International Journal of Research in Engineering, Science and Management
Volume 6, Issue 5, May 2023
https://www.ijresm.com | ISSN (Online): 2581-5792

Electric Vehicle Battery Prognostics

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***Abstract*: This study describes a method for tracking and managing battery temperature using an electrical vehicle battery prognostics system. Lithium-Ion Batteries are typically employed as the power source in EVs. But in two-wheeler EVs, there is no cooling system present when the battery temperature exceeds the safe level. It is quite difficult to stop the exponential rise in temperature and there are a lot of dangerous mishaps caused by battery burning. As a result, this research describes a technique for tracking and managing battery temperature. With this technique, the battery's voltage, current, and temperature are all monitored. The data from sensors is relayed to Arduino, which checks the pre-set and real-time parameters and sends a signal to the cooling system if the parameters are too high.**

***Keywords*: electrical vehicle battery, monitoring, controlling, peltier module.**

1. Introduction

A battery is a device that uses an electrochemical reaction to transform chemical energy into electric energy. In an electronic circuit, an electrochemical reaction happens when electrons move from one material to another. Unlike electric vehicles, which get their electricity straight from a large battery pack, internal combustion engine vehicles obtain their energy by burning petrol or diesel. In a battery electric vehicle (BEV) or hybrid electric vehicle (HEV), an electric vehicle battery is a rechargeable battery that powers the electronics motors.

As opposed to deep-cycle batteries and starter, lighting, and ignition batteries, electric vehicle batteries are made to provide power for extended periods of time. In general, lighter batteries are preferred because they lighten the load on the vehicle and increase performance.

Due to their high energy density in relation to their weight, lithium-ion and lithium polymer batteries are the most popular battery types in contemporary electric vehicles. To speed up their development process, it is essential to have access to the correct tool for virtually designing each new generation of cells, battery packs, and batteries, as well as forecasting battery performance. Although the industry has met all of these requirements, there are still numerous unfavourable events that can occur, such as battery shorts, internal temperature increases, and battery fires caused by overcharging.

2. Scope of Research

- Early fault detection allows for the avoidance of hazards.
- Batteries' internal temperatures increase exponentially and are challenging to regulate.
- The sensors measure the ambient temperature, voltage, humidity, and current.
- Because of controlling, the temperature is kept at a safe level.
- To ensure the battery operates safely.
- To prevent unintended battery-related incidents.

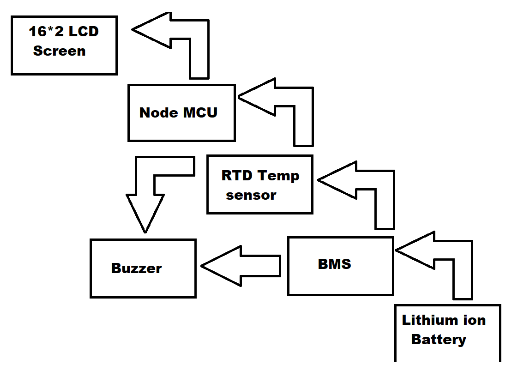

Fig. 1. Block diagram

3. Literature Survey

When there is an internal or external short circuit after an accident where the cell may be deformed, overcharging it beyond the maximum specified voltage, or during rapid charging when excessive current is passed through it, a lithium-ion battery can reach a terminal thermal runaway stage. A poorly constructed product's inadequate ventilation may cause the temperature to rise. The vulnerability of lithium to high temperatures is the root of the issue. All batteries function best when they are at room temperature, however temperature will inevitably rise when charging or discharging. Due to their propensity for overheating, lithium-ion batteries require an effective thermal management system. A battery's internal chemical reactions could result in permanent harm if it is fully depleted over an extended period of time, which would reduce battery life.

Li-ion batteries must reach temperatures of a few hundred degrees Celsius before experiencing a thermal runaway event.

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Around 45 to 55°C, the majority of modern batteries automatically shut off. You won't observe a thermal runaway (fire) even if these thermal-based safety measures don't work because batteries cannot heat themselves up to a few hundred degrees Celsius during normal operation. A battery with poor thermal design will heat up by about 30°C above ambient. Battery fires are caused by short circuits that result in unregulated current in 99% of cases. Only in this situation do cells reach temperatures above 100°C.

4. Hardware Requirements

A. Arduino UNO

Fig. 2. Arduino Uno

Arduino UNO is an ATmega328-based microcontroller. It features 6 analogue pins and 14 digital input/output pins. The Arduino board requires 5 volts to operate. It comes with a USB cable and is programmed using the Arduino IDE, which stands for Integrated Communication Area on USB type B. It is linked to the supply using an adapter.

B. Peltier Module

Fig. 3. Peltier module

The Peltier effect powers thermoelectric coolers. The object has two sides, and when a DC electric current passes through it, heat is transferred from one side to the other, causing one side to become colder while the other increases in temperature. The "hot" side is connected to a heat sink to maintain room temperature, while the "cool" side degrades below it.

C. DHT 11 Sensor

It is the greatest option for a variety of applications, including those that are the most demanding, because to its small size, low power consumption, and up to 20 metre signal transmission. The component is packaged with a single row of four pins. The ability to connect is simple, and users can request certain packages.

Specifications:

- V_{CC} – 3.3 to 5 volts
- Temperature:
  Measuring range – 0 to 50
  Sensitivity: +-1
- Humidity:
  Measuring range – 20% to 90%
  Sensitivity - +-1%

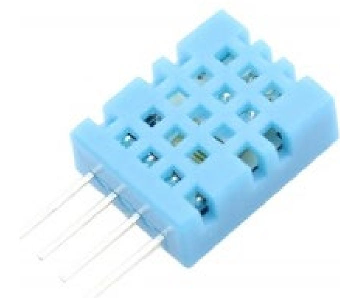

Fig. 4. DHT 11 sensor

D. Current Sensor

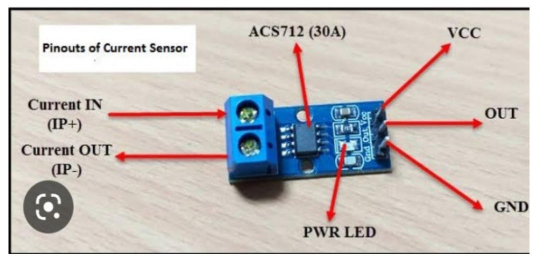

Fig. 5. Current sensor

A Hall Effect-Based Linear Current Sensor is the ACS712. Both DC (Direct Current) and AC (Alternating Current) can be measured by this sensor. Based on the range of its current sensing, the ACS712 Sensor comes in three different varieties. They are +/-5A, +/-20A, and +/-30A, respectively.

The ACS712 sensor module has 3 pins:

V_{CC}: Power supply – 5v

GND: Ground

OUT: Analog output voltage

E. LCD

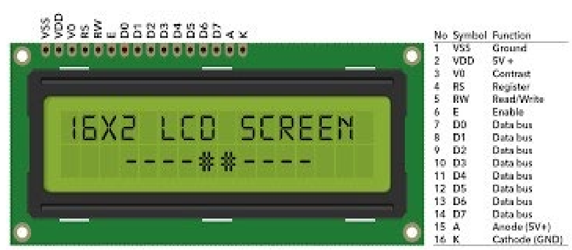

Fig. 6. LCD

Liquid crystal displays, or LCDs, are used to show values. Values are displayed using properties of light modulation. To modify the optical characteristics of liquid crystal, electric voltage is applied.

LCD are used to display the information.

We are using 20*4 LCD Display which will indicate

1. Temperature
2. Humidity

3. Current
4. Voltage

F. Transformer

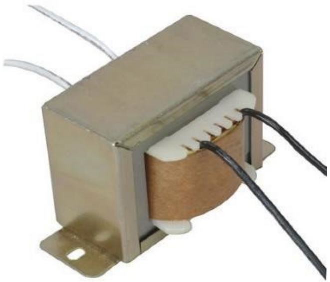

Fig. 7. Transformer

Transformers are electromechanical devices that employ the electromagnetic induction theory to adjust the voltage ratio. Through a transformer, the voltage is increased or decreased depending on the situation. The winding ratio between the primary and secondary windings determines whether a step is up or down. When supply is provided to the primary winding, electromagnetic induction causes the flux from the primary winding to link with the secondary winding. In the project, the distribution system is demonstrated using a step-down transformer. The output current is 5A and the output voltage is 12V or 0V.

G. Sensors

Current, voltage, oil level, and temperature parameters are chosen for monitoring purposes. Therefore, the parameters are detected using the following sensors:

H. Voltage Sensor

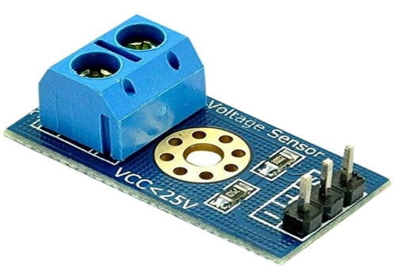

Fig. 8. Voltage sensor

The Voltage Sensor Module is a straightforward but very practical component that multiplies an input voltage by five using a potential divider. Using the analogue input of a microcontroller to monitor voltages considerably higher than it can sense is possible with the 0-25V Voltage Sensor Module. There are 5 pins total on the voltage sensor module, with 2 on the front and 3 on the back. The Arduino analogue input pin can handle 5V of power. As a result, using this module with Arduino is simple. The input voltage should not be higher than 3.3Vx5=16.5V if the controller has 3.3V systems.

Features & Specifications:

1) Output Type: Analog
2) Input Voltage (V): 0 to 25

I. Buck Converter

Fig. 9. Buck converter

Converter From DC To DC Buck Step Down Module is a step-down switching regulator that works with Arduino UNO, other main boards, and basic modules. It is capable of driving a 3A load with high efficiency.

Specifications:

- Input Current – 3A(Maximum)
- Load Regulation - +-5%
- Voltage Regulation - +-2.5%
- Output Voltage – 1.23 to 30v
- Output Type – Step-down Converter

J. Cooling Fan

To cool the hot side of the Peltier module, it is positioned there. When temperatures rise, the Peltier module enters the picture and begins to reduce the temperature using thermo cooling. However, during this time, the temperature on the hot side begins to rise, which a fan can help to lower.

Fig. 10. Cooling fan

5. Working and Circuit Diagram

For electrically powered materials, the battery pack is crucial, hence the battery's condition needs to be maintained. However, temperature variations will have an impact on its functioning, particularly in the case of lithium-based batteries. Therefore, the plan is to use a Peltier-based device to either cool or heat the batteries. The BTMS (Battery Thermal Management System) issue can be resolved with this technique in space applications where fan-based cooling technologies are not an option. One of a lithium battery's key qualities is its operating temperature; if the battery cells function within a certain range, the battery's efficiency is believed to be significantly higher. Even a 3–5 °C temperature differential between two paralleled cells can cause a 25%–40% change in cell current, worsening cell imbalance and shortening battery cycle life [10–26]. When supplied by an electric source, a Peltier cooler is an active device that, depending on the polarity, produces a temperature difference by transferring heat from one side of the device to the other. A thermoelectric device like the Peltier has cooling as its primary use, while it can also be used for heating. It can be used to regulate either cooling or heating temperatures. Peltier models, which are tiny chips attached to the battery's body, have one side that becomes hotter and another side that gets cooler. The DHT11 sensor detects rising battery temperatures and relays this information to the controller, which then activates the Peltier model. For the Peltier model to turn on or off, the temperature cut-off can be specified. When the temperature rises, the controller immediately activates the Peltier model, regulating the battery's temperature.

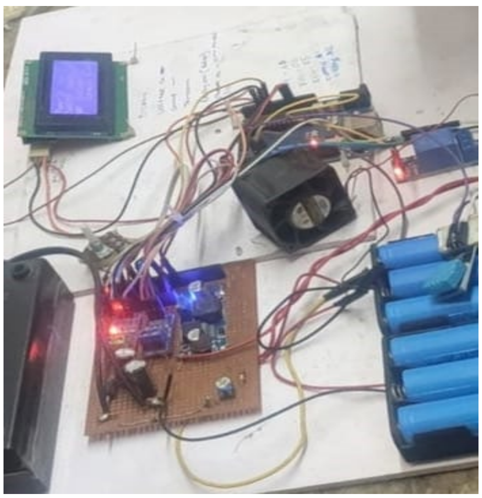

Fig. 11. Hardware model

6. Conclusion

This paper presented a method for tracking and managing battery temperature using an electrical vehicle battery prognostics system.

References

[1] https://global.kyocera.com/prdct/ecd/peltier/#:~:text=Peltier%20module%20(thermoelectric%20module)%20is,it%20at%20the%20target%20temperature.
[2] https://docs.arduino.cc/hardware/uno-rev3
[3] https://in.element14.com/sensor-current-sensor-technology#:~:text=A%20current%20sensor%20is%20a,current%20range%20and%20environmental%20condition.
[4] https://www.fiixsoftware.com/glossary/what-is-a-voltage-sensor/#:~:text=A%20voltage%20sensor%20is%20a,industrial%20controls%20and%20power%20systems.