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Battery Thermal Management System inElectric Vehicles using Sensors

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Abstract *- One of the most important systems for increasing the battery's performance and lifespan in an electric vehicle is the Battery Thermal Management System (BTMS). The purpose of this paper is to critically evaluate previous studies and research on the types, designs, and operating principles of BTMSs used in the building of various-shaped lithium-ion batteries, with a focus on cooling methods. In recent years, as consumers have demanded more environmentally friendly ways to tackle climate change, the number of electric vehicles has surged. Due to faulty battery design and a malfunctioning battery management system, some electric bikes recently caught fire. Therefore, the project's goal is to maintain a focus on the battery's temperature and detect smoke in order to alert the user by providing a cooling system, smartphone notification, emitting an alarm, and constantly cutting off the vehicleto avoid any further damage.*
Keywords *– EV Battery, Temperature Sensor, Smoke Sensor, ESP8266, Arduino, LCD, Power Supply, Cooling fan.*

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I. INTRODUCTION

An embedded system is an ensemble of computer components and software that may be designed or that is fixed in capacity and created for a single purpose or for a single function within a bigger system. An embedded system may be found in a variety of items, including industrial machinery, agricultural and process sector equipment, vehicles, medical devices, cameras, home appliances, aeroplanes, vending machines, toys, and mobile devices. Although embedded systems are computer systems, they can have simple user interfaces (UI) or elaborate desktop apps (GUI), such as those seen in mobile devices and devices with embedded systems that are designed to execute a single purpose. Button, LED, touchscreen, and some other types of user interfaces are feasible. Additionally, some systems employ remote user interfaces. Microprocessors or microcontrollers may be used in embedded systems. A central integrated circuit (IC), which is often built to do computing for real-time processes, is present in both scenarios. Although Microprocessor superficially identical, the latter only incorporates a central processing device (CPU), which demands the addition of upgrade kits like memory chips, while the former is built to function independently. Microchips or microcontrollers may be used in embedded systems. A primary integrated circuit (IC), which is often built to do computing for real-time processes, is present in both scenarios.

As fuel prices have been rising in recent years, electric vehicles (EVs) have become more and more popular. Many manufacturers are looking for alternate energy sources other than gas as a result of this circumstance. Since they are less polluting, using electric resources can help the environment. Electric vehicles also offer significant benefits in terms of energy conservation and environmental preservation. Lithium ion and lead acid batteries, which are used in the majority of electric cars, are rechargeable. Due to battery capacity and body design, electric vehicles typically have a small range.

II. EXISTING SYSTEM

Combustion engine automobiles are being replaced by electric vehicles. However, there was a lot of misconception about the systems and preservation of battery-powered vehicles when they first appeared. Today's automotive market tendency demonstrates that these significantly reducing are speculative lowering. The thermal management of electric automobiles is currently the most concerning issue that still exists. To keep the internal combustion engine cool in ordinary automobiles, thermal management is paramount. The engine's heat is dissipated by the condenser, coolant, and thermostat systems. Thermal management in electric vehicles involves cooling the combustion engine, electric motor, and the system of batteries. We'll focus on a bit deeper the reason why thermal management is so important in electric vehicle design. Electric vehicles and battery pack effectiveness, period of time, and debt are directly related. Discharge power supply for starting and At optimal alleviating the battery's health, regenerative braking performance, and acceleration are all at their peak. Battery life, the ability to drive an electric car, and fuel efficiency all suffer as the temperature rises. Battery thermal management is essential because ofthe battery's total thermal influence on electric vehicles.

III. PROPOSED SYSTEM

In terms of personal and public transportation, electric vehicles are now the most environmentally friendly option. The suggested system is made up of many sensors, including a current sensor, a smoke sensor, and a temperature sensor. Lithium-ion batteries have a high energy and current density, which makes them a common component in electric vehicles. The battery's temperature will be detected by the temperature sensor, which will then determine the battery's performance. In an electric vehicle, the coolant will automatically turn on with the help of a relay module when the temperature and smoke sensors are high. We must convert the analogue outputs from the smoke sensor and temperature sensor into digital format because they are of an analogue nature. To do this, we will use the controller's built-in 10-bit, 13-channel ADC. Moreover, this data is sent to Node MCU so that it may be uploaded to the cloud. Wi-Fi is incorporatedinto Node MCU.

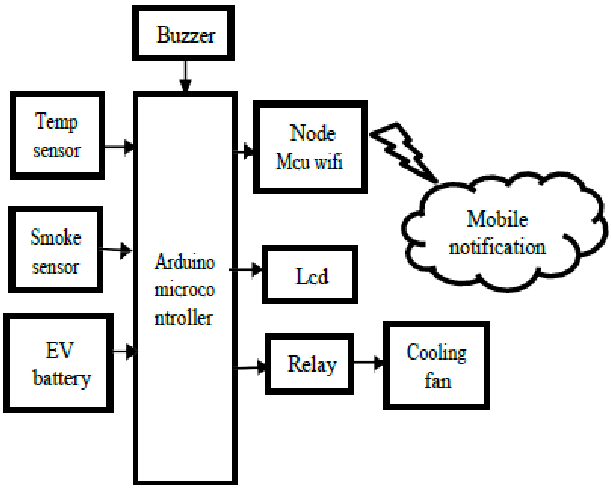

Fig 3.1 Block diagram of the system

A. MICROCONTROLLER UNIT

A microcontroller board with ATmega328 at its core is the Arduino Uno R3. It contains 6 analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power connector, an ICSP header, and a reset button. It also has 14 digital input/output pins, six of which can be used as PWM outputs. Instead, it has a USB to serial port converter Atmega16U2 (or Atmega8U2 up to version R2) programmed into it. The Uno board in revision 2 (A000046) features a resistor that draws the 8U2 HWB line to ground to make accessing DFU modesimpler.

Fig 3.2 Arduino Uno R3

A moderate System-on-a-Chip (SoC) called the ESP8266 serves as the foundation of the open- source Node MCU (Node Micro Controller Unit). The Embedded Systems-designed and -produced ESP8266 has all of the essential components of a computer, including CPU, RAM, networking (WiFi), and even a contemporary operating system and SDK. This makes it a fantastic option for all types of Internet of Things (IoT) projects. The ESP8266 is difficult to access and use as a chip, though. Using the ESP8266 as an embedded controller chip in mass-produced devices is not problematic at this degree of integration. For their adaptable IoT controller, the Arduino project developed an open-source software development kit (SDK) and hardware architecture.

The Arduino hardware is a microcontroller board with standard data ports, LED lights, and a USB connector, similar to Node MCU. Standard interfaces for interacting with sensors or other boards are also defined. Contrary to Node MCU, the Arduino board can include a number of memory chips, CPU chips (usually an ARM or Intel x86 processor), and programming environments. For the ESP8266 chip, there is also an Arduino reference design provided. However, Arduino's versatility also leads to significant disparities between vendors. For instance, the majority of Arduino boards lack WiFi capabilities.

B. EV BATTERY

The most well-known battery is the lead acid battery, which was created in 1859 by French physicist Gaston Planet. Cells have a reasonably large range of energy-to-weight ratios because they can deliver high impulse currents despite having low bioenergetic-to-weight and bioenergetic-to-volume ratios. Lead (Pb) on the negative electrode and lead

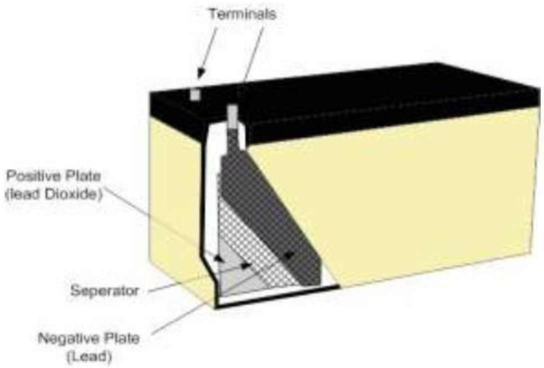

Fig 3.3. Lead-Acid battery

dioxide (PbO2) on the positive plate are converted into dilute sulfuric acid when a SLA battery is dead (PbSo4). Water is produced from sulfuric acid (H2SO4) (H2O). Water is created at the negative plate by the production of hydrogen. All gases are generated with proper and precise control of the cellvoltage.

C. TEMPERATURE SENSOR

Many ordinary devices contain temperature sensors. For addition, thermal maintenance and control are critical for home ovens, freezers, and thermostats to operate effectively. Chemical engineering also uses temperature control. Examples of this include keeping a chemical reactor's temperature at its ideal set point, monitoring the temperature of potential runaway reactions to guarantee operator safety, and preserving the temperature of streams released into the environment to reduce negative environmentalconsequences.

D. SMOKE DETECTOR

Large industrial and commercial buildings typically include smoke detectors linked to a central fire alarm system. The majority of residential smoke detectors, sometimes referred to as smoke detectors, emit an audible or visual signal from the detector itself or, if there are many interconnected units, multiple detectors. Smoke detectors for homes can be standalone battery-powered units or a network of connected units with backup batteries.

IV. DESIGN AND ANALYSIS

4.1 BASIC DESIGN AND OPERATION:

A basic electromagnetic relay consists of a moving iron armature, a core, or many sets of contacts, and a coil of wire wound around a soft iron yoke that provides a low resistance flux channel. The armature is attached mechanically to one or more groups of moving contacts and suspended from a yoke. It is held in place by a spring, leaving an air gap in the magnetic core when the relay is de- energized. In this state, one of the two sets of contacts of the indicated relay is closed and other set is open. Depending on the way they are used, other relays could have more or fewer contact sets. The armature and the yoke of the relay are connected bya wire.

4.2 POWER SUPPLY SYSTEM

A transformer is connected to an AC voltage, commonly 220 V rms, and lowers this AC voltage down to the necessary DC output level. The subsequent full-wave rectified voltage from the diode rectifier is first initially filtered to create a DC voltage by a straightforward capacitor filter. Typically, there is some AC voltage ripple or variation in the resulting DC voltage. Even when the load linked to the DC output voltage varies or the

DC input voltage changes, the regulator circuit eliminates the ripple and maintains the same DC current value. One of the well-liked ac voltage IC units is typically used to achieve this voltage regulation.

Fig 4.2 Block diagram of the supply

4.3 TRANSFORMER

The transformer reduces the supply voltage (between 0 and 230 volts) to a level (0-6V). A precise rectifier built on an operational amplifier is then linked to the transformer's secondary winding. A precision rectifier has the benefit of giving a peakDC output voltage for the remainder of the design.

4.4 BRIDGE RECTIFIER

A bridge rectifier is a circuit in which four diodes are linked in the manner depicted in the image. The network's diagonally opposed corners supply the circuit's inputs, and the other two corners supply the circuit's outputs. Now, current travels from point A to D4 and then back to point A through RL, D2, and the secondary of T1. An arrow with a dot in it points in this direction. On the D2 and D4 waveforms (3) and (4) may be seen. As a result, there is almost 1000V of peak output voltage across the load resistor. The bridge rectifier circuit offers a higher output voltage than the standard full wave rectifier circuit, despite the fact that both circuits utilize the same transformer.

4.5 VOLTAGE REGULATOR

Voltage regulators comprise a class of widely used ICs, Regulator IC units contain the circuitry for reference source, comparator amplifier, control device and overload protection all in a single IC. The IC units provide regulation of either a fixed positivevoltage, a fixed negative voltage or an adjustably setvoltage.

The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts. A fixed three- terminal voltage regulator has an unregulated DC input voltage Vi applied to one input terminal, a regulated DC output voltage Vo from the other terminal, with the third terminal connected to ground. Series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, Series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

The path for current flow is from point B through D1, up through RL, through D3, through the transformer secondary back to point B, this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

After one cycles, the polarity across the transformer secondary reverse, D2 and D4 are biased and reversed D1 and D3 sided. Current will now flow from A to D4 RFE/RL via D2, T1 secondary and A.

This path is indicated by a decided arrow waveform (3) and (4) observations in D2 and D4. Current flow through RL is always in one direction. From modern times flows through the load (RL) in both circuit voltage applied, the bridge rectifier is full.

V. RESULTS

A. SOFTWARE SIMULATION

We use equipment like temperature sensors, smoke sensors, motors, LCDs, and cooling fans in this software simulation. The operating motor will stop and the cooling fan will automatically switch on if the battery temperature increases above a predetermined maximum range (for example, we set above 40). The cooling fan will reduce the battery's maximum heat output and at the same time, we'll get a notification on our phone to alert the user.

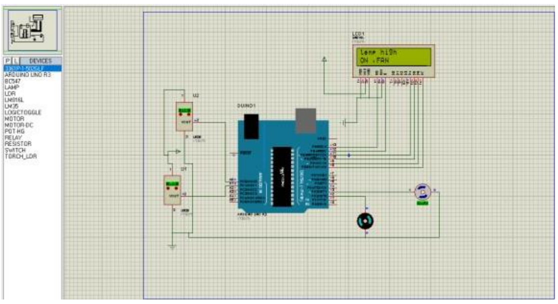

Fig 5.1 Software Simulation

B. HARDWARE OUTPUT

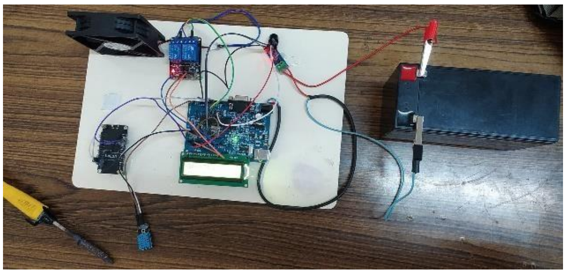

Fig 5.2 Hardware implementation

In this hardware implementation, the temperature sensor, smoke sensor, 2-channel relay module, Node MCU WiFi, Cooling fan, and Rechargeable lead acid battery are the components that are used. In our project demo, the temperature rises when external heat is given to the temperature sensor, and we can see this on the LCD. The cooling fan will turn on and the buzzer sound will increase when the temperature climbs above 40. The user receives both a notice message and a regular message by constructing an IOT cloud webpage.

VI. CONCLUSION

Technology has made it feasible for all devices to be connected with one another today. For battery storage and connectivity with other devices connected, a smart battery is also required. A smart BMS is mandatory for a smart battery. Infrastructure, amenities, and technological innovation will lead to a growing society. The development of electric vehicles, battery packs, and the BMS was first detailed in this work. The specifics of the BMS were then reviewed, including its definition, goals, purposes, and layouts. The next section is a survey of the literature on battery modelling and BMS hardware system design. We also glanced at the limitations of early battery models and the downsides of various BMS hardware systems. In this paper, an improved battery model was proposed forth by considering the self-discharging effect, temperature impact, and fading capacity effect those are similar to all batteries.

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