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Dual Smart Batteries Management for E-Vehicle using IOT

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Abstract: The battery is a fundamental component of electric vehicles, which represent a step forward towards sustainable mobility. Though the electric vehicles are introduced domestically, majority of the global transportation still depends on the IC engine. The transition from the conventional IC engine to E-vehicle is very minimum. The main cause for this minimum transition is the issues created by the batteries in the E-vehicles. Recently most of the e-vehicle batteries were experiencing the explosion and general failure issue. The general causes for the explosion and failure of battery is classified into three main categories, Over-heating of the battery, Over-loading of the battery, during accidents. In this paper, we are providing a system which continuous monitoring the battery using a microcontroller and preventing all these causes. The temperature monitoring in the batteries of the E-Vehicle is very important and many complication may occur due to the improper monitoring method. Some of the issues are also caused by overloading of the battery, that is charging the battery beyond the limit or charging the battery for longer period of time, will also have an impact on the battery's life and performance. Finally, during accidents, some of the survey shows that during accident the flow of current from the battery would be very high, which results the explosion of battery. This project utilizes a Battery Management System (BMS)) to manage battery cells in Electric Vehicles (EVs). Battery Management System is an automated control system which is employed to prevent batteries in the e-vehicle from explosion and failure

Keywords: E-Vehicle Charging, Battery Management System, Battery Switching, Solar Powered E-Vehicle

I. INTRODUCTION

The technologies for global transportation are dominated by IC Engine powered vehicle that leads to major threat to Green gas emission. Even though the global transportation technology partially moved to Hybrid fuels and battery electric vehicle. These technology improvement are not attracted the global customer because of its cost and its compatibility. Recently batteries in EV were exploiting due to many reasons. In most of the cases battery overloading is the main cause for the exploitation. EVs today have "wet" lithium-ion batteries, based on liquid electrolytes, to shuttle energy around. The problem is, these batteries are typically slow to charge and contain flammable material that poses a risk of fire in a crash, among other issues. Since in the hottest climate the battery discharges much faster than in normal condition. This is because of the heat, the heat is the first enemy of lithium-ion battery. Through the continuous monitoring of the battery temperature, the controller will try to maintain a ideal condition (by Cooling mechanism). Battery-shift mechanism is an automated process which is used to improve the battery life and also prevent any trouble takes place due to battery.
Mostly the battery can exploit and releases hazardous gases when an accident takes place. The BS-mechanism includes a vibration sensor in the vehicle which when detects the accident make the battery detached from the supply. This prevents the battery from the accident. Battery technology is crucial to the feasibility of electric cars and has progressed over time. TVA is exploring ways to re-use cutting-edge batteries too depleted for transportation for evening solar power distribution. Most common type of batteries used are Nickel-Cadmium, Lead-acid, Nickel-Metal-Hydride and Lithium-ion Comparison in battery dynamics and other characteristics are essential to understand which type of battery is suitable for a system.

In this charging strategy was discussed deeply through a Photovoltaic (PV)-based Battery Switch Station, which is one of typical integration systems to implement solar-to-vehicle. . From this paper, we have studied a novel charging strategy for the PV-based BSS considering the service availability and self-consumption of the PV energy [1].

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Here inferred about (SPEV), it is supported with a charging cable that plugs in to the vehicle and into a 230v wall socket. The electric vehicle have a built in features like security system, drive guidance system, route detection, android app support, Wi-Fi, Battery Update [2].

From this paper, we inferred about how to avoid overloading a EV battery transformer (DT) in a insular area through the means of a new smart electric vehicle (EV) charging scheduler [3].

The contribution of this paper is mainly on a novel charging strategy for the PV-based Battery Switch Station (BSS) considering the service availability and self-consumption of the PV energy. And also the general switching technology [4].

From we observed how to optimize the structure designing in safe charging mode. . It analyses the structure of charging equipment, and introduces the measures of safe charging in two aspects: power grid side charging safety and equipment side charging safety [5].

In this paper, we are going to prevent the battery with the help of a battery management system, which completely monitors the battery and takes the necessary control actions. Also, every parameters which causes the battery explosion and issues has been analysed and corresponding preventive control action has been programmed in a microcontroller. A battery switching mechanism is incorporated for charging strategy. Charging could be done using both the conventional plug-in method and also using solar panel.

II. BATTERY MANAGEMENT SYSTEM

Battery Management Systems (BMS) are used to monitor and control power storage systems, assure health of battery cells and deliver power to vehicle systems, BMS monitors the voltage, current, temperature, and wear levelling of battery cells. Additional functions include monitoring faults, system health, available energy and remaining useful lifetime. Individual lithium-ion battery cells are in the 3 – 4V range. They are connected in series to deliver higher voltage, and in parallel to increase capacity, main functions include cell balancing, cell health and wear levelling, charge and discharge monitoring and safety assurance.

In order to reduce the ageing by charge and discharge behaviour, it is advisable to have smooth charging and discharging programs. That means, a regular high power charging should be avoided, even though it might refresh the battery if pre-coded considered. Furthermore, it is recommended to use the battery within the status of charge of 20 % to 80 %. For standard charging mode, this is the soc span in which a current controlled charging is used. In contrast utilizing the full capacity of up to 100 % so it may reduce the durability of the battery. In the situation in where the charging procedure is controlled, the discharging takes place at random from the point of view of the battery as it is influenced by the vehicles user. With regards to this there is only a current restriction for the discharge which should be taken into account. Therefore it can be said that the ageing of the battery is influenced very little by the discharge process. In addition to the current flow the temperature should be observed. Some batteries have an exothermic behaviour which can be initiated by a high temperature. On the other hand low temperatures can also mean a change within the battery leading to further restrictions of the allowed charge and influences the soc as well. In regards to customary batteries, the temperature limits are set to −20 ◦C for low temperatures and at 70 ◦C for high temperatures. Traction batteries sometimes offer a higher temperature range which likewise leads to a higher battery price. The restrictions for charging the battery are set between 0 ◦C and 45 ◦C. This means that in harsh winters or hot summers there must be an active temperature control to heat up or cool down the battery before proceeding.

Description of battery status: As previously mentioned there are several descriptions for the batteries' status. There is the mentioned status of charge. In addition, there is also the state of function (sof) and the depth of discharge (dod). These are the main state variables battery-management-systems must work with. Battery-management-systems allow the observation of the battery and must estimate and calculate the state of the battery. Often this is an estimation as it is not possible to really measure the different statuses, as they are influenced by a number of processes within the battery, which are dependent on the load and the temperature. Having ascertained the batteries' status, the battery-management-system submits the states. Active systems are able to control the load and may switch off the load in a dangerous battery situation. Within electric vehicles this can also lead to a reduced power feeding which means a secure mode with lower speed and acceleration.

Status of Charge: Status of charge means the amount of energy which is stored in the Battery. It is measured by the open circuit voltage of the battery. As this is a virtual voltage which cannot be measured it must be calculated back out of the

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terminal voltage. The status of charge is relatively represented by the values between 0 to 1. Simultaneously it can be said 0 % to 100 %. Where 1 or 100 % respectively stands for the maximum open circuit voltage and 0 or 0 % for the minimum allowed open circuit voltage.

Depth of Discharge: The depth of discharge includes the same information like the state of charge, but it shows the analogue amount of discharge. According to this calculation the depth of discharge varies between 0 to 1 or 0 % to 100 % respectively. In contrast to the state of charge 0 stands for a fully charged battery and 1 for an empty battery.

III. HARDWARE DESCRIPTION

3.1 PIC 16F877A:

This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC architecture into an 40 package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART).

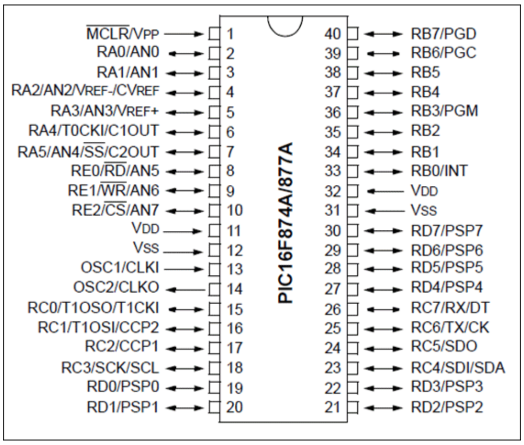

Fig 3.1.1 Pin Configuration of PIC16F877A

- PIC16F877a is a 40-pin PIC Microcontroller, designed using RISC architecture, manufactured by Microchip and is used in Embedded Project.
- It has five Ports on it, starting from Port A to Port E.
- It has three Timers in it, two of which are 8-bit Timers while 1 is of 16 Bit.
- It supports many communication protocols like:

i. Serial Protocol.
ii. Parallel Protocol.
iii. I2C Protocol.

- It supports both hardware pin interrupts and timer interrupts.

3.2 LM 35:

LM35 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of lm35 over thermistor is it does not require any external calibration. The coating also protects it from self-heating. Low cost (approximately $0.95) and greater accuracy make it popular among hobbyists, DIY circuit makers, and students. Many low-end products take advantage of low cost, greater accuracy and used LM35 in their products. It's approximately 15+ years to its first release but the sensor is still surviving and is used in any products.

LM35 Temperature sensor Features:

- Calibrated Directly in Celsius (Centigrade)
- Linear + 10-mV/°C Scale Factor

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- 0.5°C Ensured Accuracy (at 25°C)
- Rated for Full −55°C to 150°C Range
- Suitable for Remote Applications
- Operates from 4 V to 30 V
- Less than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Non-Linearity Only ±¼°C Typical
- Low-Impedance Output, 0.1 Ω for 1-mA Load

Fig 3.2.1 Temperature Sensor LM35

3.3 Vibration Sensor:
Vibration sensor module SW-420 based on the vibration sensor SW-420 and Comparator LM393 to detect if there is any vibration that beyond the threshold. The threshold can adjust using an onboard potentiometer. When this no vibration, this module output logic LOW the signal indicates LED light, and vice versa.
If the module does not vibrate, the vibration switch was on the close state, the output of low output, the green indicator light. The product vibrates, vibration switches momentary disconnect, the output is driven high, the green light does not shine.
The output can connect to the microcontroller, which to detect high and low level; so as to detect whether the environment exists vibration, play a role in the alarm.

Fig 3.3.1 Vibration Sensor SW-420

3.4 Solar Panel:

The 10W 12Volts 36-cell Solar Panel (41 x 30 cm) for DIY Projects is ready to use without requiring a frame or special modifications. We have chosen to sell these Polycrystalline solar cells because they are Laser cut to the proper size and encapsulated in the special sun and weather-resistant materials which give them unique characteristics. You will not regret using such high performance, compact solar cells.

The 12v 10W mini Solar Panel has Polycrystalline solar cells which are encased and protected by a durable outer poly frame. This 3v 150mA mini Solar Panel for DIY Projects is light weighted, very strong and weather-resistant substrates

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or injection moulded trays custom-designed for the target product. These Small Epoxy Solar Panels are simple to install or add to your existing product and their construction requires no frame or special modifications. Polycrystalline solar cells have 2 to 3 times the power of amorphous thin-film solar panels. Very small space is required for installation and to connect 12v Solar Panel, just solder or crimp to the copper tape

Features:

1. 100% new high quality.
2. 12 volt 10-watt polycrystalline solar panel USB charging
3. High conversion speed, high-efficiency output.
4. Excellent low light effect.
5. High transmittance tempered glass.

Fig 3.3.4 Solar Panel 12V 10W

3.5 Wifi-Module Node MCU:

NodeMCU is an open source development board and firmware based in the widely used ESP8266 -12E Wi-Fi module. It allows you to program the ESP8266 Wi-Fi module with the simple and powerful LUA programming language or Arduino IDE. With just a few lines of code you can establish a Wi-Fi connection and define input/output pins according to your needs exactly like arduino, turning your ESP8266 into a web server and a lot more. It is the Wi-Fi equivalent of Ethernet module. Now you have internet of things real tool. With its USB-TTL , the nodeMCU Dev board supports directly flashing from USB port. It combines features of WIFI access point and station + microcontroller. These features make the NodeMCU extremely powerful tool for Wi-Fi networking. It can be used as access point and/or station, host a webserver or connect to internet to fetch or upload data.

Features:

- Finally, programmable Wi-Fi module.
- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included, plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc
- Wi-Fi Networking
- Event-driven API for network applications.
- PCB antenna.

Fig 3.5.1 Wi-Fi Module Node MCU

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3.6 Lead-Acid Battery:

Lead acid batteries are the most commonly used type of battery in photovoltaic systems. Although lead acid batteries have a low energy density, only moderate efficiency and high maintenance requirements, they also have a long lifetime and low costs compared to other battery types. One of the singular advantages of lead acid batteries is that they are the most commonly used form of battery for most rechargeable battery applications (for example, in starting car engines), and therefore have a well-established established, mature technology base**.**

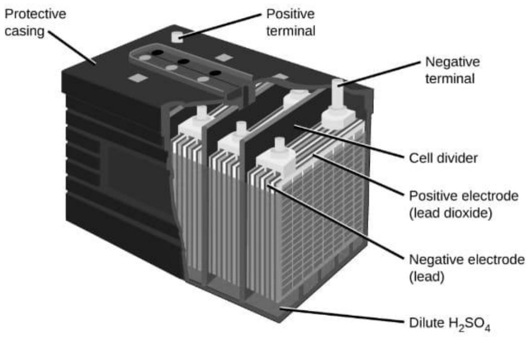

Fig 3.6.1 Lead-acid Battery

IV.SOFTWARE DESCRIPTION

4.1 MP LAB IDE:

MPLAB IDE is a free, integrated toolset for the development of embedded applications on Microchip's PIC and dsPIC microcontrollers. MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free software simulator to hardware debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools.

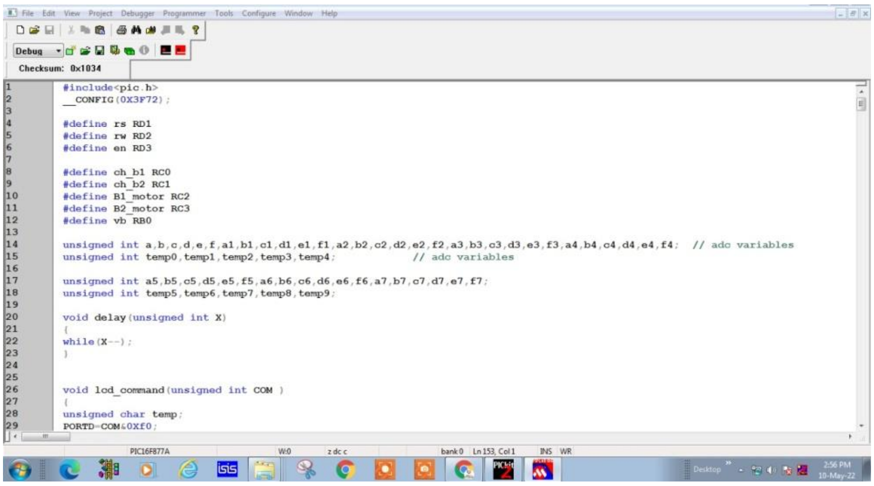

Fig 4.1.1 MP LAB IDE

4.2 Arduino Sketch IDE :

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Here the wifi-module (ESP8266-12E) has been programmed with the help of the Arduino Sketch IDE. This module which when connected to the desired network will

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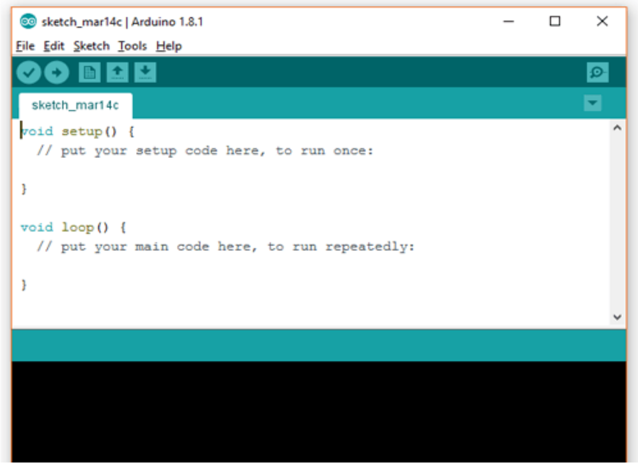
start communicating with the free cloud storage called "Cayenne". The program has been coded in such a way that certain parameters will be shared to the cloud storage via this module.



4.2.1 Arduino Sketch IDE :

V. BLOCK DIAGRAM OF THE SYSTEM

The block diagram of the system is shown below,

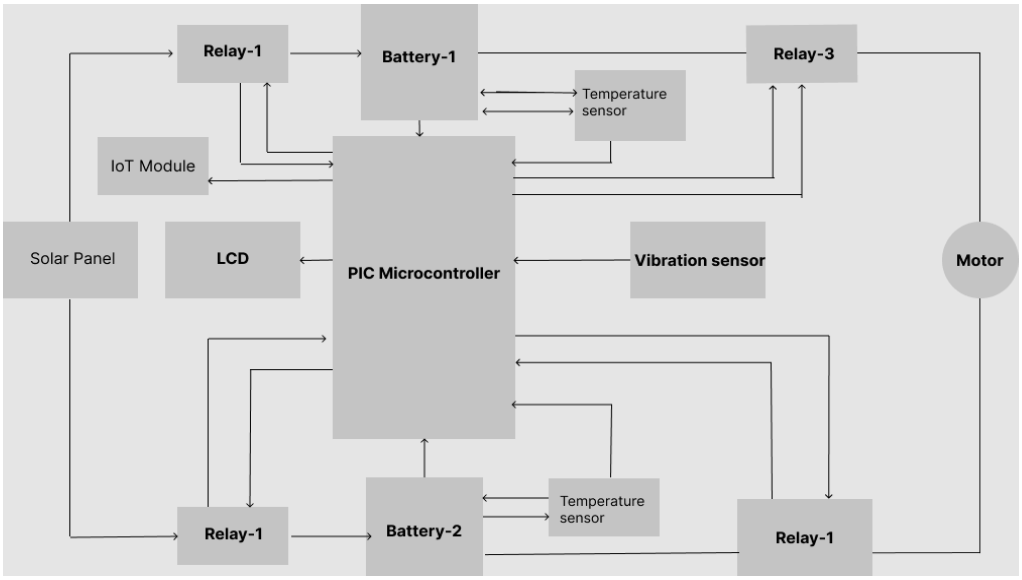


Fig 5.1 Block diagram of the system

VI. EXPERIMENTAL SETUP/HARDWARE PROTOTYPE

The below figure depicts the hardware prototype that has been developed to realize the proposed methodology. The tests were conducted using the below experimental setup.

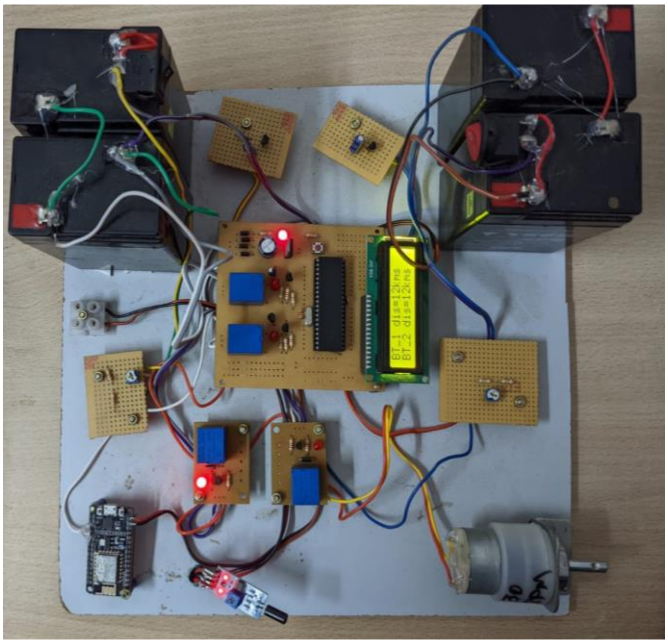


Fig 6.1 Experimental Setup

VII. OPERATION:

Generally we can classify the operation of this Battery Management System into three categories. As we discussed earlier in this paper, the ultimate objective is to protect and prevent the batteries of the electric vehicles from explosion. This could be achieved by analyzing the parameters causing the battery explosion and failure. When we sort out the parameters by impact created, the temperature would be at the top, followed by the overloading of the battery and some explosion can also takes place during an accident. The operation is continuous monitoring all these parameters and taking necessary control actions through the controller.

Temperature Monitoring: As the temperature is the primary concern in the battery explosion, it should be monitored continuously. The temperature sensor (LM35) is three terminal linear temperature sensor from National semiconductors. It can measure temperature from-55 degree celsius to +150 degree celsius. The voltage output of the LM35 increases 10mV per degree Celsius rise in temperature. LM35 can be operated from a 5V supply and the stand by current is less than 60uA. This sensor is well-known for measuring the surrounding temperature with a wide range. The sensor will be mounted in a way which near enough to measure the temperature of the battery. It should be interfaced with the controller which will display the temperature in the LCD screen. For example, BT1 TEMP : 34, and the controller will also uploads the data to the cloud through the wifi-module. If the temperature exceeds the threshold, the controller will send the alert message to the LCD screen as "High Temp Detected Reduce the Speed-limit", and will also boost up the default cooling system installed for the battery.

Battery Switching Mechanism: Battery Switching Mechanism (BSM) is a simple switching technique implemented in order to prevent the over-loading of the battery. Over-loading the battery beyond the limit will also be a factor for the explosion. When a battery is charging for a longer period of time, high current will flow through the battery which causes the affects the battery performance. This could be prevented through this BSM technique, initially the battery should be divided into two as battery1 and battery2, if battery1 is charging, then the vehicle will run through the battery2 and vice-versa. When the system gets on, the controller will start comparing the voltage level of the two battery,

```
If (battery1>=95%)
{
        If (battery2>95%)
                "Disconnect the charger from both the batteries"
        Else:
}               "Charge Battery2"
Else:
{
```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```
    If (battery1>battery2)
        "Charge Battery2"
    Else
        "Charge Battery1"
}
```

The above is the logic behind the BSM, using this technique will reduce the failures due to the overloading of the battery.

Prevention during accident: As some of the report says that the accidents will also be cause to the battery explosion and failures. It is because of the high current (due to short circuit) which flow through the battery makes the cells gets damaged and causing release of hazardous gas or explosion. Although manufacturers and battery makers have made huge strides in improving vehicle safety, a violent crash in an electric vehicle can still result in the car catching fire. This can happen if the battery short circuits and heats up. In this Prototype, vibration sensor (SW-420) is used to detect accidents since there will be an enormous amount of vibration during accidents. When the vibration exceeds the threshold, the sensor will detect and communicate to the controller. The controller will detach the battery from the motor, makes the circuit open. Hence there will be no current flowing through the battery during accidents which protects the battery from getting exploded.

VIII. RESULT:

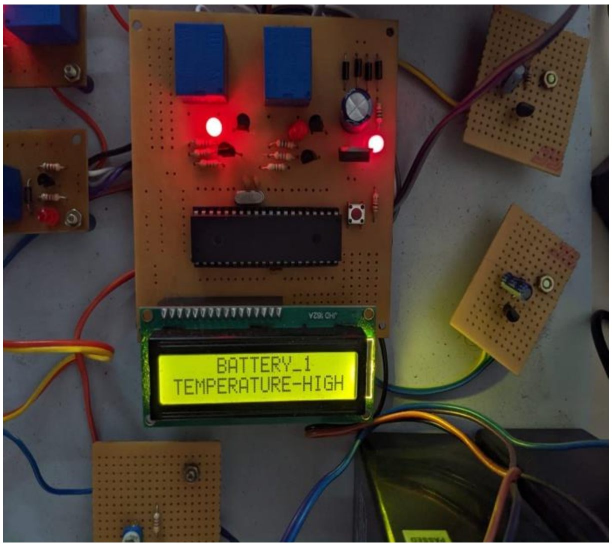

Fig 8.1 Temperature Monitoring

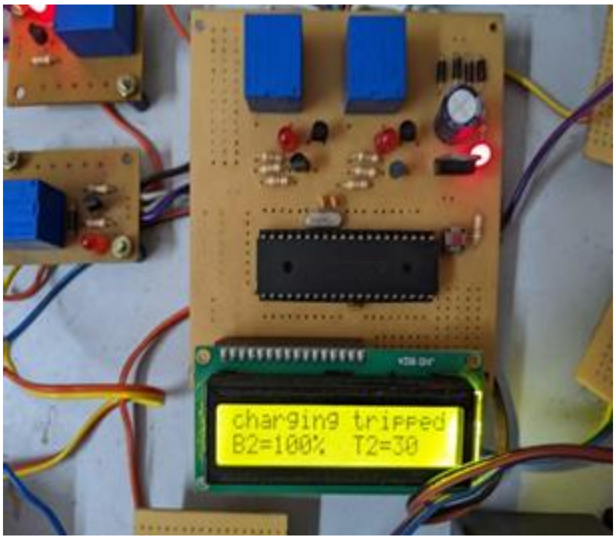

Fig 8.2 Battery Switching Mechanism

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IX. CONCLUSION:

As a conclusion, Various Causes of battery explosions of the electric vehicle such as over heating, over loading and accidents are detected using desired sensors, problems are rectified with the help of the temperature monitoring system, battery switching & management and accident detection system. The batteries are charged using PV cell (Solar panel) as well as conventional charging.

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