# Intelligent Electric Vehicle Battery Monitoring System

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**Abstract -** In recent years the need for battery vehicles has become the need of the automobile industry. The heart of the Electric vehicle system is the Battery. The performance, range, and safety of an electric vehicle (EV) depend heavily on the battery is ability to operate properly.The proposed system can precisely and consistently track the status of charge level of the battery along with the measurement of battery temperature, output voltage and current values. In this project, a voltage sensor, current sensor, and temperature sensor are used with Arduino as microcontroller. The sensors are used to measure the battery parameters and the values are sent to the Arduino micro controller. Controller checks the safe level of the battery parameters and issues alert signal if the battery is operating with unsafe values. To prevent damage to the battery and fire, the battery will be promptly withdrawn from operation when the safe levels are exceeded.

***Key Words*:** Arduino, voltage sensor, current sensor, temperature sensor and battery level indicator

## 1.INTRODUCTION *( Size 11, Times New roman)*

The need for battery monitoring systems that can precisely and consistently track the status of charge and health of the battery is rising as electric cars (EVs) gain in popularity. The performance, range, and safety of an electric vehicle (EV) depend heavily on the battery's ability to operate properly. In this project, a voltage sensor, current sensor, and Arduino microcontroller are proposed as components of a system for monitoring an EV battery. In order to prevent overheating, the system also has a temperature sensor that can determine when the battery temperature rises over a safe level. At that time, a cooling system is activated. To prevent damage to the battery and fire, the battery will be promptly withdrawn from operation when the temperature exceeds the safe level.

## 2. Literature Survey

A study by Zhang et al. (2021) proposed a battery management system for an electric vehicle that includes voltage and current sensors, a temperature sensor, and a microcontroller for data acquisition and analysis. The system was designed to monitor the state of charge and temperature of the battery and to activate a cooling system when the battery temperature exceeded a safe threshold. The study found that the proposed system was effective in managing the battery temperature and improving the overall performance of the battery.

In another study, Liu et al. (2020) proposed a battery management system for electric vehicles that incorporated an Arduino microcontroller, voltage, and current sensors, and a wireless communication module for data transmission. The system was designed to monitor the state of charge, health, and temperature of the battery, and to provide real-time data to the driver or fleet operator via a mobile application. The study found that the proposed system was effective in improving the efficiency and safety of the battery, and in providing valuable insights for vehicle operators.

A paper by Saha et al. (2020) discussed the development of a battery management system for an electric rickshaw that included voltage and current sensors, a microcontroller, and a temperature sensor. The system was designed to monitor the state of charge, temperature, and health of the battery, and to activate a cooling system when the battery temperature exceeded a safe threshold. The study found that the proposed system was effective in improving the overall performance and reliability of the battery.

Another study by Ghaffari et al. (2019) proposed a battery management system for an electric vehicle that incorporated a current sensor, voltage sensor, temperature sensor, and microcontroller for data acquisition and analysis. The system was designed to monitor the state of charge, temperature, and health of the battery, and to activate a cooling system when the battery temperature exceeded a safe threshold. The study found that the proposed system was effective in improving the overall performance and safety of the battery, and in extending its life.

In a different study, Khan et al. (2019) proposed a battery management system for electric vehicles that used a microcontroller, voltage and current sensors and a GSM module for data transmission. The system was designed to monitor the state of charge, health, and temperature of the battery, and to provide real-time data and alerts to vehicle operators or fleet managers via SMS. The study found that the proposed system was effective in improving the efficiency and reliability of the battery, and in providing valuable insights for vehicle operators.

This work aims to improve the reliability, safety, and performance of electric vehicle battery monitoring and protection systems using Arduino. It will implement advanced algorithms for SoC estimation, introduce intelligent protective measures, and optimize communication protocols for seamless data exchange, ultimately contributing to the efficiency and longevity of electric vehicle power sources.

## 3. Block diagram and descirption

This project uses the Arduino UNO module which works as microcontroller. All the required parts and circuits are connected to it. The Arduino program will enable the different connected circuits to operate in the designated intervals. The different modes of operations are controlled by the control system.

The block diagram can be categorized according to the different modules illustrated below.

1. Power Supply Module
2. Sensor Module
3. Controller Module
4. Display Module

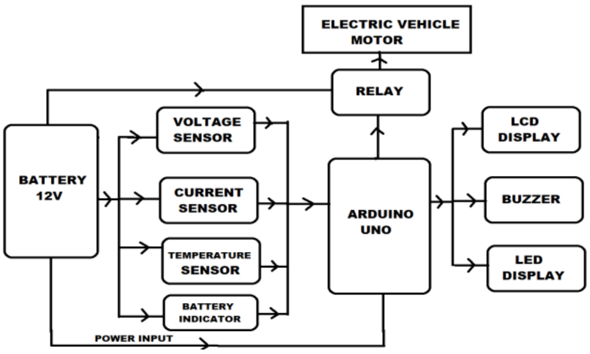


**Fig -1**: Block diagram of proposed system

3.1 Power Supply Module

The entire system is powerd using 12V lithium ion battery. Battery gives power for Vin pin of the arduino. Sensors are powered with 5V from arduino 5V pin. Motors are operated with 12V supply using the relay system

3.2 Sensing Module

3.2.1 Voltage sensor:

In electronics, a voltage divider (also known as a potential divider) is a simple linear circuit that produces an output voltage (Vout) that is a fraction of its input voltage (Vin). Voltage division refers to the partitioning of a voltage among the components of the divider.

The formula governing a voltage divider is similar to that for a current divider, but the ratio describing voltage division places the selected impedance in the numerator, unlike current division where it is the unselected components that enter the numerator.

A simple example of a voltage divider consists of two resistors in series or a potentiometer. It is commonly used to create a reference voltage and may also be used as a signal attenuator at low frequencies.


**Fig -2**: Voltage, current and temperature sensors

3.2.2 Current sensor

A current sensor is a device that detects and converts current to an easily measurable output voltage, which is proportional to the current through the measured path. There are a wide variety of sensors, and each sensor is suitable for a specific current range and environmental condition. Among these sensors, a current sensing resistor is the most commonly used. It can be considered a current-to-voltage converter, where inserting a resistor into the current path, the current is converted to voltage in a linear way. The technology used by the current sensor is important because different sensors can have different characteristics for a variety of applications.

Current sensors are based on either open or closed loop hall effect technology. A closed-loop sensor has a coil that is actively driven to produce a magnetic field that opposes the field produced by the current being sensed. The hall sensor is used as a null-detecting device, and the output signal is proportional to the current being driven into the coil, which is proportional to the current being measured.

3.2.3 TEMPERATURE SENSOR

The Temperature Sensor LM35 sensor series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

The LM35 series are precision integrated-circuit LM35 temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 sensor thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 sensor does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C sensor is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D sensor is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

3.2.4 Battery level indicator

All batteries have certain voltage limit to discharge, if it goes beyond the prescribed limit, the life span of the battery will reduce drastically. Being electronics enthusiasts, we all might have a battery for testing our prototype circuits. Since we concentrate on the prototype during experiment, we care less on the battery.

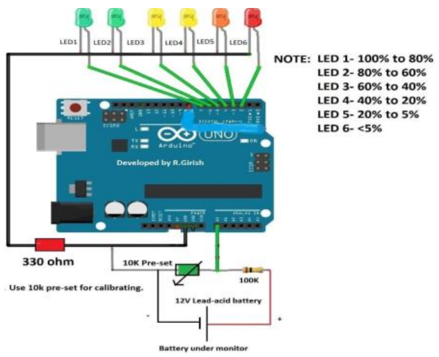


**Fig -3**: Voltage, current and temperature sensors

The proposed circuit will show you how much energy left in the battery, this circuit may be connected to battery, while you prototyping your circuits. When this circuit indicates low battery, you may put the battery to charge. The circuit has 6 LEDs, one LED glow at a time to indicate the voltage level of the battery. If your battery is full, the left most LED glows and you battery is dead or about to die, the right most LED glows.

3.3 Microcntroller

Arduino act as a micro controller in this project .It receives data sensed by all the sensors and by using the program the measured values are checked with threshold values of the battery. If any value exceeds the threshold value, the micro controller issues an output signal to the output devices based on the program and the requirement

3.4 Output Module

Arduino issues output signal to the following devices to indicate and alert the battery values

- Buzzer
- Relay
- LCD with I2C
- DC Motor

## 4. Circuit Diagram and Operation

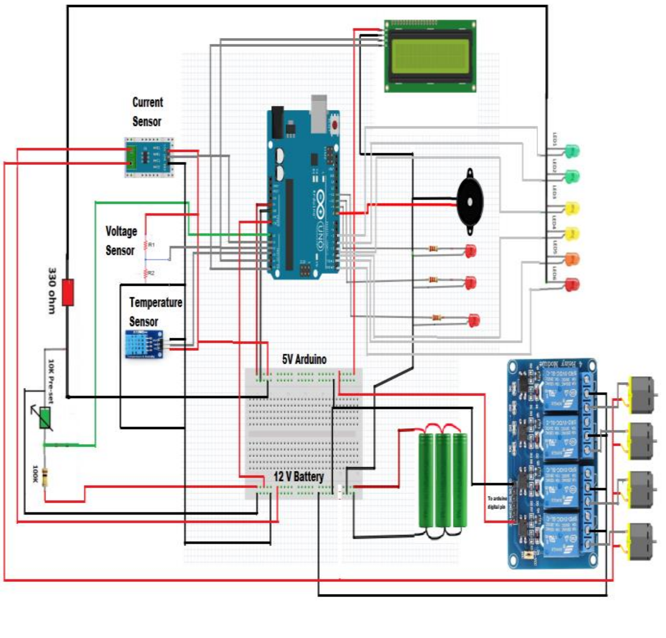


**Fig -4**: Circuit Diagram

The proposed system used 12V lithium Ion battery as the power source.Microcontroller Arduino is connected with Vin pin from 12V battery supply. 5V required for the voltage sensor, current sensor, temperature sensor, relay for motors and battery level indicator circuits are received from the arduio 5V pin

Four motors used to drive the car are connected to 12V supply through the relay system with programmed on/off control. Voltage Sensor: Voltage level of the battery is checked using the potential divider circuit. Sense pin is connected to the Arduino analog input.

Current Sensor: 12 V battery is the main source of supply for the proposed battery monitoring system. Motors are the major consumer of current. Hence, motors are connected to the battery through the current sensor ACS712. When the motors are in operation the value of current taken from the battery is sensed using Arduino analog input.

Temperature Sensor: Battery temperature is measured using the LM35 temperature sensor module. The safe level of the temperature is less than 40 degree Celsius. If the battery temperature exceeds the level then alerting signal will be given by arudio using the buzzer.

Battery level indicator: When the motor is continuously driven by the battery, the battery level is decreased. The available level of battery is indicated using LED's and the user can get alert or information regarding the left out battery charge so that charging can be done.

## 5. Technical Innocation

On conducting a brief literature survey it is found that the existing battery monitoring systems are using PIC Mircro controllers. They are difficult to program, design and extend for any future operations. Also converting them into wireless system involves more complexity. In the proposed system Arduino is used as the microcontroller which is available free of cost and easy to write coding. Also sensors that are compatible with Arduino works with great accuracy and the are cheap. Arduino codes and the circuit systems can be easily be modified or programmed for any future extension at any point of time without wasting cost and time. Our system is under construction of converting into IOT using wireless monitoring system.

## 5. Conclusion

The proposed system is constructed with simple and advanced microcontroller and sensor systems to achieve battery monitoring. Battery parameters like voltage, current, temperature and levels are measured using appropriate sensors. The measures values are found to be accurate and easy to transmit for further investigations The proposed system can help the community in finding ease of use of battery operated vehicles as the battery is protected from any dangerous values of voltage, current and temperature. At the outset the proposed system finds suitable for operating in unmanned and manned electric vehicles with less cost, more feasibility and simplicity.

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