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Machine Overheating Detection Using Microcontroller in Electric Vehicles

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Abstract:- **Objective:** This proposed system is used to detect the temperature of Battery and Motor. This project is very beneficial in the EV industry where it is extremely important to take action in case the device heats up too much. **Methods:** The mechanism uses an advanced digital temperature sensor to identify the accurate temperature in all the dimensions of the battery pack & motor parts and transferring the information to the microcontroller. The data is processed by the Arduino UNO microcontroller, which then sends the temperature for display on an LCD panel. The 16x2 LCD panel shows the increase and decrease in motor and battery temperature. We can set a pre-safe temperature limit, and if the system exceeds that temperature limit, an alarm/buzzer will sound to indicate that the system has exceeded the pre-safe limit. **Findings:** The technology alerts the driver and reduces vehicle speed after some stipulated period with the aid of the Motor Driver and Microcontroller when the temperature rises above the pre safe limit or there is any chemical leak in the battery pack. During the alert period, the driver must perform the necessary activities to keep the vehicle safe. The supply to and from the battery is shut off and allowed to cool or undergo any maintenance when the temperature rises above the safe temperature limit. **Novelty:** By harnessing the power of microcontrollers and cutting-edge technology, this project not only addresses the pressing issue of machine overheating but also sets the stage for a new era of intelligent, temperature-regulated electric vehicles.

Keywords: *EV industry; Temperature sensor; Battery pack; Arduino UNO; LCD; Motor Driver*.

1. Introduction

Today's battery because of their environmental friendliness, powered vehicles are becoming more and more popular. These automobiles are known as electric vehicles, or EVs. To make electric vehicles practical and secure for usage in everyday scenarios, a lot of research is being done in this area. Battery Management System (BMS) is a crucial component that is frequently referred to as the brains of an electrical vehicle. The central monitoring device for the many battery characteristics used in electric vehicles or other electric systems, such as SOC, temperature, voltage, and current ranting, among others, is called the battery management system. The goal of this project is to maintain battery temperature by tracking the temperature of an electric car and taking appropriate action as needed.

The Battery Thermal Management System (BTMS) is a component of the battery management system that is used to monitor and maintain battery temperature in order to extend battery life and lower the risk of battery burning and system overheating, both of which can harm EVs and endanger human life. Although BTSM has undergone extensive research, there is still much to be done in this area. The temperature of the battery system can be controlled by the battery thermal management system utilizing either cooling liquid or air as the coolant. When considering the conditions in which the system is being utilized, the method using cooling liquid is more effective and can be used to cool or heat the battery as needed. Batteries can be used to store electrical energy. A battery is made up of many cells connected in series. Different material combinations can be used to create these cells. Nickel-cadmium (NiCd), lithium-ion (Li-ion), lithium polymer (Li-ion polymer), lead acid (Pb), and sodium-sulphur (NaS) are a few materials that have been used to build these cells.

The most often monitored battery metrics include temperature, voltage, current, and state of charge (SoC). Monitoring each battery in the battery bank makes sure that the operating levels and circumstances of the battery system stay ideal. In the absence of ac input power, the battery should supply power without interfering with system device operations. The battery needs to be in good shape in order to supply enough power to the devices without interruption for the systems to function without an ac input. It is necessary to periodically check each battery in the battery bank in real time in order to determine its state. This system's major objective is to periodically update users on the state or condition of each battery within the battery bank and convey alert information to authorized parties via an IoT module. Some key battery parameters need to be measured on a frequent basis to determine the battery's current status. The terminal voltage, load current, capacity, discharge current, and room temperature of each battery are crucial factors.

1.1 Battery Management System

The "brain" of a battery pack is essentially its battery management system, which monitors and reports vital data for the battery's performance and safeguards it from harm under a variety of operating conditions. As a result, monitoring battery status requires a battery management system. According to the state of the world today, the Internet of Things (IoT) is utilized in a variety of scientific fields to monitor, collect, and analyze data from distant battery sites. Numerous sensors are included in this system to measure the physical parameters. The input voltage, current, temperature, and charging status of the battery can all be measured using these sensors. This system allows for the determination of real-time data and the analysis of data uploaded to the cloud. A battery pack with four or more series-connected cells is monitored, balanced, and protected by a battery management system. BMS measures the current flowing through the battery as well as the voltage, temperature, and each battery cell. The system balances the cells and guards them against overcurrent, overcharging, deep discharge, and overheating based on the measured data. The goal of a battery management system is to keep an eye on a battery as it operates and protect it from harm under diverse working situations. In addition to being utilized in autos, the battery is also employed in UPS, off-grid, and alternative power systems.

1.2 Embedded System

In Embedded System products, microcontrollers are frequently used. One and only one task is performed by the microprocessor (or microcontroller) in an embedded product. A printer is an example of an embedded system because the processor within solely does the data retrieval and printing. Compare this to a PC that is Pentium-based. Any number of programs, including word processors, print servers, bank teller terminals, video game players, network servers, and internet terminals, can be utilized with a PC. Software can be loaded and run for a variety of applications. Of course, the fact that a PC has RAM memory and an operating system that loads application software into RAM and uses the CPU to operate it is the main reason it can handle several activities.

The C standards committee created Embedded C as a set of language extensions for C programming to solve issues of commonality between C extensions for various embedded devices. In the past, the C language has needed nonstandard extensions to accommodate unusual features like fixed-point arithmetic, many separate memory banks, and fundamental input/output functions. The C Standards Committee expanded the C language in 2008 to solve these problems by establishing a uniform standard that all implementations must follow. It has a variety of features not found in standard C, including named address spaces, fixed-point arithmetic, and fundamental I/O hardware addressing. The majority of conventional C's syntax and semantics are used by embedded C, including the main () function, variable definitions, data type declarations, conditional statements (if, switch, case), loops (while, for), functions, arrays and strings, structures and unions, bit operations, macros, unions, and more.

2. Significance

In order to raise a visible, tabular warning flag when an operational machine unit is experiencing overheating, this device is designed to be placed on (or in thermal contact with) a surface of an apparatus, machine or the like. The warning flag is sized and placed to alert operating workers in the area that the operating unit is at risk of being damaged due to its overheated state. Benefits of temperature sensor and buzzer-based overheat detectors using microcontrollers. The project is simple to use.

Machine overheating detection using a microcontroller in electric vehicles carries significant scientific and technological importance, as it addresses critical safety, performance, and sustainability aspects of electric vehicle (EV) operation. Here are some key points highlighting its significance:

1. Safety Enhancement.
2. Optimal Performance.
3. Battery Life Extension.
4. Energy Efficiency.
5. Environmental Impact.
6. Reliability.
7. Advanced Materials and Sensors.
8. Data Analytics and Machine Learning.
9. Regulatory Compliance.
10. Consumer Confidence.

Machine overheating detection using a microcontroller in electric vehicles is a scientifically and technologically significant development that addresses critical safety, performance, and sustainability issues. It contributes to the overall advancement of EV technology and supports the transition to cleaner and more efficient transportation systems.

2.1 Hardware requirements

- Arduino UNO
- Temperature sensor
- Motor driver
- DC Motor
- Battery
- LED
- LCD
- Jumper wires

2.2 Software requirements

- Arduino IDE
- Embedded 'C'

3. Problem description

Threats to security and safety are significant challenges in today's globe. Consider a few scenarios in this situation, including: Because not all electrical energy is converted to power, some energy is lost as heat, which increases motor temperature, reducing working duration and shortening motor life. When there is an internal short circuit, which can happen when the battery receives a significant shock, the battery will experience a high current discharge and will heat up. Failure of the charge controller causes the battery pack to be overcharged and over discharged, which raises the temperature. The motor windings, battery pack, and electric vehicle all suffer significant damage as a result of the temperature rise (over heating) of the motor and battery in EVs and leads to EV burning in the end.

4. Methodology

Our suggested solution focuses on the main goals such as to detect the temperature of the battery pack and compares the temperature with the rated temperature or threshold value in order to create an innovative yet easy and affordable solution to the aforementioned problem. In addition to making a warning signal for the user, it delivers input to the controller. To determine whether a motor is overheating, the temperature is measured and compared to a threshold value. In addition to making a warning signal for the user, it delivers input to the controller. We can control the operation of the motor using the signal from the microcontroller.

The majority of production equipment currently uses temperature detection systems. This technology is utilized to monitor the motor and battery temperatures in electric vehicles. A temperature monitoring system is now included into the BMS, however if the BMS isn't functioning correctly, the temperature won't be tracked, which can damage an EV.

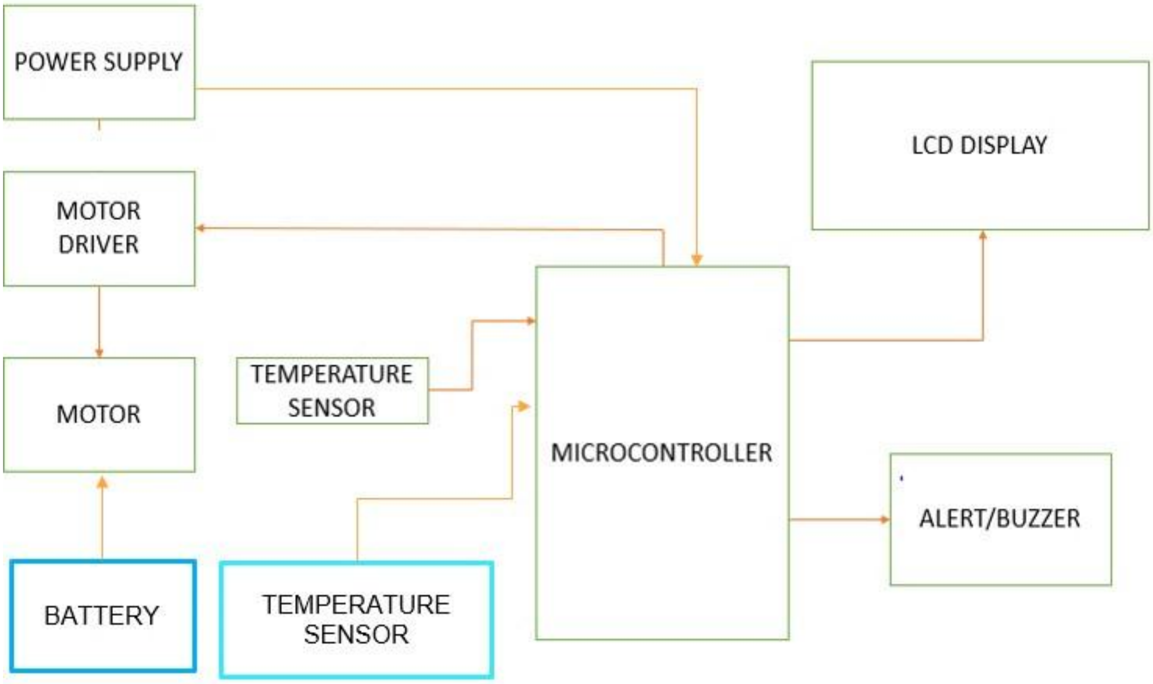

Figure 1 The block diagram of the project

If the motor or battery is discovered to be overheated, it will inform the driver of the vehicle until the temperature reaches the highest threshold value while operating the motor at a constant, reduced speed. The signals from the microcontroller terminate the motor's operation with the aid of the motor driver if it starts again and reaches the maximum temperature and continuously alert the driver. The power supply is isolated from the motor using the motor driver circuit if the motor temperature exceeds the threshold value for the specific motor design defined in the controller program. The design of the vehicle, the size and type of the motor and battery, as well as the driving conditions of the vehicle, can all affect the maximum temperature of a motor and battery in an electric car. In general, the battery should not exceed 20°C and the maximum temperature for an electric car motor should be between 120°C and 180°C. It is crucial to remember that the maximum temperature limitations may range between different electric vehicle manufacturers and models, as well as depending on the ambient temperature, the pace of charging and discharging, and the length of operation.

4.1 Source Code for Microcontroller

```
#include<OneWire.h>
#include<DallasTemperature.h>
#include<LiquidCrystal.h>

LiquidCrystal Lcd(13, 12, 11, 10, 9, 8);        //RS EN D4 D5 D6 D7
```

```
#define ONE_WIRE_BUS 2
#define alert 4
#define Motor 5
#define Speed 6
#define light 7
#define bright 3

OneWire oneWire(ONE_WIRE_BUS); DallasTemperature sensors(&oneWire);

int deviceCount = 0;
float tempB;
float tempM;
void setup(void)
{
pinMode(alert, OUTPUT);
pinMode(Motor, OUTPUT);
pinMode(light, OUTPUT);
sensors.begin(); // Start up the library
Serial.begin(9600);
Serial.print("Locating devices...");
Serial.print("Found ");
deviceCount = sensors.getDeviceCount();
Serial.print(deviceCount, DEC);
Serial.println(" devices.");
Serial.println("");
digitalWrite(alert, LOW);
digitalWrite(Motor, LOW);
digitalWrite(light, LOW);
analogWrite(Speed, 255);
analogWrite(bright,165);
delay(1000);
Lcd.begin(16, 2);
delay(100);
}
void loop(void)
{
sensors.requestTemperatures();
Serial.print("Sensor ");
Serial.print(0);
Serial.print(" : ");
tempB = sensors.getTempCByIndex(0);
Serial.print(tempB);
Serial.println(":C");
Lcd.setCursor(0, 0);
Lcd.print("B T:");
Lcd.setCursor(4, 0);
Lcd.print(tempB);
Lcd.setCursor(10, 0);
Lcd.print("C");
Serial.print("Sensor ");
Serial.print(1);
Serial.print(" : ");
```

```
tempM = sensors.getTempCByIndex(1);
Serial.print(tempM);
Serial.println(":C");
delay(1000);
Lcd.setCursor(0, 1);
Lcd.print("M T:");
Lcd.setCursor(4, 1);
Lcd.print(tempM);
Lcd.setCursor(10, 1);
Lcd.print("C");

if ((tempB < 40) && (tempB > 35))
{
analogWrite(Speed, 50);
analogWrite(bright, 50);
digitalWrite(Motor, HIGH);
digitalWrite(light, HIGH);
digitalWrite(alert, HIGH);
delay(400);
digitalWrite(alert, LOW);
delay(7000);
Lcd.setCursor(12, 0);
Lcd.print("          ");
}
else if (tempB > 40)
{
digitalWrite(alert, HIGH);
digitalWrite(Motor, LOW);
digitalWrite(light, LOW);
delay(3000);
Lcd.setCursor(12, 0);
Lcd.print("HIGH");
delay(1000);
}
else if ((tempM < 40) && (tempM > 35))
{
analogWrite(Speed, 50);
analogWrite(bright, 50);
digitalWrite(Motor, HIGH);
digitalWrite(light, HIGH);
digitalWrite(alert, HIGH);
delay(400);
digitalWrite(alert, LOW);
delay(7000);
Lcd.setCursor(12, 1);
Lcd.print("          ");
}
else if (tempM > 40)
{
digitalWrite(alert, HIGH);
digitalWrite(Motor, LOW);
digitalWrite(light, LOW);
```

```
delay(3000);
Lcd.setCursor(12, 1);
Lcd.print("HIGH");
delay(1000);
}
else
{
digitalWrite(alert, LOW);
digitalWrite(Motor, HIGH);
digitalWrite(light, HIGH);
analogWrite(Speed, 255);
analogWrite(bright, 165);
delay(1000);
}
}
```

5. Results and discussion

The electric vehicle's motor and battery temperatures are sensed by our project. On the LCD panel, the motor and battery's current temperatures are shown. When a system's, motor's, or battery's temperature surpasses the pre saturation value, which we fixed the threshold value in the microcontroller (threshold value – 5 deg). The motor speed will be reduced, and the driver will receive a warning signal continuously. The system is shut down when the temperature hits or surpasses the threshold setting. The driver should be aware of the vehicle throughout the alert period and take the required steps to cool the vehicle.

Currently we are setting 40deg as maximum threshold value and 35deg as pre saturation value in the Arduino microcontroller. These temperature settings vary for different EV's according to the surrounding temperature and different rating of the motor and battery pack of the electric vehicles.

5.1 Hardware model

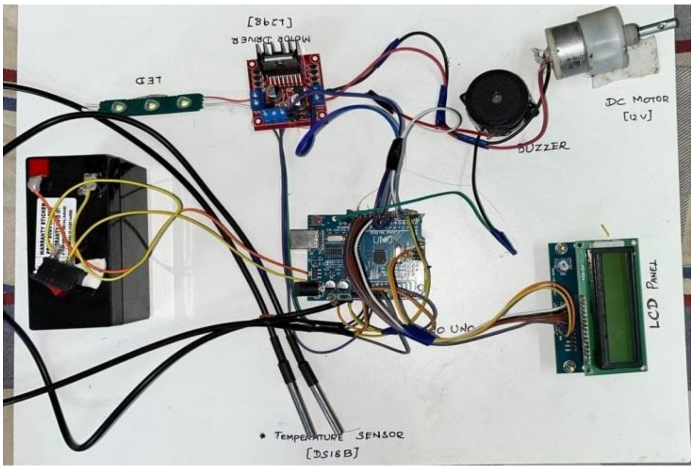

Figure 2 Demo project in off mode

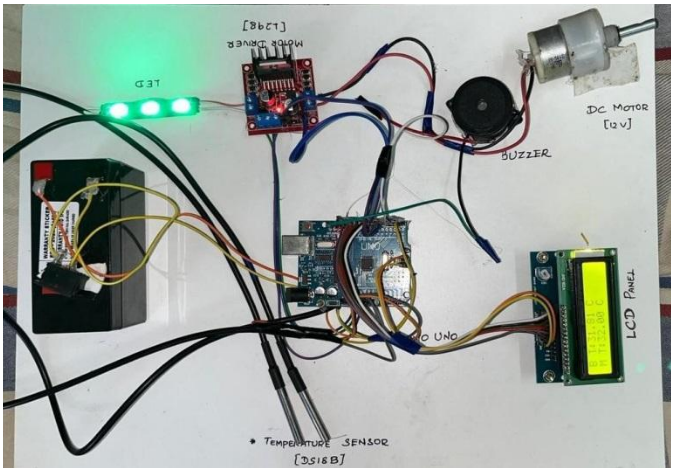

Figure 3 Demo project in on mode

Our Project Is Justified With SDG Goal 7 "AFFORDABLE AND CLEAN ENERGY" And SDG Goal 9 "INDUSTRY INNOVATION AND INFRASTRUCTURE"

Figure 4 SDG goal 7

Figure 5 SDG goal 9

6. Conclusion

In conclusion, an electric vehicle's (EV) microcontroller must be used to detect motor and battery overheating in order to ensure safe and dependable operation. Temperature readings can be tracked and compared to a threshold value by putting temperature sensors on the motor and battery and attaching them to the microcontroller's ADC inputs. The microcontroller can activate an alert or cut off the motor or battery to prevent overheating if the temperature rises beyond the threshold setting. The temperature readings can also be sent to a central monitoring system for additional analysis or stored in memory by the microcontroller. Overall, installing a microcontroller-based temperature monitoring system in an EV is a good way to stop any dangers and guarantee the vehicle's safe operation. Such safety precautions are becoming more crucial as EV use rises in order to guarantee the vehicles' dependable operation as well as the security of its occupants and the environment. All of the earlier experiments were unique in that they had separate temperature measurement system for the motor and the battery. In this instance, a single device uses temperature detection for both the battery and the motor. Finally, we are monitoring the Motor and Battery temperatures and protecting our electric vehicle.

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