction approach. The main purpose of this approach is to build a model of the static scene (i.e. without moving objects) called background, and then compare every subsequent frame of the sequence to this background frame in order to identify the regions of motion, called foreground (the moving
authentication for banking and security system, and giving preferential access to authorized users i.e. access control for secured areas etc.
A real time door lock access system by face recognition system based on PCA is presented in the project. The technique used here involves generating the 'Eigen faces' then projecting training data into face space and evaluation of a projected test element by projecting it into face space and comparing to training data. The face recognition systems presented here can extract the features of face and compare this with the existing facial images of database. The faces considered here for comparison are still faces.

3. Hardware & Software Required

- Atmega lm 328,
- Ir sensor,
- Raspberry pi
- pi Camera
- Gate
- Open cv
- c embedded system
- and arduino ide

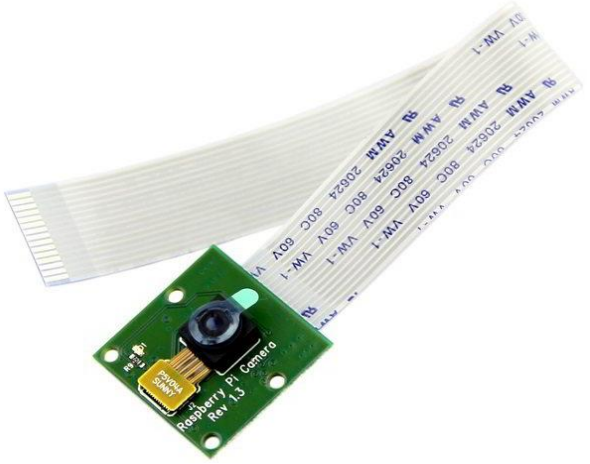
4. RASPBERRY PI.3

Raspberry Pi 3 B+ was introduced by Raspberry Pi foundation on 14th March 2018. It is an advanced version of Raspberry Pi 3 B model that was introduced in 2016.
It is a tiny computer board that comes with CPU, GPU, USB ports, I/O pins, WiFi, Bluetooth, USB and network boot and is capable of doing some functions like a regular computer.
Features of the B+ version are almost same as B model; however, USB and Network Boot and Power over Ethernet facility only come with B+ model. Also, two extra USB ports are added to this device.
The SoC (system on chip) combines both CPU and GPU on a single package and turns out to be faster than Pi 2 and Pi 3 models



5. PI CAMERA

Pi Camera module is a camera which can be used to take pictures and high definition video. Raspberry Pi Board has CSI (Camera Serial Interface) interface to which we can attach Pi Camera module directly. This Pi Camera module can attach to the Raspberry Pi's CSI port using 15-pin ribbon cable.



6. SERVO MOTOR

The simplicity of a servo is among the features that make them so reliable. The heart of a servo is a small direct current (DC) motor,
These motors run on electricity from a battery and spin at high **RPM** but put out very low **torque** (a twisting force used to do work— you apply torque when you open a gate). An arrangement of gears takes the high speed of the motor and slows it down while at the same time increasing the torque. (Basic law of physics: work = force x distance.)

7. INFRARED IR SENSOR CIRCUIT DIAGRAM AND WORKING PRINCIPLE

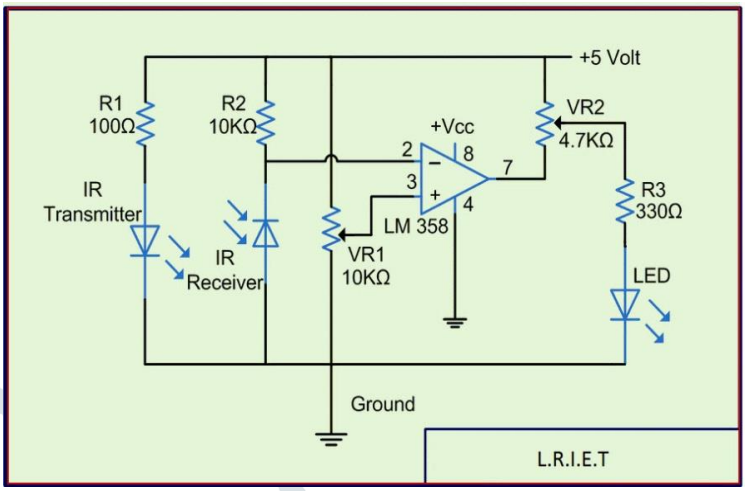
An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received.

8. IR SENSOR

IR Sensor Circuit Diagram and Working Principle

An infrared sensor circuit is one of the basic and popular sensor module in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real time. This circuit comprises of the following components

LM358 IC 2 IR transmitter and receiver pair
Resistors of the range of kilo ohms.
Variable resistors.
LED (Light Emitting Diode).



In this project, the transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analyzed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.
When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC (LM339). Thus the output of the comparator goes low, but the LED does not glow. When the IR receiver module receives signal to the potential at the inverting input goes low. Thus the output of the comparator (LM 339) goes high and the LED starts glowing. Resistor R1 (100), R2 (10k) and R3 (330) are used to ensure that minimum 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs respectively. Resistor VR2 (preset=5k) is used to adjust the output terminals. Resistor VR1 (preset=10k) is used to set the sensitivity of the circuit Diagram. Read more about IR sensors.

9. SERVO MOTOR

A Servo motor (or servo) is a rotary actuator that allows for precise control of angular position, velocity and acceleration. Servos are found in many places: from toys to home electronics to cars and airplanes. If you have a radio-controlled model car, airplane, or helicopter, you are using at least a few servos. Servos also appear behind the scenes in devices we use every day. Electronic devices such as DVD and Blu-ray Disc TM players use servos to extend or retract the disc trays.
Servo vs PWM
PWM stands for Pulse Width Modulation. PWM is the process of turning ON and OFF digital voltage quickly

to simulate a range of voltage. For example... If the digital output pin of a micro is 3.3v, and the PWM is set for a 50% duty cycle, the output voltage would be approx 1.65v. This is because the microcontroller is turning ON and OFF the digital 3.3v pin real quick, which is producing a simulated lower voltage. You can use PWM to vary the brightness of an LED, for example. A servo uses PWM as well. The "frame" of a servo PWM signal is 20ms. Many controllers, such as Arduino libraries do not maintain the 20ms specification defined for servos. Because of this, challenges have been introduced to servo manufacturers when decoding incoming PWM signals. This has caused the need for servos to be "Smarter" by adapting to the unusual PWM transmitted by poorly written libraries which do not adhere to the servo PWM Standard. The EZ-B does adhere to servo PWM standards

10. HHOW DOES A SERVO MOTOR WORK

The simplicity of a servo is among the features that make them so reliable. The heart of a servo is a small direct current (DC) motor, similar to what you might find in an inexpensive toy. These motors run on electricity from a battery and spin at high RPM (rotations per minute) but put out very low torque (a twisting force used to do work— you apply torque when you open a jar). An arrangement of gears takes the high speed of the motor and slows it down while at the same time increasing the torque. (Basic law of physics: work = force x distance.) A tiny electric motor does not have much torque, but it can spin really fast (small force, big distance). The gear design inside the servo case converts the output to a much slower rotation speed but with more torque (big force, little distance). The amount of actual work is the same, just more useful. Gears in an inexpensive servo motor are generally made of plastic to keep it lighter and less costly. On a servo designed to provide more torque for heavier work, the gears are made of metal (such as with EZ-Robot Servos) and are harder to damage.

With a small DC motor, you apply power from a battery, and the motor spins. Unlike a simple DC motor, however, a servo's spinning motor shaft is slowed way down with gears. A positional sensor on the final gear is connected to a small circuit board. The sensor tells this circuit board how far the servo output shaft has rotated. The electronic input signal from the computer or the radio in a remote-controlled vehicle also feeds into that circuit board. The electronics on the circuit board decode the signals to determine how far the user wants the servo to rotate. It then compares the desired position to the actual position and decides which direction to rotate the shaft so it gets to the desired position.

11. CONCLUSION AND FUTURE WORK

In this proposed system door access system by using face recognition and along with the Intruder detection system has been presented. This system has been tested successfully with home door lock access control based on face recognition method by verifying enrolled facial images. The police department control room of a nearby place and concern persons will be informed successfully about the intruder detection via e-Mail and SMS alert generations along with details attached. The proposed system is completely standalone and wireless to form a reliable, robust, easily operable, and low price security system. The internet communication has been achieved by connecting through USB cellular data card. The battery power source has been provided to make this whole system as standalone security device successfully. I conclude that various operations are successfully tested and results are documented.
This proposed system can be enhanced by using the infrared image scanner camera to find concealed weapon detection under the clothes of the human body. We can also use this security system by making required modification to the system in an area like banking sector to provide more security to the lockers, based on their facial authentication and keep track of account holders record of information when and who is accessed the lockers. In this way we can enhance the proposed system effectively by making some modifications according to requirements.

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Design of an Electrical Drive-Train for the Retrofit of a Conventional Auto-Rickshaw into an Electric Auto-Rickshaw

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***Abstract*- In this paper, we discuss about the numerous advantages that electric vehicles possess over conventional fuel combustion vehicles that employ fossil fuels to power them. We also propose the design of an electric auto-rickshaw by performing the retrofit of the already existing conventional auto-rickshaw by removing the mechanical drive-train and replacing it with an electric drive-train. The BLDC motor has been chosen due to its high efficiency, low maintenance and robust nature, after an extensive comparison with the other available motor options. The BLDC motor will be controlled by using hall sensors that help in determining the position of the rotor. The BLDC motor is fed using a PWM modulated inverter. This paper also deals with the design and simulation of a DC-DC buck converter that is used to step down the voltage to the necessary level required by the motor to run.**

***Index terms*- BLDC motor, Drive-train, Electric vehicle, Induction motor drive, Pulse width modulation**

I.INTRODUCTION

According to a survey by the World Health Organization (WHO), 91% of the people in the world stay in a place that has a pollution level far beyond the threshold set by the WHO. Wikipedia, an online encyclopedia also says that approximately 27% of the total air pollution in India is caused due to transportation. Almost 4.2 million people die all around the world, every year due to air pollution related diseases such as asthma. This is a problem of a large magnitude and it needs to be dealt with at once. A recent article from a popular news website shows the comparison between the various places of interest in Delhi from 2018 and from 2020, after the lockdown has been enforced due to the Covid-19 pandemic. The images speak for themselves as they clearly show how clear the sky has become owing to the lack of transportation in Delhi. The air pollution levels in various cities went down by around 50% owing to the lockdown. This is a testimony to how much transportation contributes to the air pollution. 9 out of the 10 most polluted cities in the world are from India. By curbing the use of fossil fuel powered transportation, a majority of the pollution that occurs due to this can be reduced. This is where electric vehicles come into the picture.

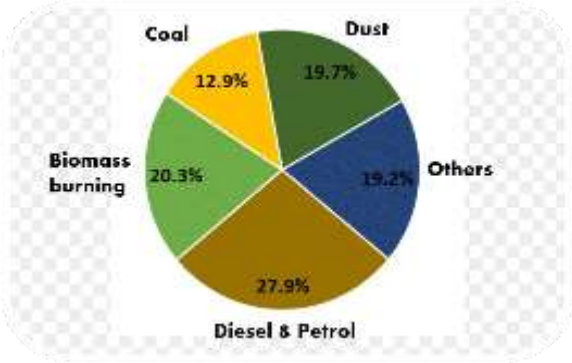

Fig-1: A graph showing the amount of total pollution caused due to different types of fuel being used.

Electric vehicles are vehicles that employ electric motors or traction motors in order to help in the propulsion of the vehicle. The global share of electric vehicles is expected to grow from 2% in 2016 to 22% in 2030. Electric vehicles can be broadly classified into three main types, those being BEV's or battery electric vehicles which employ a battery as a source in order to not only run the motor but also to run all the other electronics in the vehicle, PHEV's or plug-in hybrid electric vehicles that can recharge the battery not only through regenerative breaking but also by plugging it in to an external source, and HEV or hybrid electric vehicles which employ both

conventional gasoline and electricity in order to power the vehicle.

There are a number of ways in which an electric vehicle can be manufactured. In order to tackle this problem effectively, we need to first find out which mode of transportation will have the most benefit from this. Auto rickshaws make up around 10% of all the urban transportation and is a viable choice to perform the retrofit on, as it not only is a public mode of transport but it also helps a lot of people. The main steps involved in the retrofitting of a vehicle are:

- Dismantling and removing the mechanical drive-train from the vehicle.
- Coupling the motor shaft to one end of the differential.
- Attaching the axles of the wheel to the other end of the differential.
- Making a permanent joint between the motor structure and the body of the vehicle.
- Completing all the internal wirings and connections.

II. COMPARATIVE STUDY OF VARIOUS TYPES OF MOTORS

Traction motors are motors that help in the propulsion of the vehicle. Traction motors are mostly used in electrically powered rails and in electric vehicles as well as vehicles that employ some sort of electric transmission systems. We have two main types of motors, AC and DC. DC motors are simple to build and are cost effective as well. But they do have a lot of disadvantages. The construction of a DC motor, while easy also seems to be its biggest issue. The presence of slip rings and brushes brings up the possibility of sparks and maintenance issues. The speed torque characteristics of DC motor shows that it cannot be used in a traction motor. If speed increases, torque decreases sharply. The torque of a vehicle determines its accelerative capability. Torque is important for the economy of the vehicle, better handling, and also plays a vital role in the handling of heavier vehicles. Better torque usually means that the vehicle can travel at a given speed with more ease and less revs, thereby making the drive smoother.

Induction motors are usually referred to as AC motors. Apart from the common advantages over DC motors such as rugged construction which in turn means lesser maintenance. This also makes the Induction motor a perfect choice for use in industrial scenarios. Induction motors have excellent torque speed characteristics. The construction of the induction motor is super simple. Squirrel cage motors do not require a slip ring arrangement as well. Compared to a DC motor, it does not have brush arrangement hence maintenance is low. Cost is also low due to lack of brushes. It also has a high efficiency in the order of 85-97%. But low starting torque, increase in rotor losses at higher speeds, reduction of efficiency, and a lower efficiency when compared to permanent magnet motors due to the presence of rotor windings means that IM have their fair share of issues. Another glaring issue is the narrow speed range over which the AC induction motor gives a useful power output. But even with these downsides, induction motors are the perfect choice for electric cars. Tesla, the world's leading electric car manufacturer uses induction motor drives in their electric cars, namely the Tesla Model S.

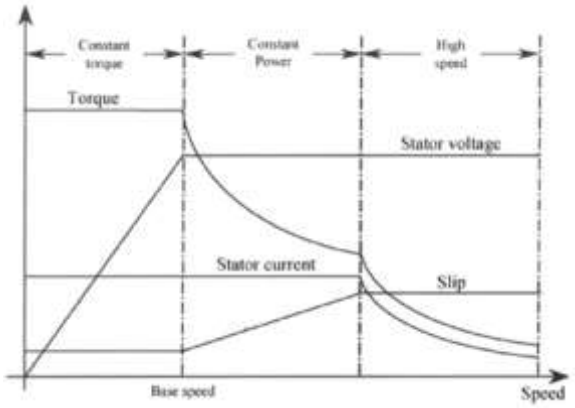

Fig-2: Characteristics of an Induction Motor

Permanent magnet synchronous motors (PMSM) are another type of motor that is being studied extensively. It is a brushless motor, thereby increasing its robustness. This also means that this type of motor requires less maintenance. The biggest advantages of a permanent magnet synchronous motor are the high efficiency, high reliability, high power density and uniform heat dissipation. But similar to induction motors, permanent magnet synchronous motors also have a narrow operative power range, meaning that there is only a narrow speed range where the motor can produce a useful power output. There are also demagnetization issues that occur due to the heat or the armature reaction. Another major disadvantage of the permanent magnet

synchronous motor is the cost. These types of motors use rare-earth metals such as Neodymium which is extremely costly, thereby driving up the price of the motor as well.

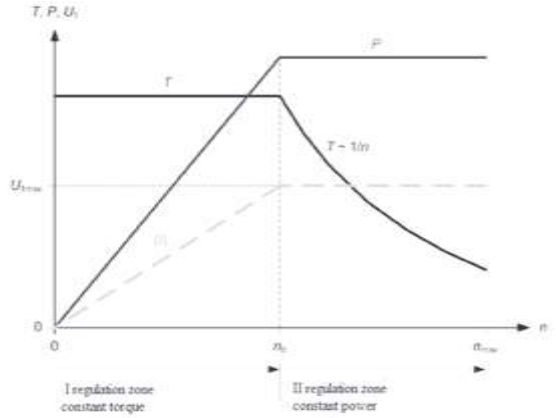

Fig-3: Torque-speed characteristics of a PMSM

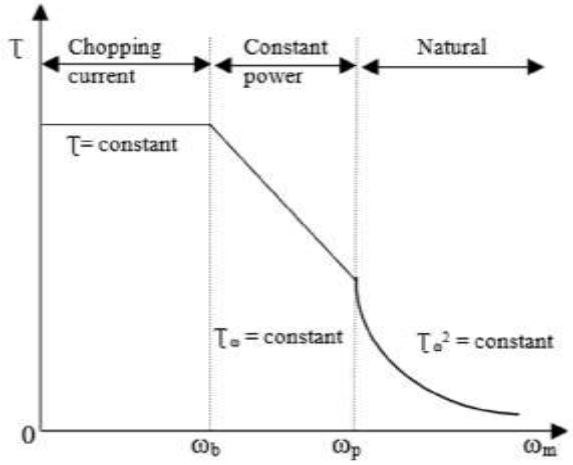

Fig-4: Characteristics of a SRM.

The switched reluctance motor is another type of motor that runs by the reluctance torque. The unique aspect of this motor is the power delivery. Unlike brushed DC motors, the power is delivered to the stator instead of the rotor. This greatly simplifies the mechanical design of the motor as the power is not being delivered to a moving part, but this also adds to the complexity of the electrical design. This means that a switching mechanism needs to be added to the motor, thereby giving the motor its name. Switched reluctance motors are actually being considered as a viable option for Hybrid Electric Vehicles (HEV) due to the ease of construction, excellent speed torque characteristics and a fairly simple control process. But this motor also has a lot of significant disadvantages such as high noise and high torque ripple.

Brushless DC motors (BLDC) are the most suited for our application. They possess excellent speed torque characteristics, a wide speed range compared to induction motors, higher power densities and low maintenance due to the lack of brushes. This also means that BLDC motors do not suffer from sparking issues that conventional brushed DC motors suffer from. The BLDC technically is a type of synchronous motor owing to the fact that the magnetic field produced by the rotor and stator rotate at the same synchronous frequency. The pair poles are energized in a sequential manner such that rotation is started and maintained. Apart from the already mentioned characteristics of a BLDC motor, it is lighter, easier to control, and less prone to failures that occur in brushed motors. By employing BLDC motors in electric vehicles, an important thing that needs to be addressed is the battery. The battery acts as a source for the BLDC motor and thereby, it must be highly efficient. The use of rechargeable batteries can help increase the efficiency of the entire system. The usage of rechargeable batteries also lets us use regenerative braking in order to replenish the charge of the battery.

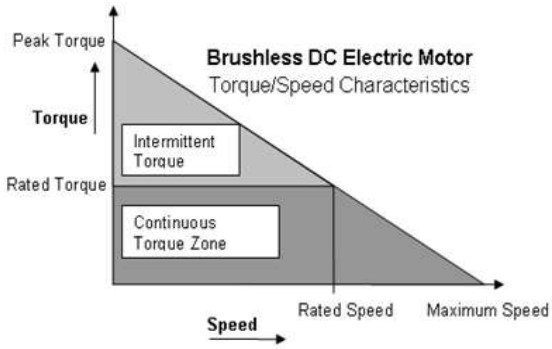

Fig-5: Torque-speed characteristics of a BLDC motor

III. DRIVE CIRCUIT FOR THE VEHICLE

We have now reached a conclusion through inspection that the BLDC motor is a viable choice that can serve our purpose. We also require a circuit to drive the motor in order to deliver the necessary power to the motor. We will be using hall sensors in order to detect the position of the rotor and to effectively perform motor control. We also use a pulse width modulated induction motor drive. For our application, we need to perform two main tasks:

- Calculation of the force required and the torque produced in order to help us in motor selection.
- Design of the DC-DC buck converter in order to step down the voltage to the required levels.

A. Design calculations for motor selection:

We have performed the design calculations for the parameters given below:

Gross weight of the auto rickshaw = 600 Kg

Kerb weight of the vehicle = 290 Kg

Maximum velocity = 40 Km/h

Wheel (rim) diameter: 10 inch = 25.4 cm = 0.254 m.

Circumference of the wheel = πd = 79.76 cm = 0.7976 m

Wheel speed = 752 rpm

Assume, transmission efficiency = 0.85

Transmission ratio (Differential rating) = 10:1

Gradient = 9°

We need to first calculate the total force that is required in order to propel the auto-rickshaw of the above parameters forward, followed by the total power output of the motor in order to sustain that motion.

B. Calculation and theory:

The force required for driving a vehicle forward is:

$$F_{total} = F_r + F_g + F_a$$

Where,

F_r = Force required to overcome rolling resistance.

F_g = Gradient resistance.

F_a = Air resistance.

F_{total} = Total tractive force that the output of the motor must overcome in order to move the vehicle.

Rolling resistance:

$$F_r = C_{rr} \times M \times g$$

Where, C_{rr} is the coefficient of rolling resistance. It is a value that will be experimentally determined for different materials and can vary by the load on the wheels, material of the wheels and that of the surface.

$$F_r = 0.02 \times 600 \times 9.81 = 117.72N$$

Air resistance:

F_a = (drag-coefficient) × (area of the front surface) × (velocity)^2 in Km/h

Here, drag-coefficient ≈ 0.0032 for small vehicles.

Area of the front surface = $(height) \times (width)$

$$= 1.7 \times 1.2 = 2.04\, m^2$$

$$F_a = 0.0032 \times 2.04 \times 40^2 = 10.44N$$

Gradient resistance:

$$F_g = \pm(weight) \times \sin\theta$$

For bodies that have wheels, the rolling resistance has to be considered in place of the weight, therefore the above equation now becomes:

$$F_g = \pm(rolling\ resistance) \times \sin\theta$$
$$= 117.72 \times \sin(9°) = 18.42\ N$$

Therefore, $Total\ force = F_r + F_a + F_g$

$$= 117.72 + 10.44 + 18.42 = 146.58N$$

Motor torque:

$$\tau_m = \frac{\tau_\omega}{(gear\ ratio) \times (transmission\ \eta)} = 2.24Nm$$

Motor power:

$$Motor\ power = \frac{2\pi NT}{60}$$

Here, N is the RPM of the motor.

$$N = N_{wheel} \times gear\ ratio = 7520\ RPM$$

Therefore, $motor\ power = \frac{2\pi \times 7520 \times 2.24}{60} = 1.76KW$

Thus, the power that needs to be given by the motor is around 1.76 KW, which means we will require a motor with a rated power greater than 1.76 KW.

IV. DESIGN OF DC-DC BUCK CONVERTER

As discussed above, we will be using a DC-DC converter in order to step down the voltage so that the efficiency can be as high as possible. In our case, we need a buck converter. The requirements for our particular use case are as follows:

- Battery voltage: 48V DC
- System voltage: 12V DC
- Head lamps = 35 KW (1 no.) = $\frac{35}{12} = 3A$
- Side indicator lamps = 10KW (2 no.) = $2\left(\frac{10}{12}\right) = 1.7A$
- Stop lamp = 10 W (2 no.) = $2\left(\frac{10}{12}\right) = 1.7A$
- Horn = 12V DC = 1A

This means that we will not only need to step down the voltage to 12V but also maintain a current of around 7.5A in order to satisfy the other electrical components.

A. Design of the DC-DC buck converter:

$$\Delta V_c = 2.5\%\ of\ V_0 = 0.025 \times 12 = 0.3V$$

$$\Delta I_{load} = 5\%\ of\ I_0 = 0.05 \times 7.5 = 0.38A$$

$$\Delta I_e = 10\%\ of\ I_0 = 0.1 \times 0.75A$$

$$Duty\ cycle\ (d) = \frac{V_0}{V_{dc}} = \frac{12}{48} = 0.25 = 25\%$$

$$L_e = \frac{V_0(V_{dc} - V_0)}{\Delta I_e f V_{dc}} = \frac{12(48-12)}{0.75 \times 20 \times 10^3 \times 48}$$

$$= 600\mu H$$

$$C_e = \frac{\Delta I_e}{\Delta V_c \times 8f} = \frac{0.75}{0.3 \times 8 \times 20 \times 10^3} = 15.63\mu F$$

$$R = \frac{V_0}{I_0} = \frac{12}{7.5} = 1.6\Omega$$

$$L = \frac{\Delta V_c d}{\Delta I_{load} \times f} = \frac{0.3 \times 0.25}{0.38 \times 20 \times 10^3} = 9{,}86\mu H$$

In order to test the design, we need to simulate the DC-DC buck converter using our calculated values. The simulation has been done using Simulink. The block diagram and the simulation results are shown below:

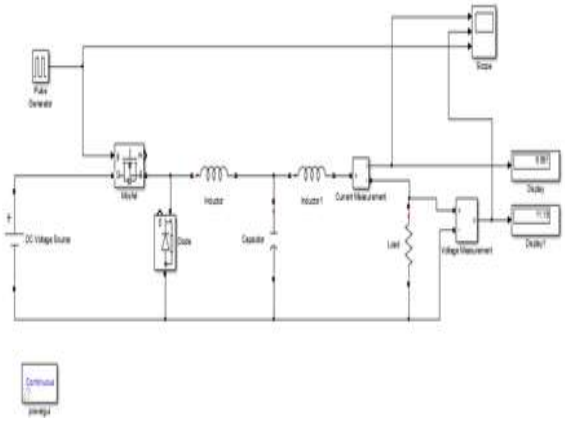

Fig-6: Simulink block diagram of the DC-DC buck converter

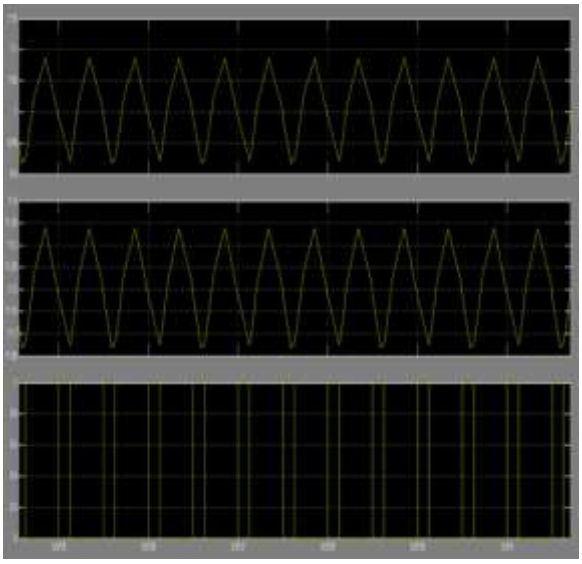

Fig-7: Simulation output waveforms

V. OBSERVATIONS

It is seen that the output waveforms and the values of the output seem to be satisfactory. The observations we can make out of the waveforms are:

- There are small variations in output voltage and current
- For continuous current conduction, the value of Inductance should be more than critical inductance
- Load side inductor further reduces harmonics in the waveforms.
- We also need to consider the acceleration factor. Mostly, the acceleration of a vehicle is around 2-5 meters per second square. So, we also consider an average acceleration as 3.5 m/s2.

VI. CONCLUSION

The study of the various motors for the usage in an electric vehicle have been studied. It is found out that the BLDC motor is perfect for this application. We also realize the need for the motor drive circuit. The study of various parameters such as the total force required in order to propel the vehicle forward and the total torque produced has been performed and the calculations have been performed for the given input parameters. Based on these parameters, we have selected what might be the suitable components that can be employed in order to fabricate the required electric drive-train that can successfully be retrofit into a conventional auto-rickshaw. We have also studied more about how the supply for the motor can be given, where we zeroed down on using a 48V battery and then stepping down the voltage to the required 12V using a DC-DC converter, more specifically a DC-DC buck converter. We have successfully designed a DC-DC buck converter for the required voltage. We have also performed the necessary calculations and simulations and the DC-DC buck converter works as desired.

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Vehicle Monitoring using IoT and Automatic Stop - Start System

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Abstract - *Electric vehicles are being widely used in recent times and thus their efficient operation mainly concerns when it is being manufactured. Thus a vehicle has to be monitored on regular intervals of time and hence their life and efficiency has to be increased. Automatic Stop - Start System is a new energy-saving product, which can obtain a good fuel economy and reduce emissions for the car. The work principle and mechanical structure are analyzed in this project. The key technologies of idle-stop-start system are analyzed based on this. Then the idle-stop-start system is modeled and analyzed.*

The project aims to develop an Automatic Stop – Start System for the Electric vehicle to save the energy consumed by the vehicle. This method helps in increasing the efficiency of the EV and the life of various components such as Batteries, Power electronic components increases.

The project also aims to build a system which can monitor various parameters such as Voltage, Speed, Temperature, Battery charge level, etc of an Electric vehicle (EV). It helps in assisting the owner to frequently checking the status of the vehicle and maintaining the vehicle whenever there are changes in the operating conditions of the vehicle. This project presents an implementation of a Wireless Internet of Things (IoT) system applied to the traction motor drive condition monitoring in electric vehicles (EVs). The design and testing of the prototype using an RL78 microcontroller module to acquire battery's voltage, current, and temperature information for the motor condition monitoring application is presented.

Key Words: Internet of Things (IoT), Electric Vehicles (EV's), Renases microcontroller, Battery, Sensor

1. INTRODUCTION

1.1 Electric Vehicles:

Plug-in electric vehicles (also known as Electric vehicles or EVs) are widely used for pollution free transportation. They can reduce emissions and even save you money. Fueling with electricity offers some advantages not available in conventional internal combustion engine vehicles. Because electric motors react quickly, EVs are very responsive and have very good torque.

EVs are often more digitally connected than conventional vehicles, with many EV charging stations providing the option to control charging from a smart phone app. Since the electric grid is available almost anywhere, there are a variety of options for charging: at home, at work or on the road. By charging often, you may never need to go to a gas station again. But EVs provide more than just individual benefits.

EVs can help India have a greater diversity of fuel choices available for transportation. India uses nearly five billion barrels of petroleum last year, two-thirds of which went towards transportation. Our reliance on petroleum makes us vulnerable to price spikes and supply disruptions.

EVs help reduce this threat because almost all India electricity is produced from domestic sources, including coal, nuclear, natural gas, and renewable sources. EVs can also reduce the emissions that contribute to climate change and smog, improving public health and reducing ecological damage. Charging your EV on renewable energy such as solar or wind minimizes these emissions even more.

1.2 Vehicle Monitoring System:

Traction motor drive system is an essential and critical component for an electric vehicle (EVs). The traction motor must be efficient and reliable as it is required to provide both speed and torque in wide operating range while maintaining precise control of the motor drive safely. To prevent the traction motor's abnormalities, improved reliabilities and effective operation with an early warning with instant notification is desirable and motor's vibration, current and temperature are practically three parameters that are well studied and widely accepted in detecting motor's failures due to electrical and mechanical faults.

According to the survey done by Institution of Electrical and Electronic Engineer (IEEE), 44% of motor's faults are from bearing and 24% are from stator. The majority of mechanical failures in motor are mechanical imbalance, rolling and bearings because a continuous stress on them can result in the major failure. Factors such as improper lubrication, improper installation, contamination and corrosion often contributed into rolling and bearings faults. A vibration sensor and current sensor are able to detect motor's rough running of bearing increasing vibration and unbalance shaft current due to the flux disturbance caused by rotor eccentricities. Bearing failure also causes temperature rise to exceed motor's predetermined load temperature.

Compared with wired system, IoT system offers many advantages such as relatively low cost, ease of installation, remote upgradeable software, and automates real-time data analysis and warning notifications to operators. In addition, the preventive maintenance of traction motor can be effectively and remotely planned at the right time with rich data collection and analysis. lt is changed from time-based or run-based maintenance to on-line predictive maintenance. The main benefits are such as cost reduction of maintenance, increased reliability, optimized traction motor performance, and improvement of accuracy in failure prediction.

This project presents a development and implementation of a Vehicle condition monitoring system based on Renases microcontrollers and various sensors.

1.3 Automatic Stop – Start System:

Most of the transportation system is heavily reliant on a petroleum-based energy source that uses finite and non-renewable sources which cause harmful effects on health and climate. In recent few decades' energy conservation and to cut down greenhouse gases are the most center of interest. In this scenario reducing energy consumption in public transport will provide sustainable cost saving, for public transport that is struggling with funds shortfall and increased demand. Most of the public sector contributes towards idling. According to an estimate every year US passenger cars, light trucks, heavy-duty vehicles consume more than 6 billion gallons of diesel fuel and gasoline. AIR quality, public health, climate change has now started receiving more attention and is becoming a greater priority. 6 common air pollutants have been described by EPA Environment protection agency, USA.

I. SO2 ii. O3 iii. Particulate matter iv.CO v. NO_X vi. Lead

Almost all of above-mentioned pollutants are available in the exhaust of vehicle except lead that has been eliminated from fuel. Exhaust is a cause of serious illness including asthma, lungs cancer, debates [2]. NO_X and P.M are two major pollutants observed by EPA from diesel engine exhaust consumption. Many different technologies are being used but most effective is Idling Reduction technique. It majorly cut down the emissions and saves fuel & protects the environment. The idle condition is one of the engine main conditions. When the bus is running on the road of the larger traffic density, about 30% fuel is used at the idle condition. In the automotive conditions emission test method, CO and HC of the idle emissions is usually about 70% of total emissions. For city buses, the docking sites is more, coupled with traffic crossing the red light stopping, the start and stop are very frequent, which will cause the most engine generated energy is consumed by the heating form during braking friction. Also, because there is a long parking condition, the engine is in the idle state for a long time, resulting in many problems, for example, the low speed, high fuel consumption and serious pollution.

2. PROBLEM STATEMENT

Whenever the vehicle comes to rest, there are standby losses as power is consumed by the electric motor and other components of the vehicle which reduces the efficiency of the vehicle. Battery consumption increases without actual movement of the vehicle and thus battery has to be charged for shorter periods.

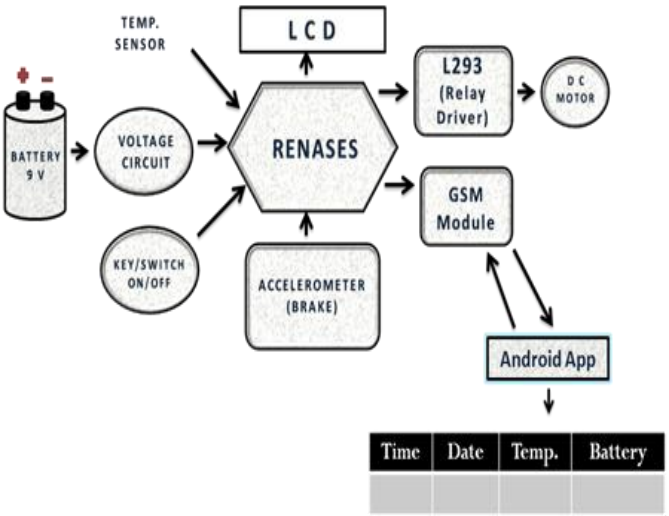
Electric vehicles are being used widely, but the owner of the vehicle may not know the condition of different components of their vehicle. This leads to poor maintenance from the user and overall life of the vehicle reduces. Thus the condition of the vehicle has to be monitored frequently or on a regular basis and the efficiency of the vehicle has to be increased whenever the vehicle is idle.

3. OBJECTIVE

The main objective of the project is to design an Automatic Stop-Start system for the Electric vehicle. Automatic Stop-Start system is used to turn the vehicle ON or OFF automatically when the vehicle is in rest condition. Stop-Start system helps to increase the overall efficiency of the vehicle.

Also monitoring various parameters in the vehicle such as voltage, temperature, speed, charge, current is carried out through IOT. Monitoring various parameters of the vehicle helps the owner of the vehicle to check the vehicle's condition on a day-to-day basis anytime and anywhere. IOT helps the user to check the status of the vehicle and gives an alert to the user either manually or automatically on various performance characteristics.

4. BLOCK DIAGRAM



When the vehicle is turned ON or turned OFF, the LCD starts to indicate that the vehicle is ON or OFF based on the vehicle's operating status.

When the vehicle is not running i.e., the vehicle is in standstill, The accelerometer does not detect any motion and thus Renases microcontroller will give an input to LCD as the vehicle is in "Standby condition".

When the vehicle is running i.e., the vehicle is in moving, The accelerometer detects the movement of the vehicle and thus Renases microcontroller will give an input to LCD as the vehicle is in "Running mode".

The microcontroller monitors the value of temperature from the temperature sensor continuously, if the temperature of the vehicle exceeds a preset or a standard value then the microcontroller sends an Alert to the user through an Android App and through an SMS.

The microcontroller monitors battery conditions i.e., voltage, charge level of the battery. If the battery voltage falls below or exceeds the rated value, then there is an alert sent to the user.

If the charge of the battery is low, then the user gets an alert with the help of GSM module and an Android App.

The LCD present in the circuit also displays the above parameters in a cyclic manner.

5. COMPONENTS USED

The design of "Vehicle Monitoring System Using IoT and Automatic Start – Stop System" includes the following components:

RL78 Renases Microcontroller: It is used to perform different functions in the project.

Accelerometer: It is used to detect the movement of the vehicle.

Temperature Sensor: It is used to measure the temperature of the drive and the battery.

GSM Module: It is used to send SMS alert to the owner of the vehicle.

Liquid Crystal Display (LCD): It is used to display the status, temperature, charge level, etc of the vehicle.

Battery: 12 V battery is used for demonstration purpose.

Voltage Measuring Circuit: It is used to measure the battery voltage.

Switch: It is used to sense acceleration and braking actions when the owner is using the vehicle.

Motor driver: It is used to supply required current to drive the motor.

DC Motor: 12 V, 100 RPM motor is used for demonstration purpose.

Voltage Regulator: It is used to supply constant voltage across the circuit.

6. CONCLUSIONS

Electric vehicles are widely used for pollution free transportation. The main advantage is the high efficiency in power conversion through its proposition system of electric motor.

In the growing market for vehicles, pollution of the environment and increasing energy crisis causes an increased demand for the development of Automatic stop – start system and vehicle monitoring system.

Almost every day a large number of vehicles stop on a traffic signal, in a traffic jam for almost an average 2 minutes and sometimes even more. During this stop, the engine is running while the vehicle is not moving this process of idling wastes a large amount of fuel as well as emits a lot of harmful emissions. Hence to obtain high efficiency and better operation of the vehicle, the vehicle parameters is monitored and energy consumption is minimized when the vehicle is idle by implementing an Automatic stop – start system.

The GSM and Android application system allows the user to monitor provided by the sensors available on the vehicle, and to control processes such as battery charging, either manually and automatically, anytime and anywhere. By monitoring the various parameters of an electric vehicle, the maintenance of the vehicle can be carried out on a regular basis or whenever there is a requirement.

By establishing the Electric vehicles with Automatic stop-start system model, the Automatic stop - start system can save fuel greatly, so the emission can be improved greatly.

7. FUTURE SCOPE

There is always chance to improve any system as research & development is an endless process. Our system is no exception to this phenomenon. Apart from the simulation of the software and hardware of the project, we can further extend or upgrade the operation of this system in the following ways:

1) Although we are using a small prototype of an Electric vehicle in our project, the implementation of the hardware can also be done on an on – road Electric vehicle.

2) The concept in the future can be extended by using Bluetooth modules and Wi – Fi modules in the place of GSM Modules.

3) Different sensors such as vibration sensors, acoustic noise sensors, magnetic flux sensors, etc can be used to detect the operating conditions in the traction motor drive of the Electric vehicle.

4) Vehicle monitoring system and Automatic stop – start system can be implemented in all the sorts of vehicles that are available in the market.

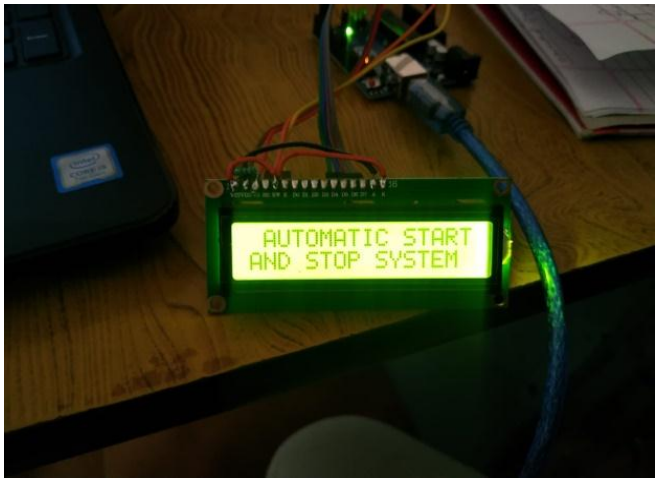


Fig: LCD displaying Name of the Project

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Fuel Level Indication and Mileage Calculation using IoT

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Abstract - *Digital technologies shape our everyday lives for calculating everything. In this project we proposed to implement a digital way to view fuel target in a vehicle using IOT. The simple aspect of this work is to check whether the fuel filled in the vehicle is appropriate to the given price or not, as for the first two pumps the tank is filled with fuel with air and then for the rest of the pumps, tank is filled with fuel. The level of the fuel is calculated with the help of float sensor. When people are moving in the highways or in the hills, they don't know how long will that vehicle will travel. So, we are embedding the mileage calculation with the level detection. With the help of the distance which is displayed in the LCD, the person can aware about how far that vehicle will move further.*

Key Words: **IOT (Internet of Things), LCD (Liquid Crystal Display), Tank, Fuel, Float Sensor, etc**

1. INTRODUCTION

Nowadays all world become digital so that we can easily deals with real time system. At same time digital fuel meter also implemented in recent vehicle system but actual fuel present in fuel tank of bike not shown in term of digits that show in terms of bar or deflecting needle so that we did not get idea about actual fuel present in fuel tank of bike it only show level of fuel present in fuel tank. To solved this problem we developed system digital fuel meter that indicate value of fuel in digits and fuel theft value of fuel shown in digits such as 1lits, 1.5lits, 2lits etc. The digital fuel meter is applicable for only for two-wheelers bikes. In our project we can add features of such as distance travelled by bike within certain amount of fuel so that we can calculate performance of bike in terms of millage. Sometimes customer fill fuel in terms of petrol from petrol filling pump they filled the petrol in digitally but in our bike there is no digital system there is bar or deflection needle system so that it not give the accurate fuel filled by customer so the petrol filling pump owner is cheated on customer but customer do not know about cheating due to traditional system because sometime fuel may minimum or maximum than filled value. All benefit goes to the petrol filling pump owner so that they many times cheated with customer. All vehicle has bar or deflecting pointer measurement system so that they don't know the exact amount of bunk into bike so that owner of petrol bunk station easily cheated on customer. Thus idea of Digital Fuel Meter is applicable for fuel indication and fuel theft also helpful to avoid cheating of customer from petrol filling station owner

In existing world, the population of the people increases day by day, so the need of the vehicle also increased. While filling the fuel in petrol bunks, people may not know whether the fuel is filled to the correct level for the amount given by them and gets cheated by the staffs who are in the bunk at sometime. During the travel, maximum people are not aware of the distance covered for the rest of fuel present in a vehicle. To overcome this drawback we have proposed this work. The sensor used in this project is float sensor to indicate the level, this sensor does not emit any type of rays and will not damage the vehicle. When the fuel is poured inside the tank, the level is analyzed and indicated at the moment itself in the digital form, with this data the distance covered by the vehicle is also shown.

2. LITRATURE SURVEY

The level of fuel is calculated with the help of the flow sensor and the ultrasonic sensor. Due to the presence of the ultrasonic sensor there may be a emission of ray from it. If there is any emission of rays it may lead the explosion of the vehicle. The Ultrasonic sensor is used for calculating the amount of fuel in the vehicle and also detects whether the vehicle may lead to any accident during the travel time. fuel float sensor which is a Indicator unit measuring and displaying the amount of electric current flowing through the sending unit. When the tank level is high and maximum current is flowing, the needle points to "F" indicating a full tank. When the tank is empty and the least current is flowing, the needle points to "E" indicting an empty tank.

3. EXISTING SYSTEM

In the current world, the fuel level indication will be in the analog meter or in the digital barcode. It is very difficult for the person to analyze the level of fuel in the vehicle. At some times, while travelling in the highways we don't know what's the amount of fuel in the vehicle and the distance travelled by the vehicle also, because of that there may be a chance of vehicle to stop while we are travelling. It gives the physical problem for the people to fill the fuel back by pushing it and moving to the petrol bunk. This will lead to the waste of time during the travel.

4. METHODOLOGY

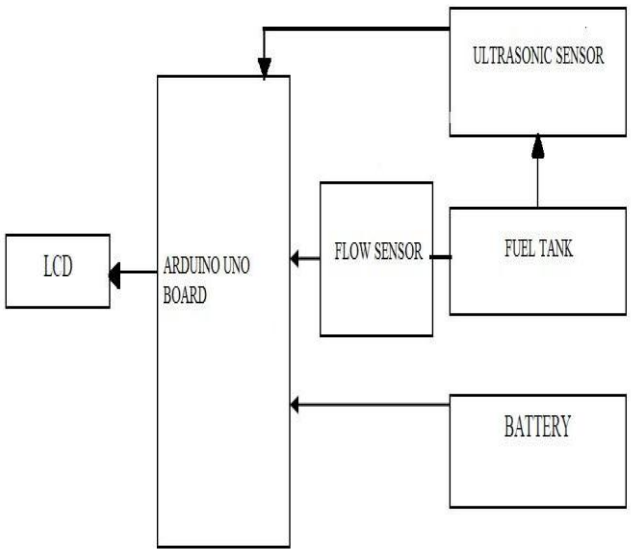


Fig-1: Block diagram of proposed system

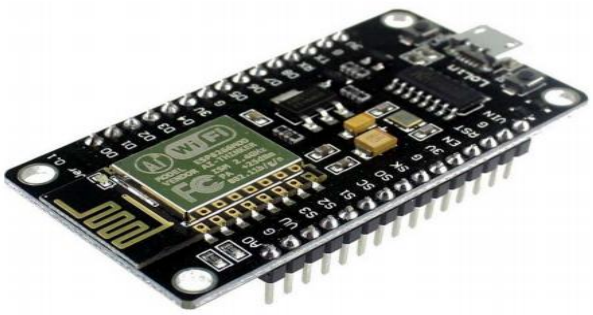
In the proposed block diagram, We Connect the fuel tank with the float sensor to calculating the fuel level. The output of the float sensor will be in the fluctuating mode. So it is controlled with the help of the controller. The analog output of the sensor is given to the nodeMCU microcontroller board. The analog input is converted into digital with the Arduino programming language and display in the LCD Board. In our work, we are converting that analog fuel detection meter into the digital display where the level of the fuel will be detected and shown for the people who are travelling in that vehicle. With the help of fuel level which has been sensed by the sensor the mileage of the vehicle will be calculated and displayed in the LCD. This helps the person to know the distance which will be covered by the vehicle.

For the indication of fuel level, two major sensors are used. One is an ultrasonic sensor used to find the duration of ultrasonic waves transmitted and received between the sensor and the surface of fuel. The results are received by arduino board. And the arduino programming converts the duration into distance. The distance converted is again converted into litres. Other is a flow sensor used to calculate the discharge of the fuel from the fuel tank. There are two outputs from the flow sensor. The first output is discharge in terms of lit/min and the second output is the total litres of fuel discharged through the sensor. Only the second output from the flow sensor (i.e the total litres of fuel discharged) is required for final fuel level indication. The modified result of ultrasonic sensor and the second output from flow sensor are taken and the difference between these two readings gives the final accurate fuel level in litres.

5. COMPONENTS USED

5.1 Node MCU

ESP8266 NodeMCU WiFi Devkit



The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

5.2 ARDUINO IDE

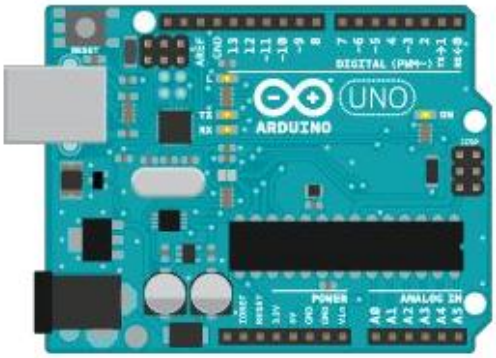


Fig 2-Arduino Uno dev. board (Fritzing part graphic)

Arduino first and foremost is an open-source computer hardware and software company. The Arduino Community refers to the project and user community that designs and utilizes microcontroller-based development boards. These development boards are known as Arduino Modules, which are open-source prototyping platforms. The simplified microcontroller board comes in a variety of development board packages.

The most common programming approach is to use the Arduino IDE, which utilizes the C programming language.

This gives you access to an enormous Arduino Library that is constantly growing thanks to open-source community.

Arduino IDE is not: AVR Studio (Yes, we know you loved EE 346, but unfortunately you won't be utilizing Assembly Language)

5.3 ULTRASONIC SENSOR

Fig- 3 Ultrasonic sensor

Active ultrasonic sensors generate high-frequency sound waves and evaluate the echo which is received back by the sensor, measuring the time interval between sending the signal and receiving the echo to determine the distance to an object.

5.4 WATER FLOW SENSOR

Fig- 4 Water flow sensor

Liquidflow sensor consists of a plastic valve body, a liquid rotor, and a hall-effect sensor. When liquid flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The halleffect sensor outputs the corresponding pulse signal.

5.5 LIQUID CRYSTAL DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module and finds a wide range of applications. A16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments.

6. EXPERIMENTAL METHOD

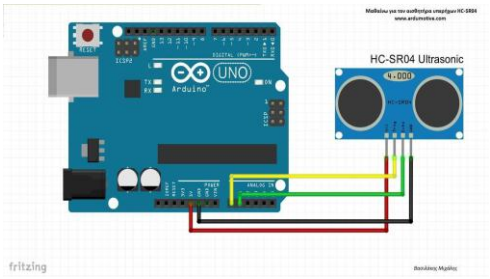


Fig 5: Circuit connection of aurdino with ultrasonic sensor

When vehicle's ignition is turned ON, the battery will power the arduino board and the sensors. At first, the ultrasonic sensor will measure the duration of the ultrasonic waves transmitted and received between the sensor and the surface of the fuel.

Now the program uploaded in the arduino board will convert the duration into distance using the formula (**distance=duration*0.034/2**) and again the distance is converted into litres by trial and error method.Note that the reading now calculated from ultrasonic sensor will not be changed until the reset button is pressed. The reset button should be pressed only when filling up additional fuel into the fuel tank.

Now the second output (total fuel passed through the flow sensor) from the flow sensor will be in terms of litres. The modified output from the ultrasonic sensor and the second output from the flow sensor is taken and the difference between these two values gives the final fuel level indication in litres which will be displayed in Liquid Crystal Display fixed near the instrument cluster. The ultrasonic sensor will be positioned inside the fuel tank where the depth is maximum. The position should be identified such that the maximum duration of ultrasonic waves is possible between the sensor and the surface of the fuel. The flow sensor will be attached to the outlet tube of fuel tank to measure the discharge and the total fuel passing through the sensor.

7. IOT TESTING PROCESS

7.1 BLYNK

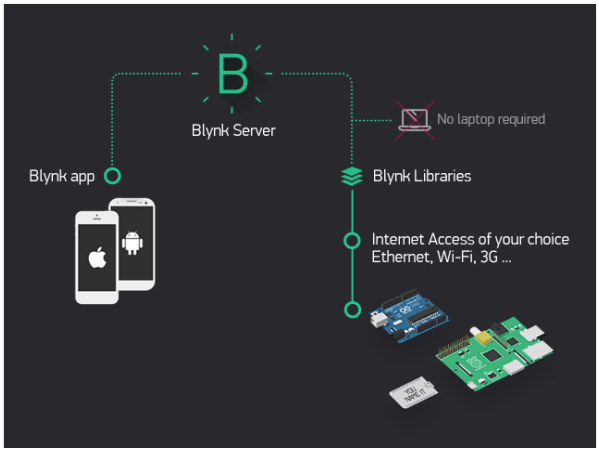
Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

There are three major components in the platform:

Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.

Blynk Server -responsible for all the communications between the Smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It is open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands. Now imagine: every time you press a Button in the Blynk app, the message travels to the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blynk of an eye.



To use Blynk app we need

7.1.1 Hardware

An Arduino, Raspberry Pi, or a similar development kit.

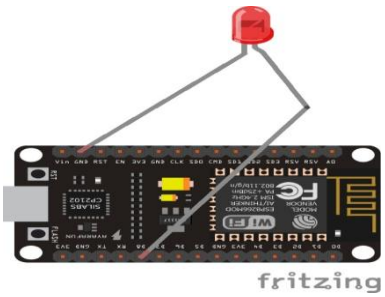
Blynk works over the Internet. This means that the hardware you choose should be able to connect to the internet. Some of the boards, like Arduino Uno will need an Ethernet or Wi-Fi Shield to communicate, others are already Internet-enabled: like the ESP8266, Raspberri Pi with WiFi dongle, Particle Photon or SparkFunBlynk Board. But even if you don't have a shield, you can connect it over USB to your laptop or desktop (it's a bit more complicated for newbies, but we got you covered). What's cool, is that the list of hardware that works with Blynk is huge and will keep on growing.

7.1.2 Smartphone

The Blynk App is a well-designed interface builder. It works on both iOS and Android.

Getting Started Let's get you started in 5 minutes (reading doesn't count!). We will switch on an LED connected to your nodeMCU using the Blynk App on your smartphone.

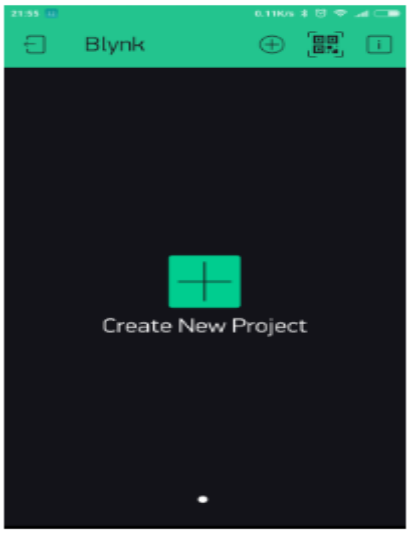
Connect an LED as shown here:



Getting Started with the Blynk App

1. Create a Blynk Account

After you download the Blynk App, you'll need to create a New Blynk account. This account is separate from the accounts used for the Blynk Forums, in case you already have one.We recommend using a **real** email address because it will simplify things later. After you've successfully logged into your account, start by creating a new project.



Choose Your Hardware Select the hardware model you will use that is Node MCU

Auth Token is a unique identifier which is needed to connect your hardware to your smartphone. Every new project you create will have its own Auth Token. You'll get Auth Token automatically on your email after project creation. You can also copy it manually. Click on devices section and selected required device. Auth token is sent to the registered email.

Add a Widget

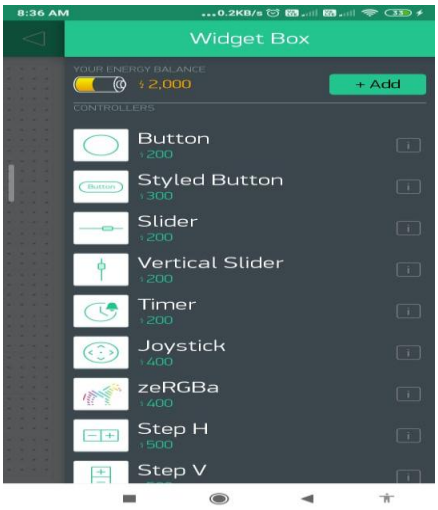
Your project canvas is empty, let's add a button to control our LED.

Tap anywhere on the canvas to open the widget box. All the available widgets are located here. Now pick a button.

Widget Box

Drag-n-Drop - Tap and hold the Widget to drag it to the new position.

Widget Settings - Each Widget has it's own settings. Tap on the widget to get to them.



Run the Project

When you are done with the Settings - press the **PLAY** button. This will switch you from EDIT mode to PLAY mode where you can interact with the hardware. While in PLAY mode, you won't be able to drag or set up new widgets, press **STOP** and get back to EDIT mode.

You will get a message saying "led is offline". We'll deal with that in the next section.

Getting Started With Hardware

How To Use an Example Sketch You should by now have the Blynk Library installed on your computer. After installing the blynklib ,GoTo file - > Examples - >Blynk - >Board_WiFi - >NodeMCU

Auth Token

In this example sketch, find this line:

char auth[] = "YourAuthToken";

This is the Auth Token that you emailed yourself. Please check your email and copy it, then paste it inside the quotation marks.

It should look similar to this:

char auth[] = "f45626c103a94983b469637978b0c78a";

Upload the sketch to the board and open Serial Terminal/Monitor. Wait until you see something like this:

Blynkv.X.X.X

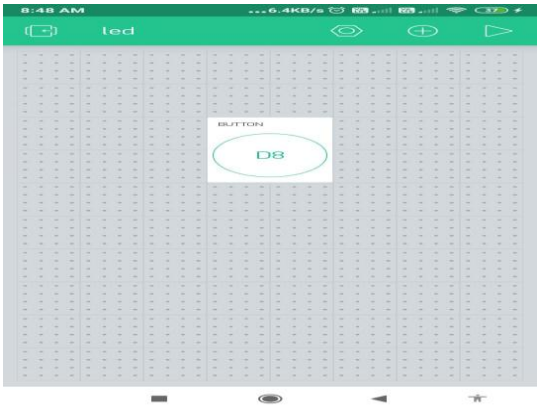
Your IP is 192.168.0.11

Connecting...

Blynk connected!

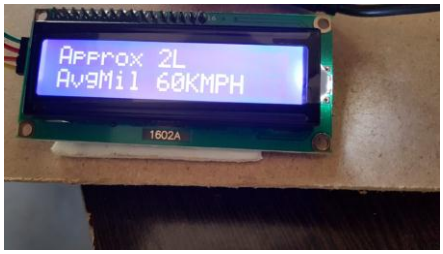
Congrats! You are all set! Now your hardware is connected to the Blynk Cloud!

Go back to the Blynk App, push the button and turn the LED on and off! It should be Blynking



8. RESULTS

The Proposed system is expected to calculate the exact quantity of the fuel level in the vehicle and the mileage of the vehicle will be calculated which is displayed in the digital meter. This helps the user to know the level of fuel in the vehicle.



9. CONCLUSIONS

The deployment of flow sensor and ultrasonic sensor in fuel level indication have yielded satisfactory results over the conventional fuel level indication. The accuracy has been increased to 94% with a tolerance of ±0.1litres. This method will yield accurate results while driving on plane surfaces or roads and the accuracy will reduce while driving on slopes or hills. The entire system is more economical and reliable. The system requires less maintenance. As years passes, technology gets updated and different solutions arises for the same problem. And the usage of ultrasonic sensor and flow sensor to digitalize and indicate the fuel level in two wheelers is one such up-gradation to this problem.

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Smart Cities Based on Internet of Things (IoT) -A vision, Architectural Elements and Future Applications

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1.HIGHLIGHTS

- Presents vision and motivations for Internet of Things (IoT).
- Application domains in the IoT with a new approach in defining them.
- Cloud-centric IoT realization and challenges.
- Different parts of smart city namely parking system, Hydroponics, Waste Management system.

2.ABSTRACT

Increasing population density in urban centers demands suitable provision of services and infrastructure to meet the needs of city inhabitants, surrounding residents, workers and visitors. The utilization of information and communications technologies (ICT) to achieve this objective presents an opportunity for the development of smart cities, where city management and citizens are given access to a wealth of real time information about the urban environment upon which to base decisions, actions and future planning. This paper presents a framework for the realization of smart cities through the Internet of Things (IoT). The framework encompasses the complete urban information system, from the sensory level and networking support structure through to data management and Cloud based integration of respective systems and services, and forms a transformational part of the existing cyber-physical system.

This IoT vision for a smart city is applied to a noise mapping case study to illustrate a new Method for existing operations that can be adapted for the enhancement and delivery of important city services.

3.INTRODUCTION

It is estimated that 70% of the world's population, over 6 billion people, will live in cities and nearby regions by 2050. The rapid increase of the population density inside urban environments, infrastructures and services has been needed to supply the requirements of the citizens. So, cities need to be smart, if only to survive as platforms that allow economic, social and environmental safety. Smart city is the one that uses information and communications technologies (ICT) to make the city services and monitoring more aware, interactive and competent. Smartness of a city is driven and enabled technologically by the growing Internet of Things (IoT) - a radical evolution of the current Internet into a global network of interconnected objects that not only gathers information from the environments (sensing) and interacts with the physical world, but also uses existing Internet standards to provide services for information transfer, analytics, and applications. The Internet of Things (IoT) is a new model that is fast gaining ground in the result of modern wireless telecommunications. The basic idea of this concept is the ubiquitous presence around us of a variety of things or objects – such as Radiofrequency Identification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through distinctive addressing schemes, are able to relate with each other and cooperate with their neighbors to reach common goals powered by the adaptation of a variety of facilitating devices such as embedded sensor and actuator nodes, the IoT has stepped out of its beginning and is on the edge of revolutionizing current fixed and mobile networking infrastructures into a fully integrated future Internet. Wireless sensor networks (WSN), as the sensing-actuation support of the IoT, effortlessly integrates into urban infrastructure forming a digital layer over it. The information generated will be shared across diverse platforms and applications to develop a common operating picture (COP) of the city. With urbanization violate the 50% obstacle; it is of utmost importance to

understand the d e m a n d f or service profiles to increase the efficiency of city management. Currently, few municipalities have plan for live monitoring, and gathering of urban process parameters. The commonly employed strategy is: data collection; offline analysis; action; followed by system adjustments and repetition of the whole process. Data collection exercises are often costly and difficult to imitate. There is thus an increased demand on municipalities to incorporate smart technologies that collect the required data and analyze them for action, all in real time. With advanced sensing and computation abilities, data are assembled and evaluated in real time to extract the information, which is further transformed to usable knowledge. This will improve the decision making of city management and citizens to turn the city smart. The paper mainly focuses on IoT implementation in making parking system, also creating an up to the mark waste management system and hydroponics cultivation system.

4.MOTIVATION

The smart city is becoming smarter than in the past as a consequence of the current expansion of digital technologies. Smart cities consist of various kinds of electronic equipment applied by some applications, such as cameras in a monitoring system, sensors in a transportation system, and so on. Furthermore, utilization of individual mobile equipment can be spread. As mentioned, a smart city employs information and communications technologies (ICT) in a way that addresses quality of life by undertaking urban living challenges encompassed by more efficient utilization of limited resources (space, mobility, energy, etc.). World leading municipalities, in terms of services and quality of life, have provided efficient services to their citizens by the forward thinking and use of technology in monitoring various environmental parameters. Most of these systems consist of sensor, data storage device, and computer at a base station where experts analyze the data. From the technological perspective, the evolution of social networking in the past decade clearly shows the usability of ICT at an individual's level. Large scale implementations at system level have made some progress in recent years. A fully integrated system of systems containing sensing, storage, analytics, and interpretation is required. The integrated system must have core capabilities of plug-and-play sensing, secure data aggregation, Quality of Service, and re-configurability. With an urban sensing system of systems in place, the ability to evaluate the impact of the preceding actions is readily available as the sensing cycle repeats. A unifying information management platform delivers a capability across application domains critical to the city. Whilst large volumes of data collection and interpretation are already performing at different levels within city councils using manual and semi-automated methods, it is mostly in isolation. As with any large organization, it is inevitable that large portions of these data remain disjoint in the time scales over which they are collected and the capacity for them to be integrated. An urban information framework enabled by IoT provides a means for consolidating these tasks and sharing data between various service providers in the city. The applications within the urban environment that can benefit from a smart city IoT capability can be grouped according to impact areas. This includes the effect on: citizens (health and wellbeing); transport (mobility, productivity, pollution); and services (critical community services). Several projects are already underway within the City of Melbourne that utilizes sensor technologies to collect application specific data. These include: public parking monitoring; micro climate monitoring; access and mobility (pedestrian, cyclists, car sand goods vehicles). A number of specific application domains have also been identified that could utilize smart city IoT infrastructure to service operations in Health Services (noise, air and water quality); Strategic Planning (mobility); Sustainability (energy usage); Tourism(visitor services, tourist activity); Business and International (city usage, access); and City Safety.

5.DEFINATIONS

Internet of Things can be realized in three paradigms—internet-oriented (middleware), things oriented (sensors) and semantic-oriented (knowledge). Although this type of delineation is required due to the interdisciplinary nature of the subject, the usefulness of IoT can be unleashed only in an application domain where the three paradigms intersect. The RFID group defines the Internet of Things as stated further-

The worldwide network of interconnected objects uniquely addressable based on standard communication protocols.

• 'Things' are active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information sensed about the environment, while reacting autonomously to the real/physical world events and influencing it by running processes that trigger actions and create services with or without direct human intervention.

• Uses information and communications technologies to make the critical infrastructure components and services of a city's administration, education, healthcare, public safety, real estate, transportation and utilities more aware, interactive and efficient.

• Interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications. This is achieved by seamless ubiquitous sensing, data analytics and information representation with Cloud computing as the unifying framework.

6.TRENDS

Internet of Things has been identified as one of the emerging technologies in IT. Due to its ease of operation the IoT has gained popularity not only in industries but also in modern households where control of various parameters such as thermostat, CCTV cameras, fans, television, lightings etc. can be controlled from one central location. IoT ensures far greater security through some modern softwares that are updated from time to time in order to ensure better security. Internet of things schematics as used in different fields is shown below in figure 1.

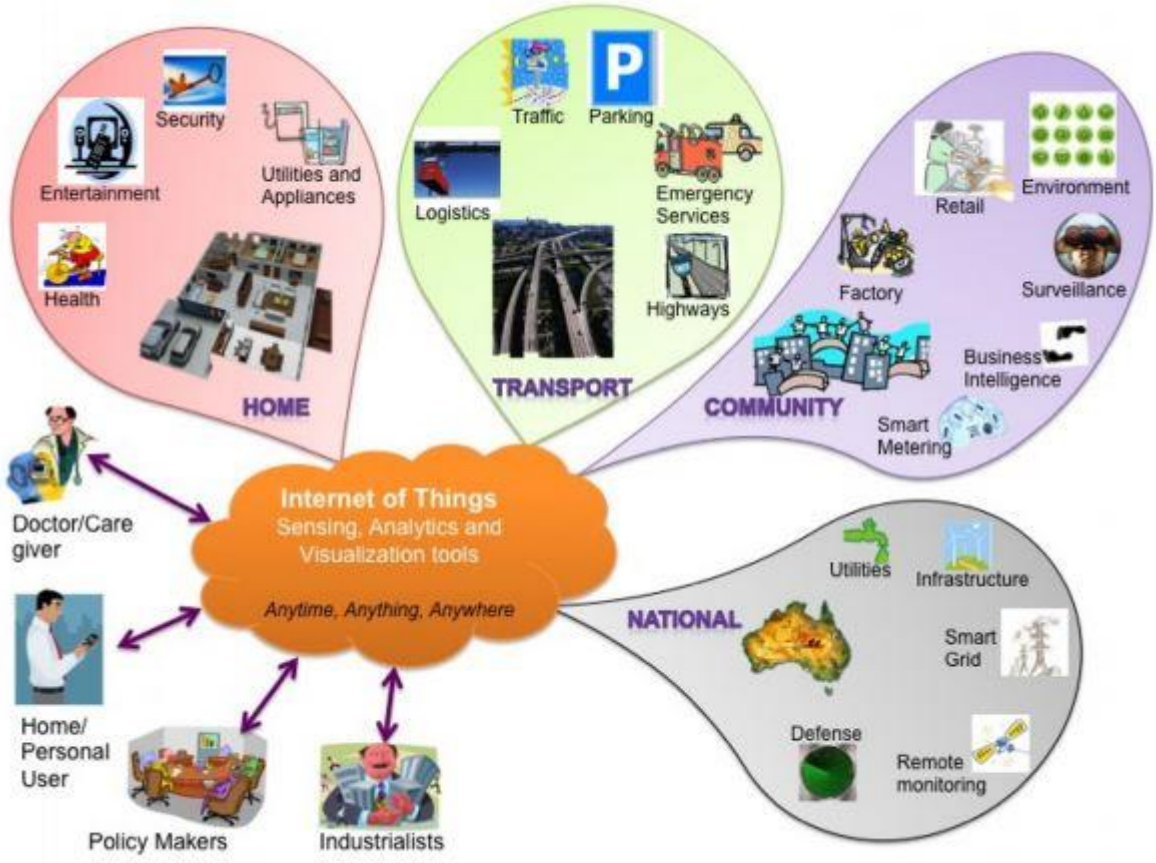


Fig. 1. Internet of Things schematic showing the end users and application areas based on data.

7.IOT ELEMENTS

We present a classification that will aid in defining the components required for the Internet of Things from a high level perspective. Specific taxonomies of each component can be found elsewhere. There are three IoT components which enables seamless functioning: (a) Hardware—made up of sensors, actuators and embedded communication hardware (b) Middleware—on demand storage and computing tools for data analytics and (c) Presentation—novel easy to understand visualization and interpretation tools which can be widely accessed on different platforms and

which can be designed for different applications. In this section, we discuss a few enabling technologies in these categories which will make up the three components stated above.

7.1Radio Frequency Identification (RFID)

RFID technology is a major breakthrough in the embedded communication paradigm which enables design of microchips for wireless data communication. They help in the automatic identification of anything they are attached to acting as an electronic barcode. The passive RFID tags are not battery powered and they use the power of the reader's interrogation signal to communicate the ID to the RFID reader. This has resulted in many applications particularly in retail and supply chain management. The applications can be found in transportation (replacement of tickets, registration stickers) and access control applications as well. The passive tags are currently being used in many bank cards and road toll tags which are among the first global deployments. Active RFID readers have their own battery supply and can instantiate the communication. Of the several applications, the main application of active RFID tags is in port containers for monitoring cargo.

7.2Wireless Sensor Networks (WSN)

Recent technological advances in low power integrated circuits and wireless communications have made available efficient, low cost, low power miniature devices for use in remote sensing applications. The combination of these factors has improved the viability of utilizing a sensor network consisting of a large number of intelligent sensors, enabling the collection, processing, analysis and dissemination of valuable information, gathered in a variety of environments. Active RFID is nearly the same as the lower end WSN nodes with limited processing capability and storage. The scientific challenges that must be overcome in order to realize the enormous potential of WSNs are substantial and multidisciplinary in nature. Sensor data are shared among sensor nodes and sent to a distributed or centralized system for analytics. Better and better security protocols are being developed for WSN in order to prevent any external or malware attacks.

7.3Addressing Scheme

The ability to uniquely identify 'Things' is critical for the success of IoT. This will not only allow us to uniquely identify billions of devices but also to control remote devices through the Internet. The few most critical features of creating a unique address are: uniqueness, reliability, persistence and scalability. Every element that is already connected and those that are going to be connected must be identified by their unique identification, location and functionalities. The current IPv4 may support to an extent where a group of cohabiting sensor devices can be identified geographically, but not individually. The Internet Mobility attributes in the IPV6 may alleviate some of the device identification problems; however, the heterogeneous nature of wireless nodes, variable data types, concurrent operations and confluence of data from devices exacerbates the problem further. Persistent network functioning to channel the data traffic ubiquitously and relentlessly is another aspect of IoT. Although, the TCP/IP takes care of this mechanism by routing in a more reliable and efficient way, from source to destination, the IoT faces a bottleneck at the interface between the gateway and wireless sensor devices. Furthermore, the scalability of the device address of the existing network must be sustainable. The addition of networks and devices must not hamper the performance of the network, the functioning of the devices, the reliability of the data over the network or the effective use of the devices from the user interface. To address these issues, the Uniform Resource Name (URN) system is considered fundamental for the development of IoT. URN creates replicas of the resources that can be accessed through the URL. With large amounts of spatial data being gathered, it is often quite important to take advantage of the benefits of metadata for transferring the information from a database to the user via the Internet. IPv6 also gives a very good option to access the resources uniquely and remotely. Another critical development in addressing is the development of a lightweight IPv6 that will enable addressing home appliances uniquely. Wireless sensor networks (considering them as building blocks of IoT), which run on a different stack compared to the Internet, cannot possess IPv6 stack to address individually and hence a subnet with a gateway having a URN will be required. With this in mind, we then need a layer for addressing sensor devices by the relevant gateway. At the subnet level, the URN for the sensor devices could be the unique IDs rather than human-

friendly names as in the www, and a lookup table at the gateway to address this device. Further, at the node level each sensor will have a URN (as numbers) for sensors to be addressed by the gateway. The entire network now forms a web of connectivity from users (high-level) to sensors (low-level) that is addressable (through URN), accessible (through URL) and controllable (through URC).

7.4 Data Storage and Analytics

One of the most important outcomes of this emerging field is the creation of an unprecedented amount of data. Storage, ownership and expiry of the data become critical issues. The internet consumes up to 5% of the total energy generated today and with these types of demands, it is sure to go up even further. Hence, data centers that run on harvested energy and are centralized will ensure energy efficiency as well as reliability. The data have to be stored and used intelligently for smart monitoring and actuation. It is important to develop artificial intelligence algorithms which could be centralized or distributed based on the need. Novel fusion algorithms need to be developed to make sense of the data collected. State-of-the-art non-linear, temporal machine learning methods based on evolutionary algorithms, genetic algorithms, neural networks, and other artificial intelligence techniques are necessary to achieve automated decision making. These systems show characteristics such as interoperability, integration and adaptive communications. They also have a modular architecture both in terms of hardware system design as well as software development and are usually very well-suited for IoT applications. More importantly, a centralized infrastructure to support storage and analytics is required. This forms the IoT middleware layer and there are numerous challenges involved which are discussed in future sections. As of 2012, Cloud based storage solutions are becoming increasingly popular and in the years ahead, Cloud based analytics and visualization platforms are foreseen.

7.5Visualisation

Visualization is critical for an IoT application as this allows the interaction of the user with the environment. With recent advances in touch screen technologies, use of smart tablets and phones has become very intuitive. For a lay person to fully benefit from the IoT revolution, attractive and easy to understand visualization has to be created. As we move from 2D to 3D screens, more information can be provided in meaningful ways for consumers. This will also enable policy makers to convert data into knowledge, which is critical in fast decision making. Extraction of meaningful information from raw data is non-trivial. This encompasses both event detection and visualization of the associated raw and modeled data, with information represented according to the needs of the end-user.

8. APPLICATIONS

There are several application domains which will be impacted by the emerging Internet of Things. The applications can be classified based on the type of network availability, coverage, scale, heterogeneity, repeatability, user involvement and impact. We categorize the applications into four application domains: (1) Personal and Home; (2) Enterprise; (3) Utilities; and (4) Mobile. There is a huge crossover in applications and the use of data between domains. For instance, the Personal and Home IoT produces electricity usage data in the house and makes it available to the electricity (utility) company which can in turn optimize the supply and demand in the Utility IoT. The internet enables sharing of data between different service providers in a seamless manner creating multiple business opportunities. Some of the applications of IoT in various fields are represented below in figure 2.

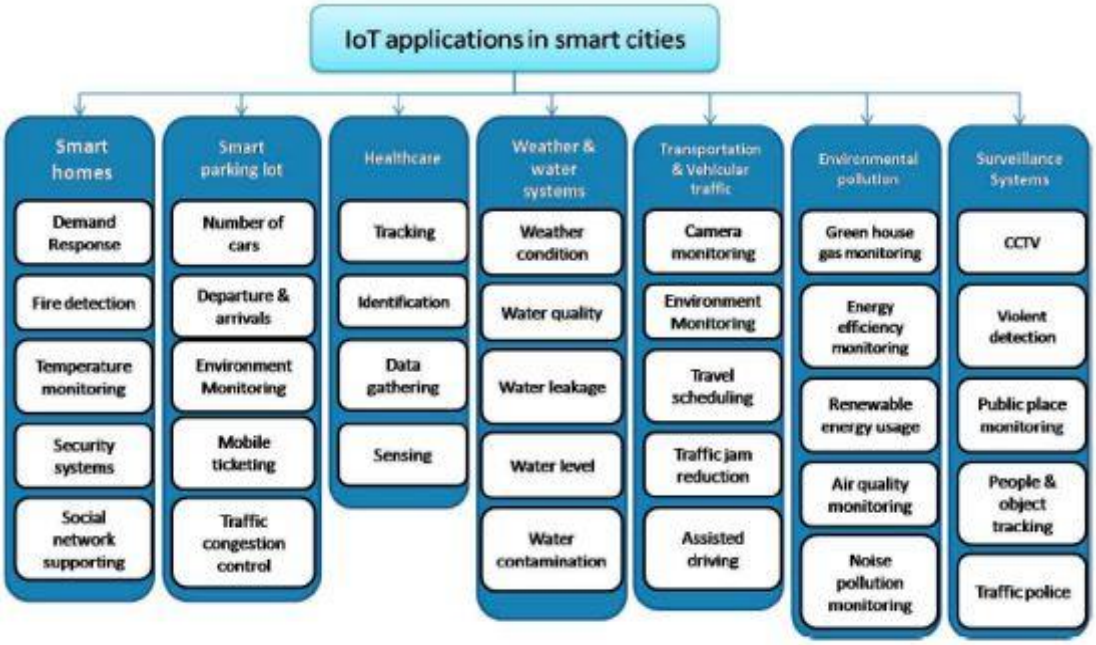


Figure 2.The main applications of the IoT

9. HYDROPONICS

Internet of Things is a new type of computing system where small electronic devices equipped with sensors are used to detect the operating environment of the system and, together with data from other sources, determine the actions that should be taken on behalf of users to increase values or create new features for the system. Automation is usually one of the goals for deploying Internet of Things either in home or workplace. Smart agriculture or smart farming is the application of Internet of Things to growing crops with the potential of saving labor and resources, more fine-grained control in watering and fertilization, and more accurate gathering of information about planting environment. Hydroponics is a method of growing plant without soil, using instead liquid nutrient solution. One benefits of hydroponics farm is reduced labor cost because the farmer does not have to prepare the soil, and watering and fertilization are usually automatically build into the hydroponics farm. Since hydroponics farm is usually partly automated, it is much easier to integrate Internet of Things to get better and more accurate data and fully automate the farm. In this research, we plan to evaluate the cost effectiveness of Smart Hydroponic farm using Internet of Things technology when compared to a regular hydroponic farm. Of course, the Smart Farm should produce better crops, but we intend to find out how much better, and whether the improvement merit the usually high cost of installation.

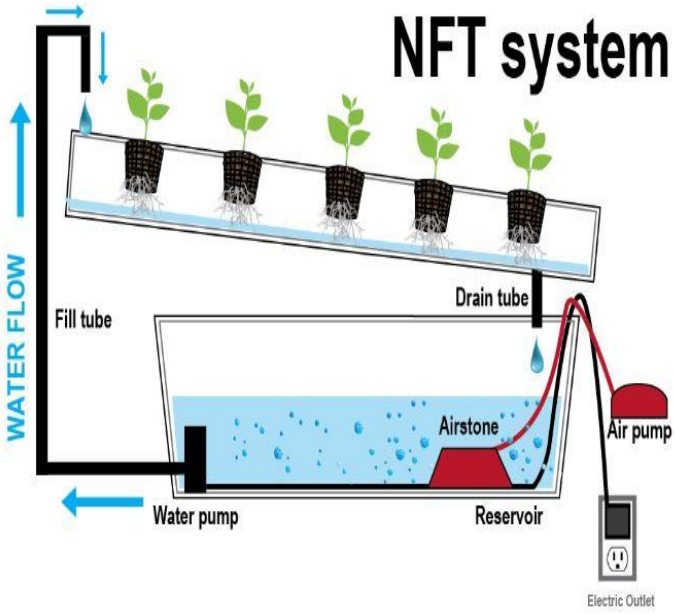
10. IMPLIMENTATION

Hydroponics is a method in growing plant in nutrient solution. It helps produce more crops than planting in the soil. It can also be seen from tomatoes grown in a building using the planting material that the yield increases by 20-25%.The three most popular hydroponic plantings are Nutrient Film Technique (NFT), Deep Flow Technique (DFT), and Dynamic Root Floating Technique (DRFT). The first one, NFT, is a method that makes nutrient flow along a one-to three-millimeter-thin film and this gives roots opportunity to be exposed to air. The second one, which is DFT, is a method in which plant is floated in water and there has to be a 3-5 cm gap between nutrient solution and planting sheet to let one part of the root be exposed to air and another is in the solution. The last method, DRFT, is quite similar to the second method; however, a nutrient circulatory system is added.

11. MATERIAL LIST

1) Five 2-to-3-millimeter-thick and 3-meters-long film rails.
2) A table (1.6 meters width, 3 meters length) 3) A 50-liter nutrient solution container (61” width x 41” length x 30” height)
4) 3/5-mm and 25-mm HDPE pipes.
5) Sonic AP 3500 water pump which can pump 2,800 liters of water per hour. The electrical power consumption is 60W and the water can go up to 2.8 meters high.

6) Four plastic buckets with cross-section area measured.
7) Arduino Mega 2560 Rev 3, a main microcontroller device.
8) Ultrasonic Sensor was used to measure water height.
9) Water Pumps DC 12V.
10) A pH sensor
11) A EC (Electrical Conductivity) sensor used to sensor concentration of nutrient solutions.
12) Water Temperature Sensor.
13) Temperature & Relative Humidity Sensor.
14) Light Sensor.



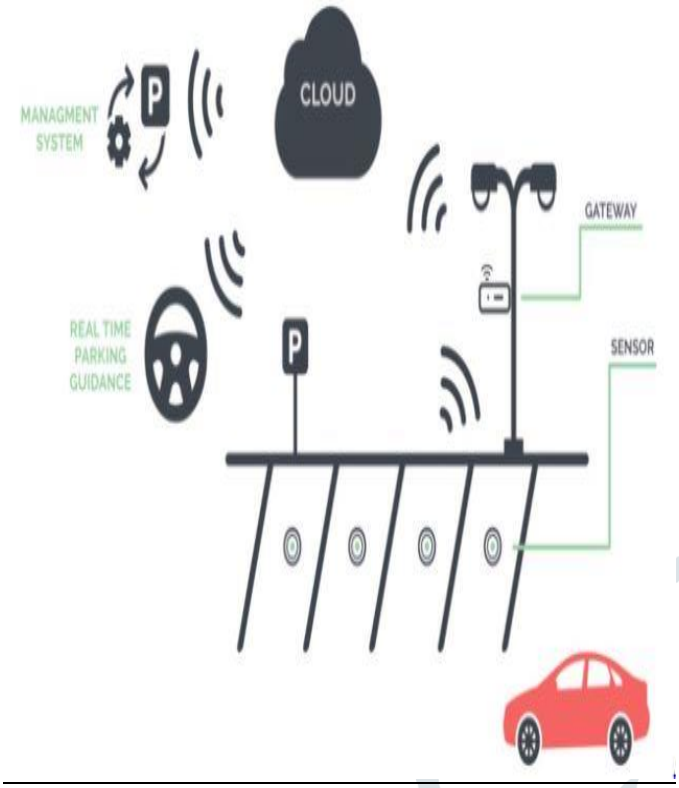
12. PARKING SYSTEM

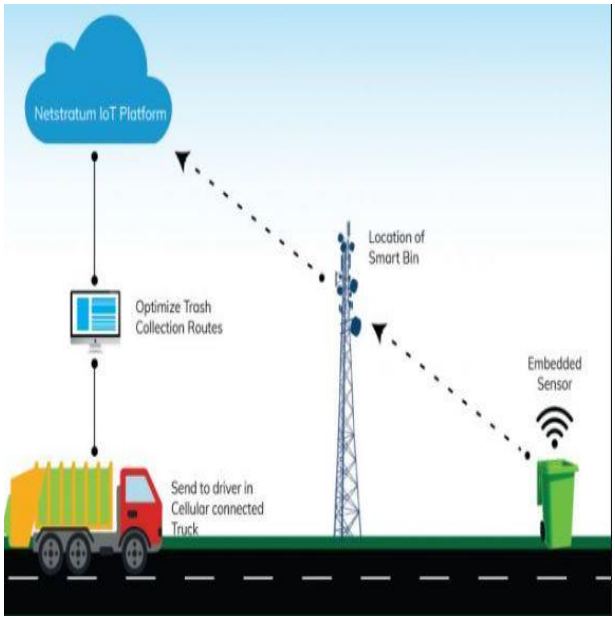
Here we propose a Smart Parking system which provides an optimal solution for parking problem in metropolitan cities. Due to rapid increase in vehicle density especially during the peak hours of the day, it is a difficult task for the drivers to find a parking space to park their vehicles. The target here is to resolve the above mentioned issue which provides the Smart Parking system. This system uses cloud computing and Internet of Things (IOT) technology. In this paper we introduce the usage of android application using smart phone for the interaction between the Smart Parking system and the user. RFID technology is used in this system to avoid the human intervention which minimizes the cost further we propose a cloud based smart parking system which uses Internet of Things (IoT). In this system, all the physical objects like Smartphone, GPS location and cloud based servers and all car parks are connected to form network architecture and it is an automatic system where we use a Radio Frequency Identification (RFID) technology. We use RFID reader which is a sensor that reads the RFID tag and authenticates the user information. All the car parks in the intended area are connected to form a parking network. The user books the parking slot using the android application by specifying his destination and the type of vehicle which is updated to the cloud. The cloud finds the shortest path which is the distance between the car park and the vehicle and allocates the parking space and this information is sent to the user. When the user starts from his place to destination, the GPS location is updated to cloud server periodically. Then, when the user reaches the car park the RFID tag is read and authenticated by the RFID reader after which the user is allowed to use the parking space. This information is updated to the cloud and to the neighbor car park. When the user exits the car park the RFID tag is read again by the RFID reader which is further updated to the cloud. Then billing process will take place in the cloud server and this information is sent to the user.

Advantages:
1. Better performance.
2. Low Cost.
3. Includes resource allocation mechanism.
4. Provides large scale parking system.

Disadvantage:
1. Car park should be registered in the smart parking system to provide service.
2. The service cannot be provided if there is no Smartphone.

12.1 ILLUSTRATION





13. Waste Management

Due to rapid population growth, disorganization of city governments, a lack of public awareness and limited funding for programs, garbage management is becoming a global problem. Due to the lack of care and attention by the authorities the garbage bins are mostly seem to be overflowing. The details of each bin are monitored by the authority with the help of GUI. Effective actions will be taken if the corresponding authority is not concerned regarding the cleaning of bins. The implementation of smart garbage management system using sensors, microcontrollers and GSM module assures the cleaning of dustbins soon when the garbage level reaches its maximum. If the dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. Smart collection bin works with the sensors which will show us the various levels of garbage in the dustbins and also the weight sensor gets activated to send its output ahead when its threshold level is crossed.

14. Conclusion

With rapid development in the emerging Internet of Things technology, we give in this paper a comprehensive blueprint of developing a smart city using IoT, which is actually motivated and strongly demanded from city councils as they seek to ensure the provision of necessary services and quality of life for city populations. In this context, we identify the key IoT building blocks of smart cities, as well as provide the approaches and resolutions to meet the irrespective communications, computing and computation necessities.

In this paper, the implementation of cloud based smart parking system using Internet of Things is discussed. This system includes RFID technology with Android application which provides user interface for control system and vehicles. The average waiting time of users for parking their vehicles is effectively reduced in this system. The optimal solution is provided by the proposed system, where most of the vehicles find a free parking space successfully. This smart parking system provides better performance, low cost and efficient large scale parking system. Security measure to ensure that the users do not misuse the parking system can be implemented.

The smart waste management system ensures that the surrounding stays clean and disposal of garbage is done suitably from time to time, it is a much more efficient method of waste disposal.

The hydroponics cultivation not only supports greenery but also enriches the beauty the surrounding it provides clean and positive environment and hence must be promoted more and more.

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Analysis of Different Approaches for Utilization of Pulsed Power

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Abstract: The increasing Research and Development in the field of High energy density devices like Microwave tubes, Lasers etc. have led to the development of various circuit models for the production of Pulsed power. Pulsed Power is a term used when stored energy is discharged as electrical energy into a load as a single or multiple short pulse of very high power and energy with a repetition rate that can be controlled. In this paper, various electrical pulse circuit configurations that are used in different applications have been analyzed. The high-power pulses studied here are found to have an overall duration in the range of few nanoseconds to few microseconds.

Index Terms **– Pulse repetition frequency, pulse duration, pulse electric field.**

I. INTRODUCTION

The science and technology which deals with fabricating of electrical energy over a comparatively long period of time and releasing it in a very short duration of time which results in the production of enormous amount of energy is called Pulsed Power. Energy is gathered at low power and low density from a long duration voltage pulse in the primary energy source and it is accumulated in huge capacity energy storage. After that the energy is swiftly released with a squeezed time and volume. Finally, the power is delivered to the load with enormous amount of power with in a short duration of time at much smaller volume. This serves as the essential idea of pulsed power.

Pulsed Power technology involves possibilities of producing

- Current in terms of several hundreds of Mega amperes.
- Voltage in terms of several Mega volts.
- Several hundreds of trillions of Joules per second of energy.
- Several hundreds of millions of watts per square centimeters of power densities.
- Millions of atmospheres of pressures.
- Millions of degrees Kelvin of temperature.

Main components of any high-power pulse circuits are shown schematically in the figure 1

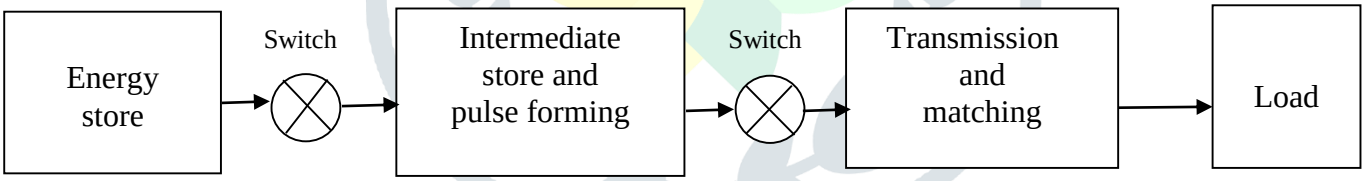

Figure 1 Main Components of a Pulsed power system.

As shown above a typical scheme is always based on an energy store which could be Mechanical energy (springs and Flywheels), Chemical Energy (Batteries), Electrical Fields (Capacitors), Magnetic Fields (Inductors) etc. However, Capacitor banks and Marx generators are widely used. Energy storage is one of the prerequisites for pulsed power applications in which charging takes place at relatively slower rate and at low power densities, thereafter the power is discharged quickly by triggering a terminating switch. This ensures large power production, ensures the required rise time and pulse duration with pulse conditioning. Lumped components are used to construct slow pulsed power systems (µs and ns range) and Transmission lines are used to construct fast pulsed power systems (ns and ps range). Diagnostics, Power controls and other ancillary elements are also to be considered for a good functional high-power pulsed power generator.

The unique advantage of Pulsed power is its very high peak-to-average power ratio which ensures exploitation of threshold and non-linear effects. This makes it suitable for applications in the medical field since the membranes of the biological cells will be opened by strong pulsed electric fields in an irreversible manner. The high peak-to-average power ratio can suppress competing heating processes. Another main advantage is its short pulse duration which allows it to exploit the time-domain for example in radar systems [7-10].

Emphasis is given on the following applications in this paper:

- Electrostatic Precipitators.
- Lasers.
- Microwave tube.
- Mercury free plasma UV lamp.
- Sterilization.
- Pasteurization.

II. DIFFERENT APPROACHES

1. Electrostatic Precipitators

Electrostatic precipitators are filtration devices that are used for controlling air pollution particularly at industrial facilities and power generating stations since they use an electric charge to remove either solid particles (dust) or liquid droplets in smokestacks and other flues. The overall performance of the electrostatic precipitators is affected by HV pulsed power supply. Efficiency of the Electrostatic Precipitators was found to increase with pulsed power since the voltage is impressed only for a very short duration and hence the chances of short circuit were found to be less over conventional continuous DC supply [10].
Analysis of a µsecond pulsed power supply which was designed with a high voltage solid-state switch for observing the performance of the Electrostatic precipitator installed at 500MW Coal power plant is been made. The ratings of the designed pulsed power supply were found to be 70kV, 400mA with pulse width of 140µs and a maximum pulse repetition of 200pps (pulse per second).
Comparison was made between conventional DC supply and Pulsed power by applying the respective voltages across the plates of the Electrostatic precipitators and results were studied.

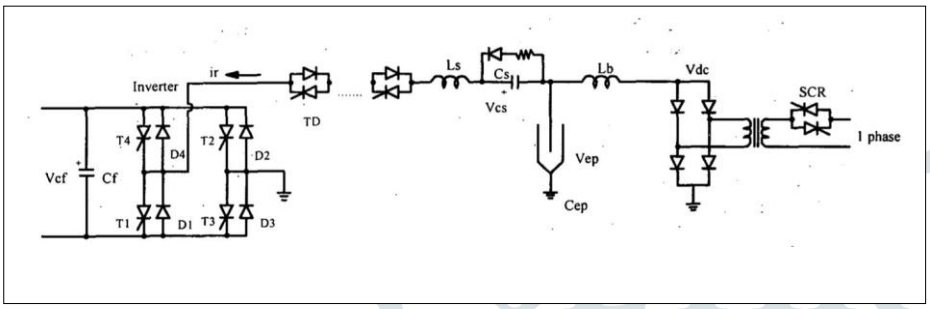

Figure 2 Proposed Circuit

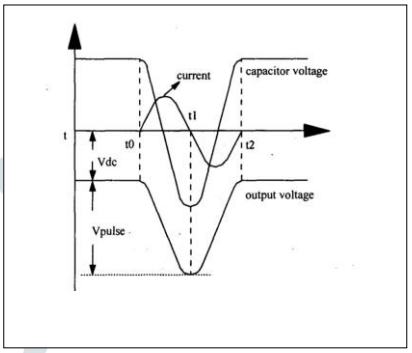

Figure 3 Output of circuit shown in figure2

The proposed topology [1] was as shown in the figure 2. As seen from the circuit it is found to contain a controllable dc power supply containing SCRs, an inverter based pulsed source of 5kV, a HV solid state switch TD, resonance tank L_s, L_c and a preventing inductance L_b. The output voltage applied to the Electrostatic precipitator was found to be a negative polarity DC voltage which was rectified that resulted in the formation of a corona amongst the collecting plates and the electrodes. In the output there was a voltage produced which was in the form of pulsed trains that were super imposed on the base voltage i.e. DC. The output pulse voltage obtained was found to have a peak voltage of 70kV and pulse width of 140µs.

Figure 3 illustrates the steady state pulse formation technique of the proposed scheme. Prior to the generation of the pulse, Vcs is the charging voltage given to the capacitor C_s. The pulse recurrence rate could be controlled up to 220pps by investigating the pulse period. The capacitor Cs which is meant for holding the charges, the Electrostatic Precipitator capacitor C_{EP} and inductor Ls when the HV solid state switch TD is closed form a series resonant circuit. Switching status of the inverter decides the involvement of 5kV in the resonant circuit as follows:
-Turning on T1 and T2: This forward biases T1, T2 and TD. V_{cs} and V_{cf} get added which reverse the direction of i_r during t1.
-Turning on T3 and T4: This forward biases T3, T4. V_{EP} and V_{cf} get added. When i_r becomes zero by the diodes of TD, then a single voltage pulse is generated and oscillations of resonance get stopped. The resonant oscillation gets stopped and one voltage pulse gets generated. By controlling this pulse-time interval the pulse repetition rate could be varied up to 200pps. Inverter compensated for the losses of the circuit and also built up the pulse voltage. The proposed circuit was found to be bulky and was not flexible for other applications.

2.Lasers

A 2kV, 40A pulse generator is been designed for this purpose. Analysis of this design makes us realize that the generator is made up of power semiconductor devices and is devoid of a HV pulse transforming device and HV DC supply. A boost converter array consisting of IGBTs, diodes LC circuits and a series connection of IGBTs and capacitors is been utilized for the design purpose which is basically a Marx circuit. The proposed circuit is found to be reliable and is suitable for generating high voltage pulses. It has simple structure i.e., to produce an output of n times the input voltage, n number of diodes, switches, capacitors and inductors were to be used.
The proposed circuit was basically a transformation of Marx circuit. The resistors of the Marx circuit which are used for charging purpose are replaced by diodes and the spark gaps that used for discharging in the Marx circuit are replaced by inductors and power semiconductor switches. In comparison to the conventional pulsed power sources, the proposed system utilizes power semiconductors as switches which enable it to have a high operational frequency up to several kHz. Since these kinds of switches are controllable, the pulse width could be varied as and when required. The proposed circuit is also found to have an important feature which is the clamping operation against over-voltages which is achieved by the capacitors across the switches [2].

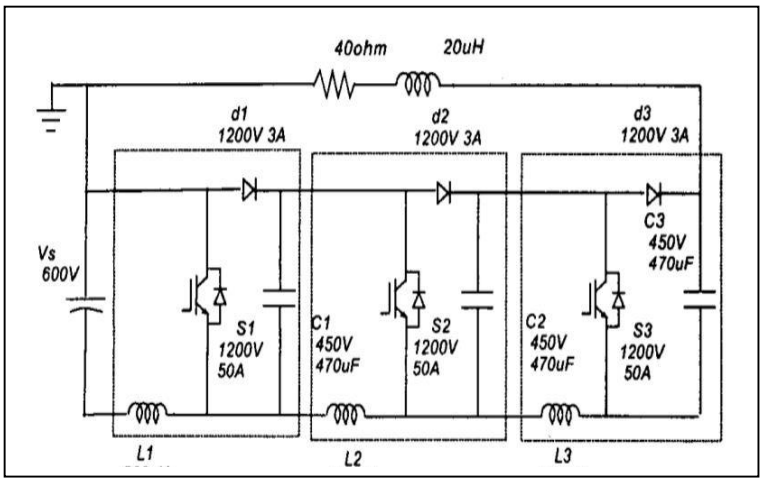

Figure 4 – Circuit Configuration

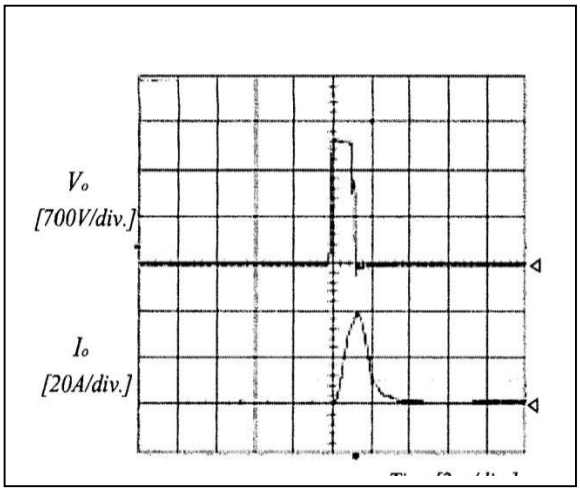

Figure 5 - Output

The proposed circuit is found to give rise to HV pulses at the on position of switches. As shown in the Figure 4, 1200V, 50A IGBT's are used as a single switch and 3 IGBTs are used as shown. Pulse width is changed from 1µs to 5µs at 1 kHz operation. Figure 5 shows the high-voltage output characteristics. It is to be observed that the pulse width is variable around 1µs to 5µs.

The proposed circuit is found to have merits such as easy control of pulse width, compact, long life, low sensitivity to difference in drive signal etc. The main disadvantage is that the power rating and the rise time cannot be varied simultaneously.

3. Microwave Tube

A HV dc pulsed power source developed for this purpose is observed to have different features like feasible control of the power factor (pf), pulse width i.e. T_{ON} and the amplification of the pulse produced. Continuous output pulse is obtained which has voltage variation of -50kV with PRF of 10Hz to 1 kHz and pulse duration of 10µs to 100µs. This system is observed to have made of continuous connection of pulse switching modules so that a pulse having the characteristics like large power, large amplitude of the voltage is produced as an output which is flexible and compact so that it could be used in various fields which demand high power. Hence there is a continuous connection of 2 modules of -25kV, 10A pulse power sources in order to obtain an output pulse having a negative voltage of 50kV and 10A current [3].

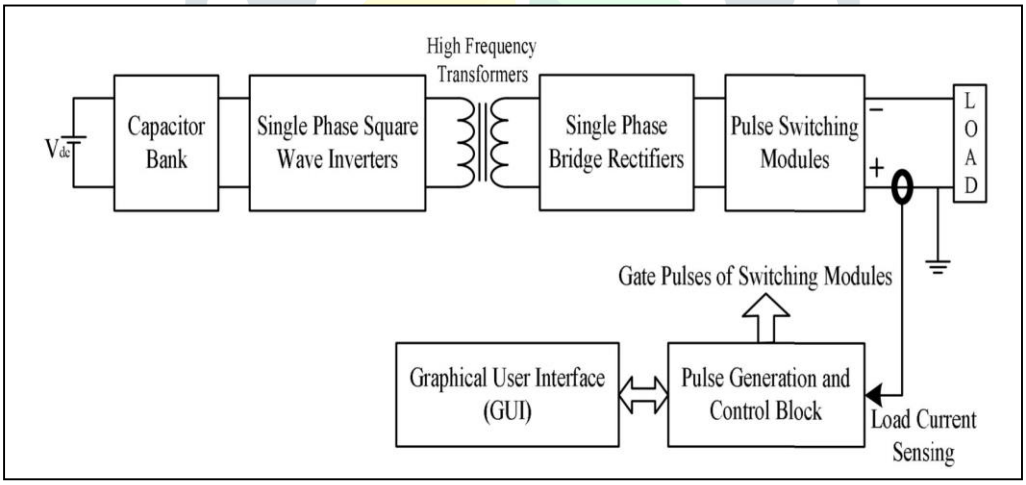

Figure 6 Block Diagram of the proposed topology

As observed from the figure 6, basic topology is found to contain bank of capacitors, step up transformer, 1Φ inverter, 1Φ rectifier, modules for switching of pulses, wireless control unit. The capacitor bank present at the source side of the square wave inverter regulates the rectified DC voltage. The regulated DC input voltage is then subjected to square wave inversion by 1Φ high frequency H-bridge inverter. Then the voltage is stepped up by the high frequency transformer which also provides isolation. Later, a regulated high voltage DC output is obtained from the output rectifier and the capacitor. Then switching of the DC voltage is done by the module meant for switching of pulses to give rise to pulses of desired pulse width and pulse repetition frequency. For gating the pulse fabrication, PC based wireless pulse generation and control unit with Graphical User Interface (GUI) having controlled Pulse Repetition Frequency (PRF) and Pulse Duration is developed. High voltage IGBT and freewheeling diodes are used by the Pulse switching module to generate required pulse output voltage. Optical Fiber cable provides the Gate control signal for the module. Xbee module controls the pulse recurrence frequency and the pulse duration. The proposed topology is found to have the merits like low losses, better reliability.

4. Hg free plasma UV lamp

In the field of disinfection of fruits, liquids, medicines, air coolers etc. the Mercury i.e. Hg free Plasma UV lamp is one of the most recent technologies that is been invented. The HV pulsed power source fabricated for this purpose is found to be efficient and is found to have employed a 1Φ AC-DC upf converter and a flyback converter. The system is found to have a constant pulse recurring frequency, pulse width and is found to produce an output as negative voltage of 5kV and 2.5A current with a prf of 25kHz and T_{ON} of 2µs supplied from a 1Φ AC supply. For the purpose of verification of the proposed circuit, simulation is also been performed where DC pulsed power source is been explained for the controlling fields that employ plasma. It is found to have utilized a H bridge type of design and as per the demands of the plasma process, there are DC supplies which perform the task of regulation to produce different kinds of pulse trains. HV pulsed power source is also analyzed which is basically designed on a base of push pull topology for the investigation of the performance of Dielectric barrier discharge (DBD) on the platforms of brightness and the energy consumed. To eliminate the over-currents resulting due to spark discharges a feedback system employing a microcontroller is included [4].

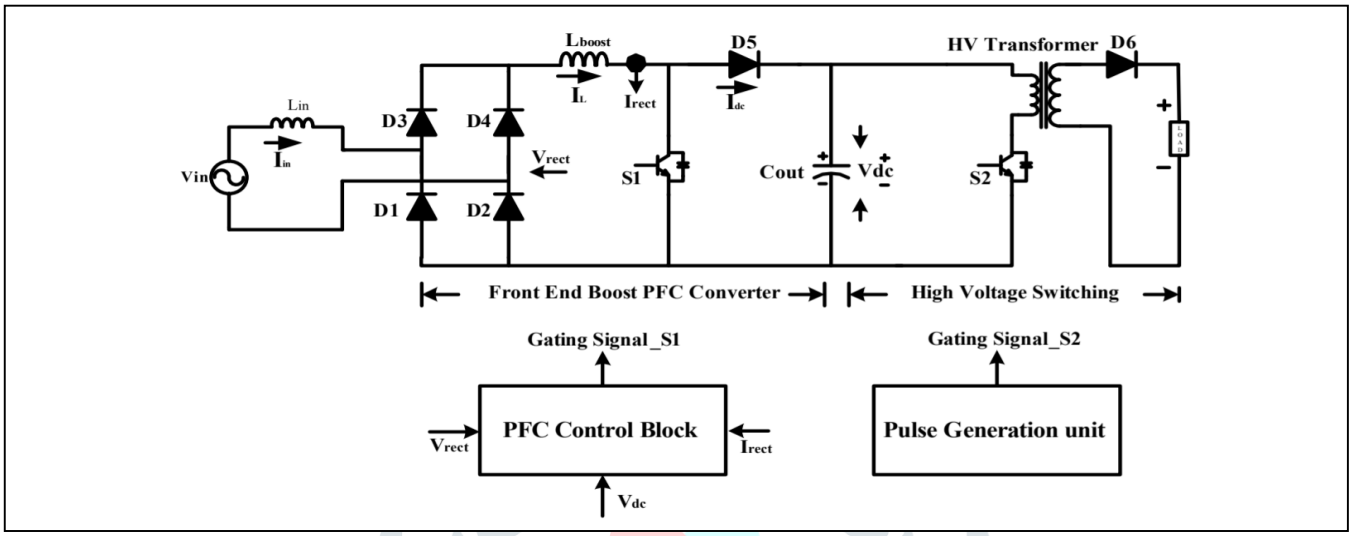

Figure 7 Schematic diagram of pulsed power supply

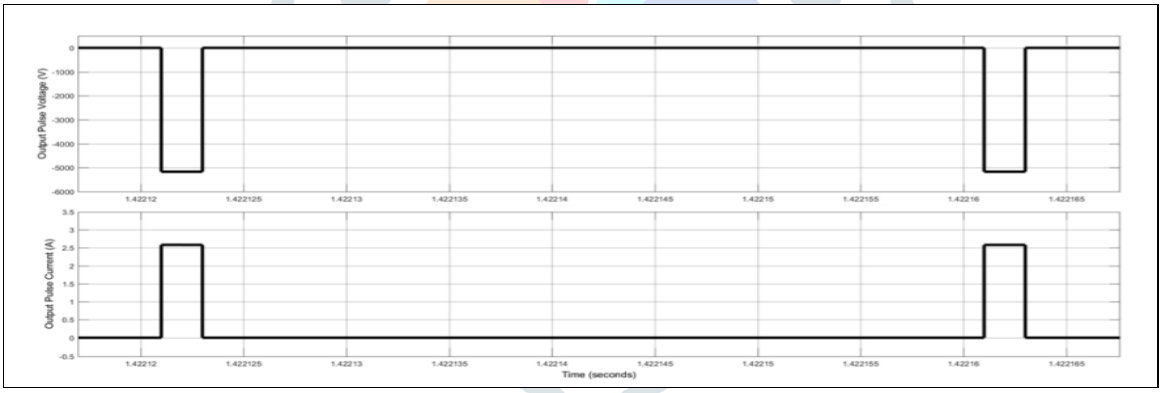

Figure 8 Output pulse waveform

HV pulsed power source for the Hg free UV lamp technique consists of 1Φ AC-DC upf converter, a generating unit of pulses, HV switching module and a transformer involved stepping up of the voltage. The 1 Φ AC will be converted into a DC regulated voltage by a AC to DC converter system. The input currents taken from the system is maintained sinusoidal and same phase as that of the final voltage by a pf correcting unit. Pulse producing unit for a HV switching purpose is found to be performing 2 functions first one being the generation of the gating signal which has a prf=25kHz and T_{on}=2µs along with the job of regulation of the output DC voltage to produce the pulse according to the requirement. The pf, the noise involved along with a PFC converter is analyzed and investigated. The proposed system includes a pulse forming network which leads to certain demerits like less improper pulse shaping, dependence of the shape of the pulse on load parameters, improper impedance equalization.
Merits of the proposed design are that it is found to be efficient and durable.

5. Sterilization

Electrohydraulic (EHD) discharge is a process where electrical discharge takes place directly inside water. A Plasma which emits ultraviolet rays that are highly intense, shock waves and also species that are found to be alive will be produced when such discharge takes place which serves as a multiple mode of action approach for sterilization which also means disinfection. Chlorella inactivation depending on the EHD is given emphasis in this section.

By carrying out EHD, the electrical energy held is released into the water across the electrode plates that are submerged in a short period which generates a high temperature and concentrated pulsed plasma in the surrounding of the dischargeable electrode. This plasma which is basically pulsed phenomenon of EHD is found to have around many appreciable impacts on the microbes like emission of highly intensive beam of UV rays, shock waves of large pressures and species that are alive [5].

Here, EHD system having more than a single electrode is designed to destroy chlorella and practical analysis of the mechanism behind the inactivation of chlorella is analyzed. A combination of Monochromator along with PMT and a high-speed CCD camera system carry out the function of finding the UV rays and bubble growth process caused by pulsed plasma, respectively and once the discharge process gets done, the chlorophyll presence is detected and scaled by a ultraviolet spectrophotometer that increases, due to the dead or inactive chlorella cells.

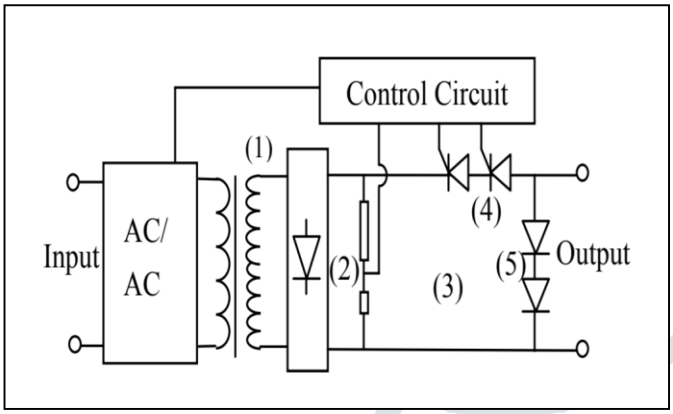

Figure 9 Proposed circuit topology

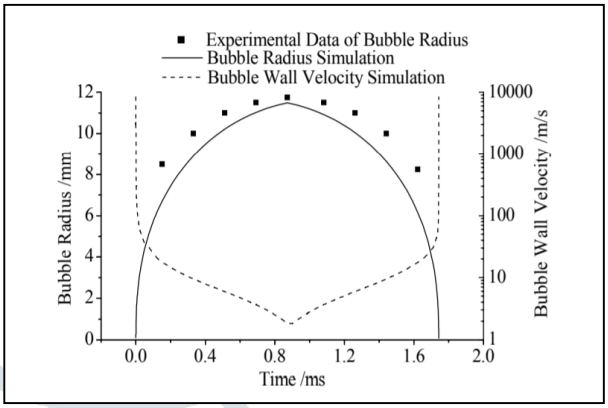

Figure 10 Result of the bubble oscillation resulting from the pulsed plasma

In the figure 9, 1 refers to the transformer that is involved in producing a negative DC. 2 refers to a basic resistance divider which evaluates the capacitor voltage (charging).3 refers to the capacitor meant for the purpose of storage. 4 refers to the semi-conductor switches i.e. a continuous connection of a pair of SCRs. 5 refers to the final pulse. Basically, there are 2 different components in an Electrohydraulic system like one is the supply which is associated with high power semiconductor switches and is capacitive and the other one is an EHD reactor which comprises of more than one electrode. Electrodes can be subjected to more than single current pulse by operating semi-conductor switches that discharge the energy via a diode like device. About 5J to 500J of energy is stored by the modules formed by combination of 2 capacitors at a relatively high voltage of -2.2kV to -5.6kV where the pulse recurring frequency is 1 to 10Hz. An extra circuit takes care of the pulse recurring frequency and the energy associated with the output produced.

The chlorella is cultured in an air incubator, in which light intensity is 6000lx and ratio of illumination time and dark time is 1:1. The inside temperature is around 25°C with a deviation of 1°C. The culture solution is made by 35g seawater salt, 1000ml purified water and some necessary nutrition. pH value is controlled around 7.5. Only 1ml of the mixture solution is sampled after each treatment to count survival chlorella number.

From the figure 10, the dependency of the radius of the bubble and the velocity of the bubble wall on each other is shown. It is found that the velocity of the bubble could attain around 1000m/s at the starting of vibration and it reduces abruptly as the radius starts increasing till radius of bubble attains it's maximum value. Then, the speed value attains 0 and begins to increase. It can also be observed that the starting speed of vibration is comparatively tiny than that present at the extreme. This denotes that size of the bubble increases at a radius not equal to 0 or when bubble is formed, it is large.

When the energy is around 5J to 10J per electrode only 75% to 78% of the chlorella cells are killed and when the energy released is around 20J about 90% of the chlorella cells are killed.

Demerits of the proposed system are that the system couldn't be used at high frequencies because of the thyristors that are used which poses a long switching time. In high voltage applications it demands the usage of withstand capacitors which increases the overall size and the cost. Advantage is that it serves as a multi-mode of action approach for sterilization and disinfection.

6. PEF Pasteurization

From time immemorial thermal heating has been used to preserve food and extend the period of storage of products like milk, fruit juices etc. But the issue with thermal heating is that it deteriorates the quality of the food by modifying the organic structures. Due to these reasons PEF i.e. Pulse Electric Field is being used as the non-heating method of preserving diary and liquid food. We can make a pulse generator using an RC circuit or RLC circuit to generate PEF of high efficiency and required wave form. Microcontroller ATMEGA 8353 is used to control the pulse frequency of the constant high-voltage that is given at the input side. The sample used here was apple juice which is found to have a very less shelf life [6].

As we are aware the storage period of apple juice is very short which is due to the microbial activities during the period of processing. S. Cervisiae is the name of the microbials. Hence, it becomes mandatory to kill these microbes which disinfects the apple juice there by increasing it's storage period in order to get a superiority in terms of quality. The apple juice contains vitamin A and vitamin C, the amount of these vitamins decreases with thermal method if pasteurization is used. In the field of liquid and semi-solid food processing, Pulse Electric Field (PEF) is the latest non-thermal technology. PEF is a process where an electric field as high as 20 to 80 kV/cm is applied to the sample food which is kept between the pair of electrodes while giving pulses of 1 to 100 µs.

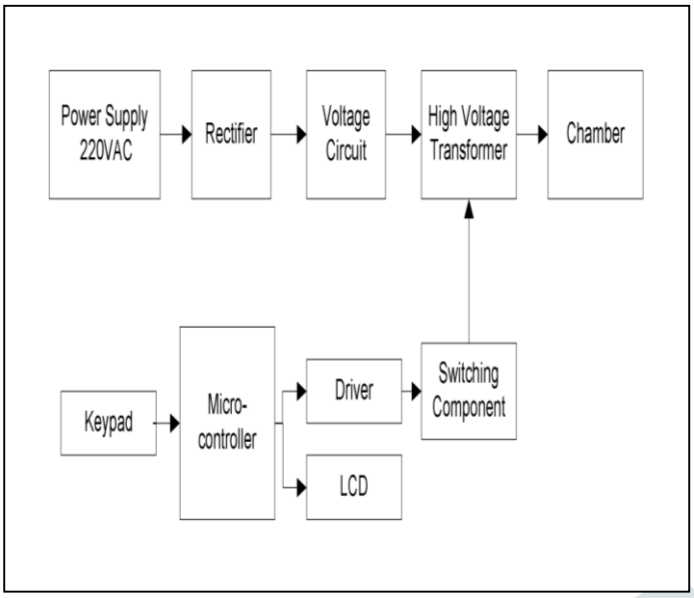

Figure 11 High Voltage Pulse Generator Block Diagram

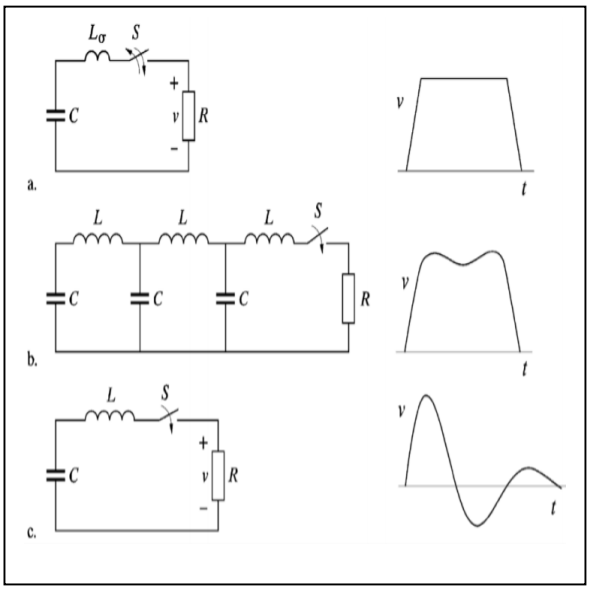

Figure 12 HV pulse generator(a), with LC(b) and with over damped oscillator (c)

The parameters to be saved in thoughts are power resulting from the electrical pulse, the duration or the overall width of the pulse, number of pulses, chamber layout. As observed from the block diagram in the figure 11, the design consists of following steps: A HV pulse formed has to be kept an eye on through keypad with highest voltage of 80kV; It is required to keep the pulse frequency as a non-variable quantity ; By the aid of a keypad, the output time period is expected to be controlled till 90 seconds at least ; A step-up transformer which has a rating of 100 kV is to be used. Micro controllers are used to carry out the job of controlling the amplitude of the voltage that is produced. Result obtained from the microcontrollers operation is connected to a voltage controller which in turn activates a relay. The voltage controller circuit utilizes relay circuit in which each relay is connected to a rectifier circuit. Based on the layout specifications, controllable high voltage is anywhere between 20 to 100 kV with an increment in terms of 20 kV scale.

As analyzed from figure 12, HV pulsed power generating circuits might be fabricated from some forms of circuit such as Resistor-Capacitor circuit (RC) and resistor-inductor-Capacitor (RLC) circuits. It is determined that the RLC circuit has better characteristics than RC circuit. A high voltage pulse generator with RC and RLC circuit generates oscillations and pulses which depends on the value of used resistors and capacitors component. High voltage (HV) transformers are then used to broaden the circuit.

High voltage pulses which must be implemented to carry out pasteurization efficiently is 20kVto 100kV. PEF pasteurization is determined to preserve the nutritional content of juice apple in preference to thermal pasteurization. PEF is a non-heating method since the fruit is processed at normal living temperature or lesser for some time which reduces the losing of nutrients from heating technique, which include vitamin A content material of apple juice.

The main advantage of this approach is Energy saving - since the energy is applied for a few micro seconds a huge amount of energy is saved whereas in thermal heating high temperature has to be applied for a longer duration of time though there is an error of about 5.41%.

III. COMPARISON OF THE DESIGNS

Table 1 Comparison of various parameters of different pulse power circuits

Applications	Voltage Rating	Current rating	Pulse width (PW) and Pulse repetition frequency(PRF)	Merits	Demerits

Electrostatic Precipitators	70kV	400mA	140µs and 220pps	Highly efficient	Circuit was Bulky
Lasers	2kV	40A	5µs and 1kHz	Compact circuit	Parameters could not be varied simultaneously
Microwave tube	-50kV	20A	100µs and 1kHz	Circuit was Reliable and Efficient	Circuit design was compact
Mercury free plasma UV lamp	-5kV	2.5A	2µs and 25kHz	Longer Life	Load dependency of the pulse shape
Sterilization	-5.6kV	2.5A	2µs And 10 Hz	Multi-mode action	High frequency operation was nil
Pasteurization	20kV	3A	20kHz	Energy saving over conventional method	Presence of error (5%)

Looking at the above table it can be inferred that each application is associated with certain advantages and disadvantages. Hence compromise has to be made if a particular application is chosen and recent research and development in this field will definitely promise better circuits with better characteristics.

IV. CONCLUSION

Different applications of the Pulsed power technology and also the designs related to the respective applications have been studied, a comprehensive comparison of the same is also made. The development of pulsed power has been made right from the period of World war II especially in the military fields. In this paper 6 applications of pulsed power are described. Apart from these, Pulsed power is also utilized in the treatment of plant cells, ion deposition, electromagnetic launcher, production of nano powder to name a few. Research is being carried out in this field which will be resulting in the invention of more reliable and affordable components for the production of pulsed power which will lead to the utilization of pulsed power in a wide variety of applications.

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A study on high frequency smart inverter incorporating supercapacitor and solar MPPT

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***Abstract*— Keeping compactness and light weight as the important considerations, an inverter design is proposed. The inverter presented here is of the type of high frequency with two stages, with sine wave output, and is compatible with all the types of battery chemistry available in the market with integrated Maximum Power Point Tracking for solar battery charging. This inverter uses ferrite core transformer instead of traditional iron core transformers. Ferrite core transformers operate at high frequency in the order of kilohertz, they are also compact, have less weight and have greater efficiency, while iron core transformers operate in the order of hertz, are bulky and less efficient. Iron core transformers also produce humming noise. Apart from the ferrite core transformer, we have incorporated super-capacitors as it reduces the stress on the battery and thus increases the lifespan of the battery. It also provides the surge or extra power demand at the start of the high power loads. We have also added a Maximum Power Point Tracking feature to the inverter which helps us to extract maximum power from the PV Cells and also helps to protect the battery from overcharging.**

Keywords*— *Maximum Power Point Tracking, Supercapacitors, Microcontroller

I. INTRODUCTION

Direct current (DC) can be converted to alternating current (AC) by using a power electronic device i.e. inverter. The specifications like input voltage, output voltage, frequency, and overall power handling depends on the design of the specific device or circuitry of the device. The power to the inverter is provided by a DC source as it does not produce any power of its own. There are 3 major types of inverters –

1. Sine wave
2. Modified Sine wave
3. Square wave.

A pure sine wave inverter can drive all types of loads such as resistive, inductive, and capacitive loads, hence, suitable for off-grid and on-grid operations. Based on the type of core used in the transformer, inverters are further divided as- Iron cored transformer inverters and Ferrite cored transformer inverters. Iron core transformers are operated under low frequency, which causes higher hysteresis loss as compared to the ferrite core transformers.

Most of the inverters existing in the market are low frequency, iron cored and thus are bulky, expensive and less efficient, making it incompetent to be used in the solar energy application [1]. Lead-acid batteries are often used in renewable energy systems and inverters. Lead Acid batteries emit a corrosive and explosive mixture of hydrogen and oxygen gases during the ultimate stages of charging, which may ignite if exposed to a flame or spark. Surge loading decreases the lifespan of the batteries and may also damage them permanently. The new storage batteries of lithium-ion chemistries are more efficient, have higher energy density, maintenance free, have longer life and are safe to use, but their charge discharge characteristics are not supported with these inverters [2]. Inverters including the solar MPPT feature are very expensive for the basic 2kW power output [3].

Therefore, in this paper we present a model of a compact two stage inverter, with sine wave output, incorporating super capacitors for surge loading conditions, supporting all kinds of battery chemistries. The inverter is designed with a ferrite core transformer that reduces the loss, thereby increasing the efficiency of the inverter. Lithium-ion batteries replace the traditional Lead acid batteries along with added features such as Solar Maximum Power Point Tracking (MPPT) which will be discussed in detail in the following sections.

The paper is further divided into following sections-

In Section II the basic outline of the structure of the two stage inverter and the logic flow using a block diagram is provided. Also, the basic understanding of operation of a two stage inverter will be discussed in this section.

Section III introduces the hardware parts and tools that are used to build the two stage inverter prototype along with the details of the softwares used for the design & simulation of the circuit diagram and programming of the microcontroller and debugging the codes. Section IV explains the circuitry of the smart inverter using a schematic diagram generated by a software- Proteus Design Suite along with a detailed discussion of each stage of operation and the components associated with it. Section V discusses the various results obtained during testing of each stage of operation. Section VI discusses the expected outcomes.

Section VII and Section VIII provides the conclusion and gives an insight about the future developments of the inverter.

II. Principle of Operation

This section discusses the basic principle of operation of the proposed system. The block diagram of the inverter is shown in Figure 1.

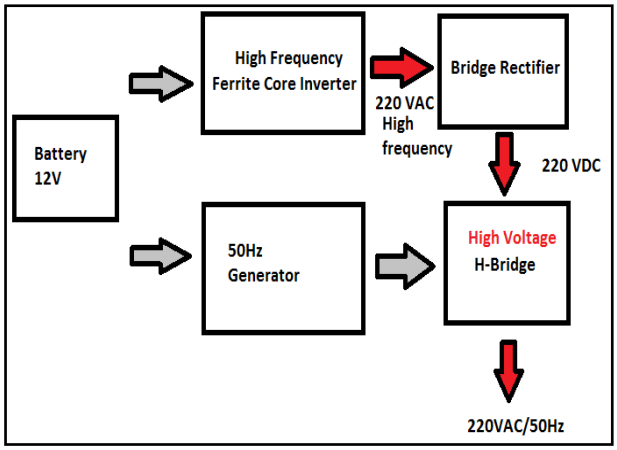

Figure 1: Block Diagram of Inverter

There are 2 stages of operation-

The first stage is DC-DC converter with output voltage of 350-400 volts, this has been done by using high frequency ferrite core transformer (EE65) switching at a frequency of 60-100kHz by MOSFET push-pull topology with SG3525 oscillator IC followed by rectification with the help of ultrafast recovery diodes.

The second stage is DC-AC sine wave output at 220-230 volt, 50Hz frequency. This is done by using the STM32 Microcontroller followed by MOSFET full bridge topology with filter circuit. This stage does not include a transformer.

Inverter has been designed with 2 stages as it provides isolation from the high voltage, high frequency first stage to low voltage and low frequency second stage. The two stage design provides isolation and protection for the low voltage DC Microcontroller circuit. Troubleshooting and problem solving will be easier due to the 2 stage design of the inverter. This two stage design process is employed within the solar Grid-Tie inverters.

III. Development Platform And Tools Used

This section mentions the hardware parts and the software used for the system design and operation along with its description and specifications.

HARDWARE COMPONENTS USED:

TABLE 1. TABLE OF HARDWARE COMPONENTS

Name of the Component	Part number / Description
The ferrite core	EE65/32/27 by MMG Magnetics, India
PWM oscillator IC for first stage	SG3525 IC
MOSFET driver IC	IR2104 and IR2110
LCD display	16x2 LCD with PCF8574 I2C controller
Wi-Fi module	ESP8266
Hall effect current sensor	ACS712 30 Ampere
Supercapacitors	3 Volt, 500 Farads, by Vinatech
MOSFET	IRF3205 (at the first stage) IRF840 (at the second stage) IRFP260NPbF (at the Solar MPPT charge controller section)
Microcontroller	STM32F103C8T6 by STMicroelectronics
Discrete components	Inductors, resistors, capacitors and DC fuses

SOFTWARES USED:

1) STMCUBE32MX for generating HAL code for the STM32 microcontroller.
2) KEIL UVISION IDE (Integrated Development Environment) for writing embedded C program, flashing and debugging for the STM32 microcontroller.
3) Proteus Design Suite for designing and simulating the circuit diagram of the inverter.

IV. Proposed Methodology

This section discusses the construction and operation of the proposed system arrangement. The schematic diagram of the arrangement is shown below in Figure 2. The system is designed by integrating four segments-

(A) Solar Maximum Power Point Tracking Charge Controller Section.
(B) Inverter Microcontroller part
(C) Inverter stage-1
(D) Inverter stage-2

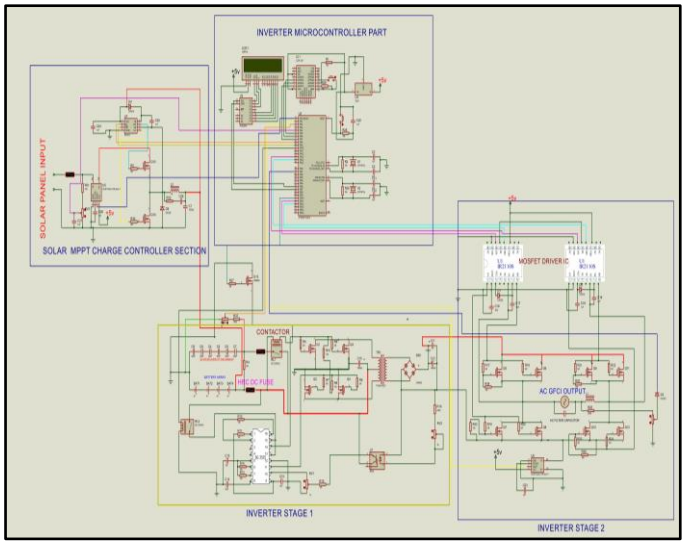

Figure 2: Complete Schematic Diagram

Integrating individual segments helps in troubleshooting and reduces the complexity in design. Each of these segments are discussed in detail below.

A. SOLAR MPPT CHARGE CONTROLLER SECTION

This section contains the circuitry associated with the solar MPPT charge controller. The solar panel is connected to the input as per the circuit diagram shown in Figure 3.

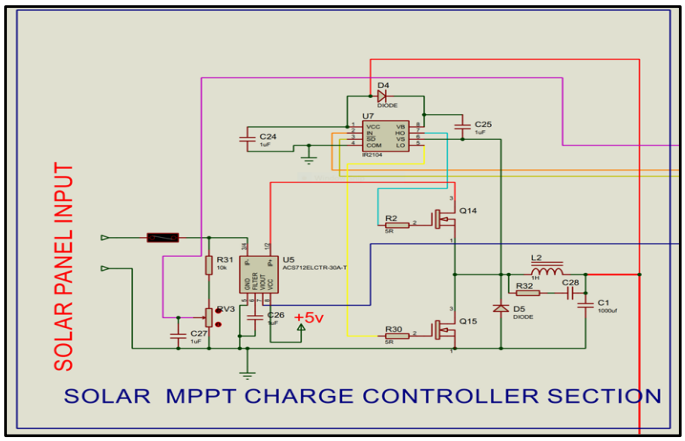

Figure 3: Solar MPPT Charge Controller Section Schematic Diagram

Here Hall effect current sensor - ACS712 30A, has been used to measure the current from the solar panel and the voltage divider consisting of a series combination of resistor with potentiometer to measure the voltage of the solar panel. The DC fuse has been provided at the input from the solar panel to provide protection against short circuit protection. These measured signals from the hall effect current sensor and the voltage divider are sent to the analog ports of the STM32 microcontroller [4].

The solar panel voltage will be stepped down and the current will be increased according to the battery voltage and capacity, this is achieved using the DC-DC Buck Converter. Two MOSFET's IRFP260NPbF are arranged one for the high side and other for the low side, with inductor and diode as per the Synchronous Buck Converter design. IR2104 MOSFET driver IC is used to drive the 2 MOSFETs as the IC is capable of driving the high side and the low side MOSFETs [5].

The size of the inductor is inversely proportional to the switching frequency, so higher the switching frequency, smaller the size of the inductor. But the switching losses in the MOSFET is directly proportional to the switching frequency that is, higher the frequency higher the losses. So, to keep the size of the inductor to minimum and maximize the efficiency, the switching frequency of the MOSFETs have been set to 50KHz, we can increase the frequency to a further extent by selecting MOSFETs which have very less Source to Drain resistance and gate charge capacitance to minimize switching losses and thus can further decrease the size of this section.

The **Perturb and Observe algorithm (P&O)** is used to track the Maximum Power Point of a solar panel [6]-[7]. By this method the power can be measured by adjusting the voltage by a small amount from the array by the controller. Further adjustments are made if the power increases, until it becomes stable and no longer increases. The Perturb and Observe Algorithm is additionally mentioned as a hill climbing method because it depends on the increase of the curve of power against voltage and therefore the fall above that time below the utmost point. Due to its ease of implementation, Perturb and observe is the most commonly used MPPT technique [8]. The Perturb and Observe Algorithm is programmed in the STM32 Microcontroller. The microcontroller also measures the battery voltage to protect it from overcharging and over-discharging.

B. INVERTER MICROCONTROLLER PART

In this section, the 16x2 LCD display has been interfaced to the microcontroller through I2C communication due to a lesser number of ports used for communication as shown in Figure 4.

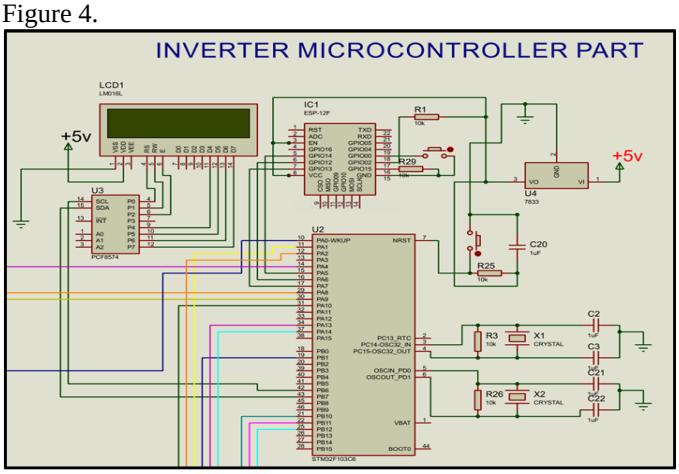

Figure 4: Inverter Microcontroller Section Schematic Diagram

IC PCF8527 is used as I2C to 8-bit expander to connect and send data to 8-bit, 16x2 LCD. The LCD is used to display various important information like, current battery voltage, inverter current output power, output current, voltage and power factor, amount of power produced by the solar panel etc., The ESP8266 Wi-Fi module has been used to communicate data wirelessly from inverter to computer or mobile. We can get detailed logs and data by accessing the inverter from Wi-Fi.

The working voltage of the microcontroller is 3.3 volts and the voltage of the Wi-Fi module is also 3.3 volts, which had been obtained using voltage regulator IC's. The voltage for LCD is 5 volts.

The microcontroller has been flashed with an embedded c program, which contains the algorithms for the inverter control processes and the MPPT algorithm for harvesting maximum power from solar panels and the battery charging algorithms for various battery chemistries like lithium-ion, lead-acid battery [9].

C. INVERTER STAGE 1

In this section, a supercapacitor bank array has been connected in parallel across the terminals of the battery with a 5-ohm, 10-watt resistor as shown in Figure 5.

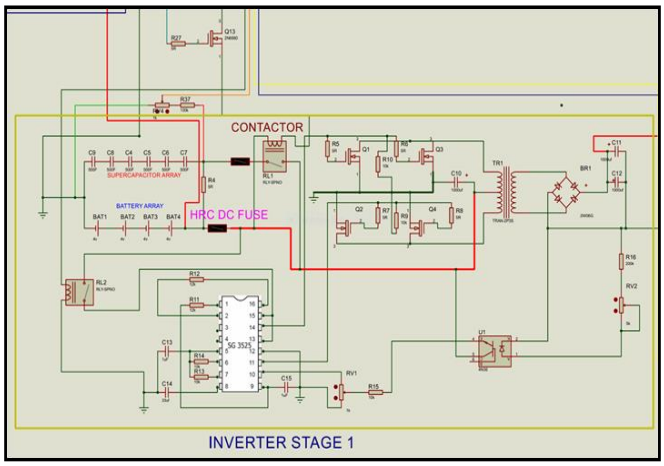

Figure 5: Inverter Stage 1 Section Schematic Diagram

This is done so because the resistance of the discharged supercapacitors is near to 0 ohms and connecting them directly across the battery terminals will create a short circuit and thus by adding a series charging resistor across, it will limit the current to safely charge the supercapacitors [10]-[11]. The charging status of the battery and the supercapacitors will be sensed by the microcontroller through voltage divider circuit with series combination of resistor and potentiometer. Thus, the microcontroller will know if the supercapacitors are charged or discharged and the current battery charge status.

The batteries are connected to the inverter first stage through HRC DC fuse for safety in case of the failure of the power semiconductor components like the MOSFETs and thus will prevent damage occurring to the batteries and the surrounding environment from sparks and fire. Input from batteries is connected to the IRF3205 MOSFETs which are in the PUSH-PULL configuration connected to the Ferrite core transformer. Since the operating frequency is high, and even the power rating of the transformer is around 2500 watts, we cannot use ordinary single core insulated copper wire due to Skin effect, hence we use the Litz wire in which a single copper wire is made up of many small twisted insulated copper wires [12].

At the secondary of the transformer 380 to 400 volts is produced at 80kHz frequency by the switching MOSFETs in the PUSH-PULL configuration and it is rectified to 400 volts DC using MUR860 8A 600V ultrafast recovery diodes in full bridge rectifier configuration [13].

The voltage feedback is given to the SG3525 IC using the PC817 Optocoupler IC. By using the Optocoupler IC, the high voltage part of the circuit is isolated from the low voltage part of the circuit and thus it is protected against any damages occurring due to the high voltage spikes. Thus, good voltage regulation is maintained when loads of different power ratings and types are connected. The voltage regulation is achieved by automatically varying the duty cycle of the switching PWM pulses given to the MOSFET's by SG3525 IC due to the inbuilt error amplifier.

The supercapacitor bank array will be used whenever the inverter needs to deliver more surge power like if the current is 6 to 7 times the rated battery discharge value and if it is within the maximum current handling capacity of the inverter, then the inverter uses the power stored in the capacitor bank by connecting them at the input in parallel with the batteries by actuating the contactor [14]-[15].

But if the current drawn is greater than the inverter current handling capacity, or if the current drawn increases to a very high value, then it will be recognized as the short circuit condition and thus the inverter will turn off the output to protect the battery and the power semiconductor components [16].

D. INVERTER STAGE 2

In this section IR2110 MOSFET driver IC is used to drive the 8 MOSFETs in Full-Bridge configuration as shown in Figure 6, which comprises MOSFETs in both High side and Low side.

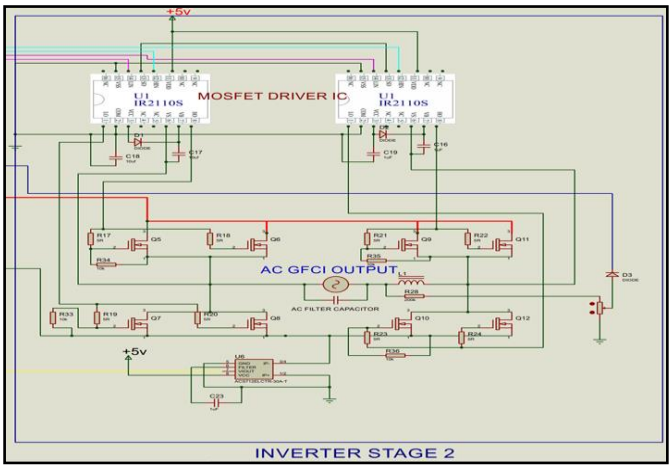

Figure 6: Inverter Stage 2 Section Schematic Diagram

The drive signals are SPWM-Sinusoidal Pulse Width Modulated waveforms and are being generated by STM32 microcontroller.
Here the SPWM waveform has been selected because all the types of loads can be driven with the Sine Waveform like, inductive loads, resistive loads, capacitive loads etc. [17].
The voltage is maintained at a constant value even when different types of loads with various power ratings are connected by controlling the PWM duty cycle of the generated SPWM signals, this control is possible with the voltage feedback taken from the output with the voltage divider circuit comprising of series combination of resistor with potentiometer [18].
The SPWM waveforms generated by the microcontroller is shown in Figure 7.

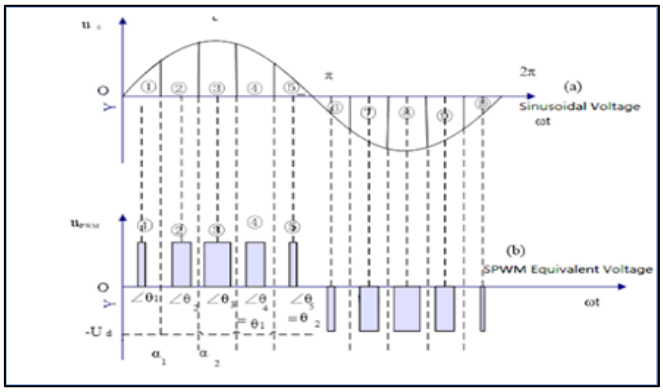

Figure 7: SPWM Waveforms

These signals are sent by the STM32 microcontroller to the IR2110 MOSFET Driver IC, which drives the MOSFET's in the Full-Bridge configuration to produce Sinusoidal AC output at 230 volts, 50 Hz frequency.
Output current is measured using the Hall effect current sensor - ACS712 30A, so with this current sensing signal provided to microcontroller, the microcontroller can determine the current operating condition of the inverter, it can also determine short circuit condition, where the current increases to very high value and the voltage decreases to zero, which is measured by the voltage feedback, thus the inverter turns off the switching of the MOSFET's to protect the power electronics components and also protects the surrounding environment from electric sparks and fires [19].
At the output the sinusoidal waveform is further filtered from high frequency noises and other harmonics by using the LC filter circuit as shown in the above circuit diagram [20].
In case of overloading condition of the inverter, where the current drawn will be more than the pre-set value, microcontroller will sense this condition also and then turns off the MOSFETs, all these various fault conditions will be displayed on the LCD screen interfaced with the microcontroller. The ESP-8266 Wi-Fi module will be used to send data wirelessly like output voltage, frequency, output power, output current, solar panel input voltage, battery terminal voltage, and in case of faults, will send the type of fault that is overload fault, over voltage fault, under voltage fault, short-circuit fault.

V. Testing And Discussion

The following specification has been considered while testing of the inverter.

TABLE 2. TABLE SHOWING VARIOUS SPECIFICATIONS

PARAMETERS	RATINGS
MAXIMUM POWER OUTPUT	2500W
MPPT INPUT VOLTAGE	12V TO 100V DC
OUTPUT VOLTAGE	220/230 V AC
CONTINUOUS OUTPUT CURRENT	11.36 Amps
OUTPUT FREQUENCY	50 Hz
OUTPUT WAVEFORM	SINE WAVE
FIRST STAGE FREQUENCY	30 TO 100 kHz
FIRST STAGE VOLTAGE	380/400V DC
INVERTER INPUT BATTERY VOLTAGE RANGE	12V TO 48V DC

Testing of the solar MPPT charge controller section has been done with the input from a standard 355-Watt mono-crystalline solar panel with open circuit voltage of 46 volts [21].
The input voltage range for the MPPT charge controller is 12 volts to 100 volts DC, this range has been obtained mainly by the maximum source to drain voltage of the MOSFET used, the diode voltage limits in the buck converter design and the inductor used with safe operating conditions.
The MPPT tracking algorithm was verified by observing the power input to the MPPT charge controller and the power output given by the controller to charge the batteries and the efficiency was observed to be more than 95%.
The Inverter Stage-1 has also been tested with input source of 14.8 volts DC from lithium-ion battery. The output voltage regulation was verified with loads of different power ratings and with no load condition at the output voltage range of 380 to 400 volts DC. The switching frequency of the MOSFET was set to 80kHz.

VI. Expected Outcomes

The resulting compactness and reduced weight of the above inverter has been obtained and it has been compared with the low frequency inverters of similar power rating which contains low frequency iron core transformers. Typical weight of the low frequency transformer of rating 1000VA is 9.21 kilograms [22] while the high frequency transformer core that is proposed here has a power rating of 2000VA, weighing 205 grams [23]. The combined weight of the transformer core

including the copper winding on primary and secondary side is 500 grams. This reduces the overall weight of the high frequency inverter by approximately 60% even with a greater power rating. The compactness of the inverter is evident from its reduced weight.

VII. Conclusion

In this proposed model, an attempt has been made to design and develop a low-cost High frequency smart Inverter incorporating Supercapacitors and MPPT. Basic components and parameters have been selected to minimize the complexity as much as possible and to make the project an economical one.

The overall reduction in weight and compactness of the inverter has been achieved in this model.

Advantages are that the inverter is compatible with any market available battery types. The MPPT has been incorporated into a single inverter unit and is available at a very reasonable cost. The Inverter has a great efficiency and less humming noise.

Drawbacks are, the inverter is off-grid so power cannot be sent to the grid and the MPPT can take power from solar power input and not from wind power.

VIII. Future Developments

The power capacity of the inverter can be increased by using a special type of MOSFET that is SiC MOSFET – Silicon Carbide MOSFET, as they have high source to gate voltage limit and less junction resistance. Alternate types of cooling like, water cooling, oil cooling can be provided instead of air cooling. This can further decrease the size of heat-sinks and thus makes the inverter compact and also increases the life of the power semiconductor components. The electric vehicle charger can also be incorporated within the single inverter unit for more reliability and more efficiency. The MPPT charger can be upgraded to support wind energy generators.

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