IOT BASED REAL-TIME MONITORING FOR SECURE OPERATIONS OF ELECTRIC VEHICLES

MINI PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project **"IOT BASED REAL-TIME MONITORING FOR SECURE OPERATIONS OF ELECTRIC VEHICLES**" is the bonafide work of "**ANU S (2116230701030) and ASHNA V (2116230701042)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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LIST OF ABBREVIATION

ABBREVIATION	ACRONYM
IOT	Internet of Things
TEMP	Temperature
SP	Set Point
LHi	Level High
LLow	Level Low
MCU	Microcontroller Unit
EV	Electric Vehicles

ABSTRACT

Electronic Vehicles have several benefits over conventional petrol and diesel vehicles such as Cheaper to run, Cheaper to maintain, Better for Environment with renewable energy, better eco friendly materials, less pollution, Energy independence and Quieter. Our state and central governments are encouraging the manufacturers and users to switch-over to EVs by subsidies and other incentives. Maybe in next few years, several EVs will be seen on the roads.

Recently several EVs are getting fired due to (1) excessive heat generated in the battery during charging and discharging and (2) short circuit that may happen when flood water rises to touch live conductors.

Such hazards and even theft of the EV can be avoided by using IoT based monitoring, alert and control of the EV. Such monitoring systems should measure temperature of the battery, speed of the EV, location of the EV and flood water level on its path, and should send them through internet based cloud systems to the mobiles and system monitors of the EV owner, thereby alerting the owner to avoid hazardous accidents.

A IoT based prototype model has been built for real-time monitoring, alert and control systems for EVs, and its performance studied.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The world is currently facing an alarming energy crisis, largely driven by the overconsumption of fossil fuels. With nearly 85 million barrels of petroleum products consumed each day and limited reserves estimated to last only a few more decades, the need for sustainable alternatives is critical. The transportation sector alone accounts for approximately 60% of this consumption, significantly contributing to environmental pollution through emissions such as CO_2, NO_x, and particulate matter. These emissions lead to global warming, rising sea levels, and ecological disruptions.

Electric vehicles (EVs), powered by clean and renewable energy, present a promising solution to these challenges. Over the decades, significant advancements have been made in EV technology to improve their performance, efficiency, and usability. However, challenges such as limited battery range, lack of charging infrastructure, and safety concerns in EV operations persist. Incorporating Internet of Things (IoT) technology into EVs enables real-time monitoring, enhanced safety, and smarter energy management, addressing many of these limitations. This project focuses on leveraging IoT to ensure secure and efficient operation of electric vehicles through real-time monitoring systems.

1.2 SCOPE OF THE WORK

This project investigates the integration of IoT technology in electric vehicles to enable real-time monitoring and secure operations. It includes the analysis of energy consumption patterns, detection of faults or abnormal activities, and implementation of data-driven safety features. The project also explores how IoT can contribute to optimizing EV performance, prolonging battery life, and enhancing user experience through intelligent data analytics.

1.3 PROBLEM STATEMENT

While electric vehicles are gaining popularity as a clean alternative to conventional transportation, concerns regarding their operational safety, energy efficiency, and lack of real-time monitoring persist. The absence of a reliable system to continuously track vehicle performance, detect anomalies, and ensure operational security limits the widespread adoption of EVs. There is a critical need for a smart, connected solution that can monitor EV operations in real-time and provide actionable insights for secure and efficient performance.

1.4 AIM AND OBJECTIVES OF THE PROJECT

The aim of this project is to design and implement an IoT-based real-time monitoring system that ensures the secure and efficient operation of electric vehicles. To fulfill this aim, the project focuses on studying the limitations of existing electric vehicle monitoring systems and identifying the gaps in current technologies. It involves designing an appropriate IoT architecture that supports real-time data acquisition and analysis specific to electric vehicle operations. A prototype will be developed to monitor key parameters such as battery status, motor temperature, and vehicle speed in real time. The system will also include intelligent alert mechanisms to detect faults and unsafe conditions, thereby enhancing operational safety. Furthermore, the data collected through the system will be analyzed and interpreted to support preventive maintenance and optimize the overall performance and reliability of electric vehicles.

CHAPTER 2

SYSTEM SPECIFICATIONS

2.1 IOT DEVICES

1. ESP8266-12E NodeMCU with Wi-Fi Module
2. L298N Motor Driver Module
3. Temperature Sensor (DHT11)
4. Current Sensor Module (ACS712)

2.2 SYSTEM HARDWARE SPECIFICATIONS

PROCESSOR	Intel Core i5 or above
MEMORY SIZE	8 GB or higher
HDD	500 GB HDD or 256 GB SSD
Microcontroller	NodeMCU ESP8266
Sensors	- Temperature Sensor (like LM35, DHT11) - Speed Sensor (Hall Effect Sensor) - Water Level Sensor

	- GPS Module (like NEO-6M)
Power Supply	5V-12V (for sensors and microcontroller)

2.3 SOFTWARE SPECIFICATIONS

Operating System	Windows 11
Programming Language	Python
Cloud Plaform	Blynk

CHAPTER 3
SYSTEM DESIGN

3.1 ARCHITECTURE DIAGRAM

An architecture diagram is a graphical representation of a set of concepts, that are part of an architecture, including their principles, elements and components

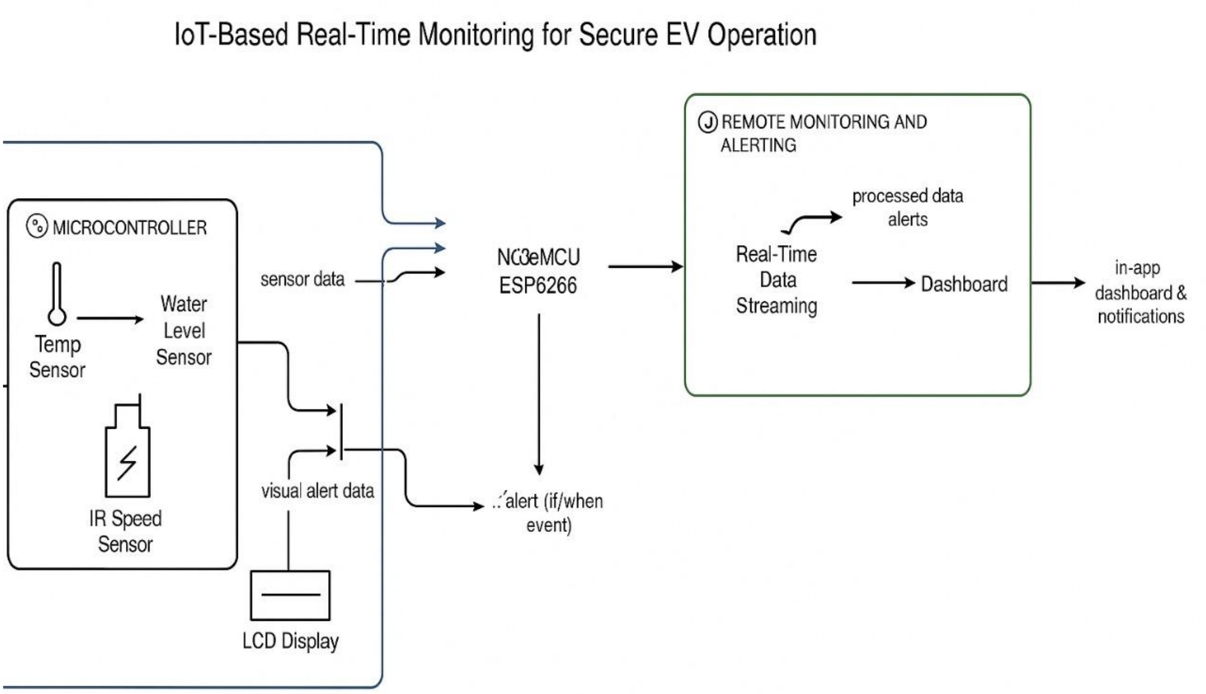

Figure 3.1 Architecture Diagram

From the above Figure 3.1, the architecture of the system is well understood.

3.2 USE CASE DIAGRAM

A use case is a list of actions or event steps typically defining the interactions between a role (known in the Unified Modelling Language as an actor) and a system to achieve a goal. The actor can be a human or other external system.

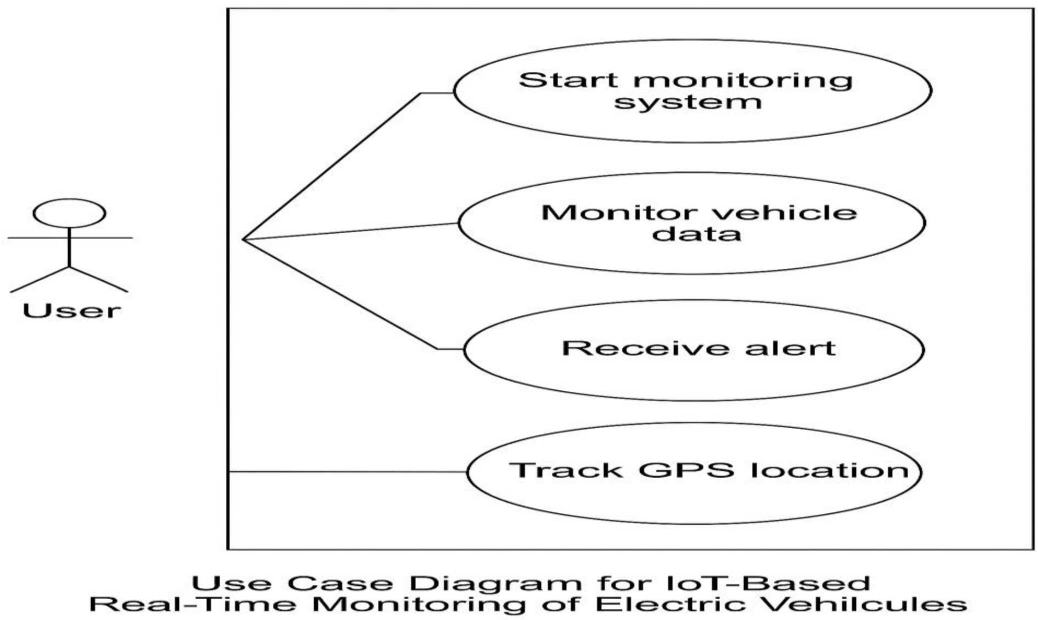

Figure 3.2 Use case diagram

From the above figure 3.2, the interactions between a role in the system is shown

3.3 ACTIVITY DIAGRAM

An activity in Unified Modelling Language (UML) is a major task that must take place in order to fulfill an operation contract. Activities can be represented inactivity diagrams. An activity can represent: The invocation of an operation. A step in a business process.

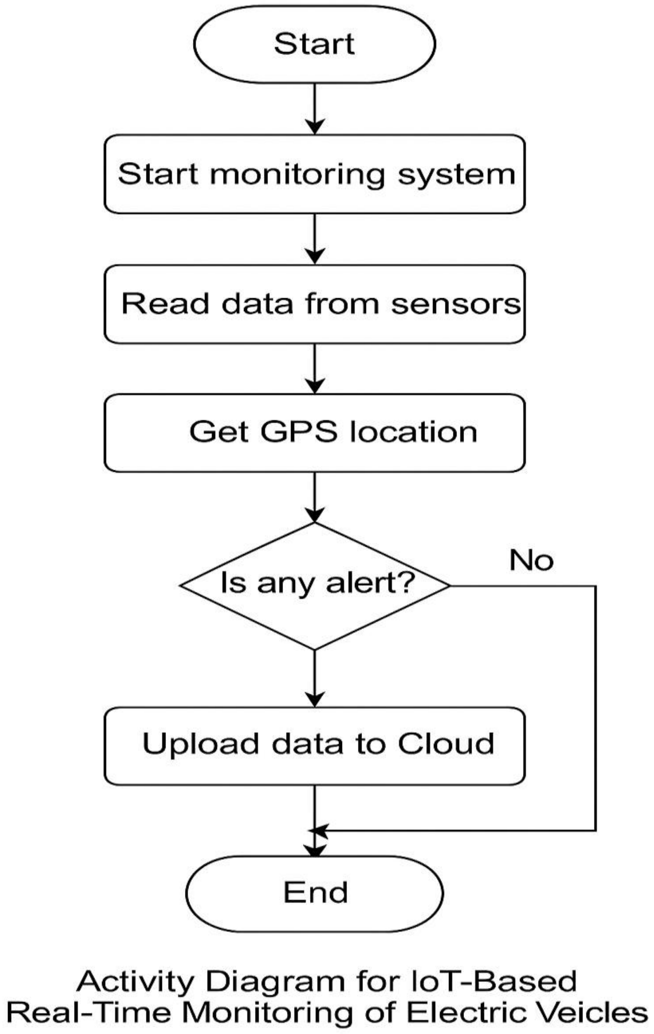

Figure 3.3 Activity Diagram

From the above figure 3.3, the activities of the system are shown

3.4 CLASS DIAGRAM

A class diagram is an illustration of the relationships and source code dependencies among classes in the Unified Modelling Language (UML). In this context, a class defines the methods and variables in an object, which is a specific entity in a program or the unit of code representing that entity.

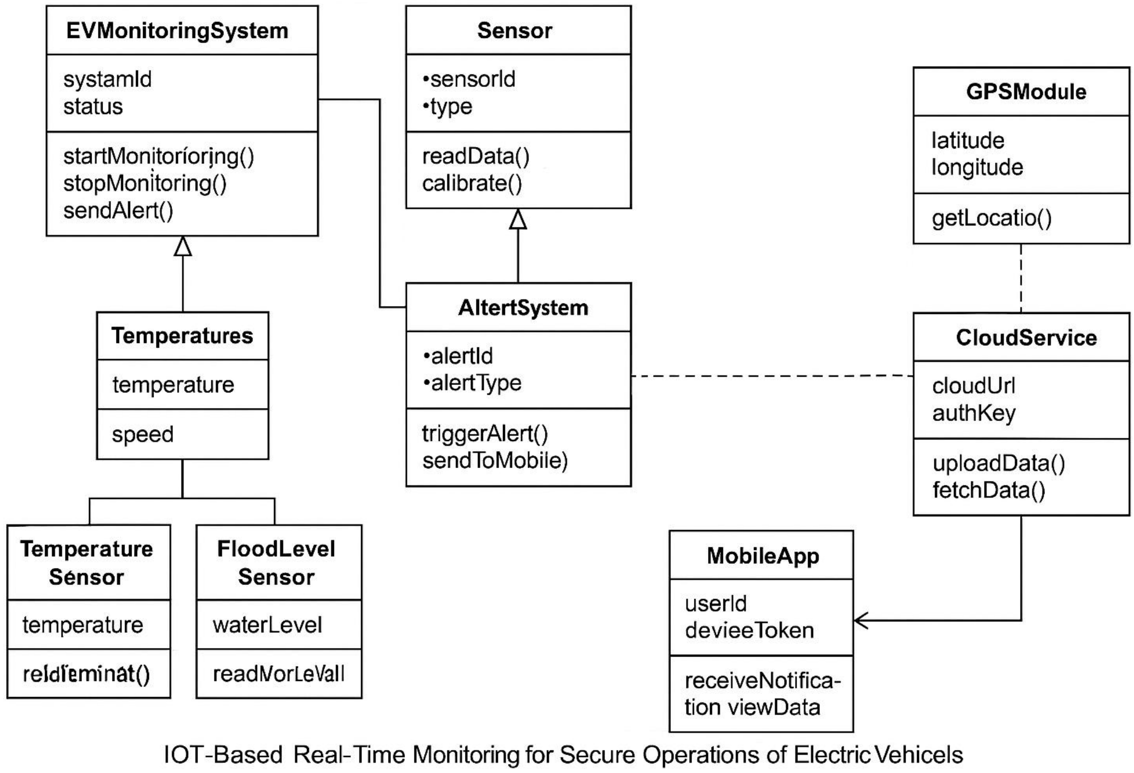

Figure 3.4 Class Diagram

The above Figure 3.4 is the class diagram for the system.

CHAPTER 4

MODULE DESCRIPTION

4.1 Power Supply Module:

The Power Supply Module is responsible for providing a stable DC voltage to all parts of the system. It uses a step-down transformer to reduce the 230V AC mains voltage to a lower AC voltage. This is then converted into DC using a bridge rectifier and smoothed with capacitors. Finally, voltage regulators provide a constant 5V or 12V DC output, which powers the microcontroller, sensors, motor driver, LCD, and Wi-Fi module. A reliable power supply ensures that all modules work without fluctuations or damage..

4.2 Sensor Module:

The Sensor Module acts as the "sensory system" of the electric vehicle, continuously monitoring important operational parameters. It includes temperature sensors to detect overheating, smoke sensors to identify fire hazards, and possibly flow or current sensors to monitor battery or coolant flow. These sensors generate real-time data, which is sent to the microcontroller for analysis. Any abnormal readings can immediately trigger alerts or preventive actions to ensure the secure operation of the vehicle**.**

4.3 Microcontroller Module:

The Microcontroller Module forms the brain of the system. Based on a PIC microcontroller, it reads input data from various sensors, processes the information, and makes decisions accordingly. It also controls the motor driver to simulate vehicle motion and updates the LCD display with real-time data. Additionally, it communicates with the Wi-Fi module to transmit the collected data to remote users. The microcontroller ensures that all parts of the system work together smoothly, automating monitoring and control operations.

4.4 Wi-Fi Communication Module:

The Wi-Fi Communication Module is crucial for enabling remote monitoring. It uses an ESP8266 Wi-Fi board to send real-time data from the electric vehicle to a cloud server or a mobile application. This ensures that users can access important information about the vehicle's condition from anywhere. In case of faults or abnormal conditions, the system can immediately alert the user through notifications, enabling faster responses and improving overall vehicle safety.

4.5 Integration Module:

The Integration Module in the system is primarily handled by the microcontroller. It acts as the central unit that integrates various hardware components such as sensors, the motor driver, the LCD display, and the Wi-Fi communication module. It collects sensor data, processes it, controls the motor based on conditions, displays information locally on the LCD, and sends data wirelessly to remote servers. Through seamless coordination of these tasks, the Integration Module ensures the electric vehicle operates securely and efficiently in real-time.

4.6 Data Analytics Module:

The cloud platform not only stores real-time sensor data but also analyzes the collected information. Through graphical representations and data logs, trends such as temperature fluctuations, water level changes, and smoke detection patterns can be observed. This analytics functionality enables predictive maintenance, anomaly detection, and early warning systems for the electric vehicle, enhancing operational safety and efficiency.

CHAPTER 5

TABLE

5.1 Historical Development of Electric Vehicles

1823	Thomas Davenport builds the first electric car with a non-rechargeable battery and a range of 9 to 19 miles (15 to 30 km).

1860	The rechargeable lead-acid battery is invented.
1882	In this year, Ernst Werner Siemens builds an electrically driven carriage. This vehicle, which was also known as the "Elektro-Motte" or "Elektromote", is considered to be the world's first trolleybus.
1900	Ferdinand Porsche presents a vehicle with inwheel motors on both wheels of the front axle at the world exhibition in Paris.
1960	Dr Charles Alexander Escoffery presents probably the world's first solar car. It is a Baker Electric from 1912 registered in California with a photovoltaic panel made up of 10,640 single cells.
1973	The first oil crisis shows the industrial nations how dependent they are on oil-exporting countries. Fuel prices rise drastically.
1991	The THINK is one of the first cars to be conceived as a purely electric vehicle and not a conversion into an electric vehicle.
1996	General Motors offers the two seater electric coupé "EV 1" (Electric Vehicle 1) with 1,100 lb (500 kg) lead-acid batteries. Later nickel-metal hydride batteries improved the performance of the vehicle
2008	The exclusively electric-powered "Tesla Roadster" built by Tesla Motors is launched on the US market with 6,187 laptop batteries connected in series. It accelerates from 0 to 62 mph (100 km/h) in 3.8 seconds.
2019	Electric cars are manufactured by so many car companies like Hyundai, Tata, Maruti, Bajaj, Volkswagen and Mahendra.

5.2 Performance Comparison of Batteries

Battery Type	Specific energy Energy/Weight (Watt-hour/kg)	Specific power Power/Weight (Watt/kg)	Cycle life
Lead-acid	30-40	180	600 cycles
Nickel-Cadmium		220	2000
Nickel-Metal Hydride (Ni-MH)	70-95	200-300	
Lithium-Ion (Li-I)	85-120	260-1350	
Lithium-Polymer (Li-P)	155	315	

CHAPTER 6

SAMPLE CODING

Code for Real-Time Monitoring and Cloud Data Upload in Electric Vehicle System

```
#include <xc.h>

#define _XTAL_FREQ 8000000

#define motor_pin PORTBbits.RB0
#define water_sensor_pin PORTAbits.RA0
#define smoke_sensor_pin PORTAbits.RA1
#define temp_sensor_pin 0
```

```
void UART_Init();
void UART_SendString(const char *data);
void ADC_Init();
unsigned int ADC_Read(unsigned char channel);
void LCD_Init();
void LCD_Display(char *data);

void main() {
   TRISA = 0xFF;
   TRISB = 0x00;
   ADC_Init();
   UART_Init();
   LCD_Init();

   while(1) {
      unsigned int temp_value = ADC_Read(temp_sensor_pin);
      unsigned int water_status = water_sensor_pin;
      unsigned int smoke_status = smoke_sensor_pin;

      LCD_Display("Temp:");
      LCD_Display(temp_value);

      UART_SendString("Temp=");
      UART_SendString(temp_value);
      UART_SendString("&Water=");
      UART_SendString(water_status);
      UART_SendString("&Smoke=");
      UART_SendString(smoke_status);
      UART_SendString("\n");

      if(smoke_status == 1 || temp_value > 50) {
         motor_pin = 0;
      } else {
         motor_pin = 1;
      }

      __delay_ms(5000);
   }
}
```

Web Application

1. index.js

```
<?php
$conn = new mysqli("localhost", "root", "", "ev_monitoring");
```

```
$result = $conn->query("SELECT * FROM DataLogs ORDER BY LogID DESC");
?>
<!DOCTYPE html>
<html>
<head>
<title>EV Monitoring Logs</title>
<style>
table { width: 100%; border-collapse: collapse; }
th, td { border: 1px solid #aaa; padding: 8px; text-align: center; }
th { background: #ddd; }
</style>
</head>
<body>
<h2>DataLogs</h2>
<table>
<tr><th>LogID</th><th>DATA</th><th>LogDate</th><th>LogTime</th></tr>
<?php while($row = $result->fetch_assoc()): ?>
<tr>
<td><?= $row['LogID'] ?></td>
<td><?= $row['DATA'] ?></td>
<td><?= $row['LogDate'] ?></td>
<td><?= $row['LogTime'] ?></td>
</tr>
<?php endwhile; ?>
</table>
</body>
</html>
```

2. insert.php (IoT Device Sends Data)

```
<?php
$conn = new mysqli("localhost", "root", "", "ev_monitoring");

$data = $_GET['data'];
$date = date('Y-m-d');
$time = date('H:i:s');

$conn->query("INSERT INTO DataLogs (DATA, LogDate, LogTime) VALUES ('$data', '$date',
'$time')");
echo "Logged";
?>
```

CHAPTER 7

SCREEN SHOTS

1. Dashboard Page

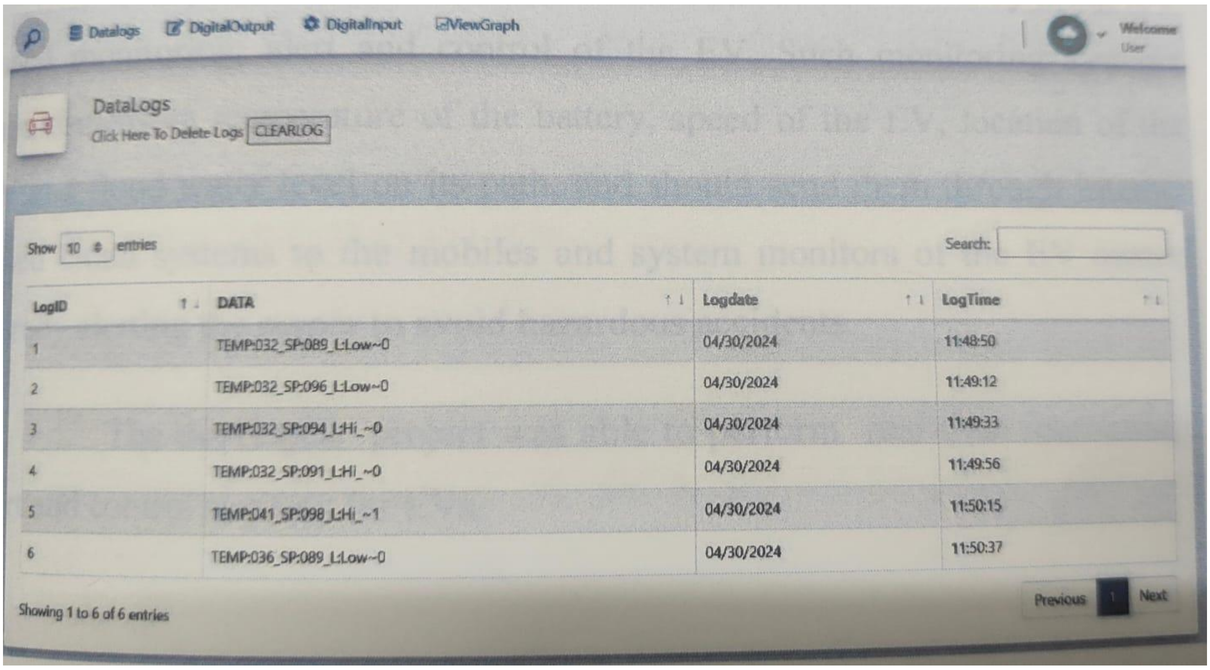

Figure 7.1 Results on the remote computer monitor

2. Results on the Microcontroller Display

Figure 7.2 Data Received on Microcontroller

CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENT

The IoT-based real-time monitoring and notification system for electric vehicles (EVs) effectively addresses the challenges associated with monitoring the health and performance of EVs in a dynamic environment. By integrating sensors and communication protocols, the system provides continuous, accurate data on key parameters such as battery status, temperature, charging levels, and vehicle location. Real-time alerts ensure that the driver or fleet manager is promptly notified of critical events, allowing for proactive maintenance and optimal performance management. This system contributes to enhancing the safety, efficiency, and longevity of electric vehicles, while also promoting better decision-making through data-driven insights.

Future enhancements to this system can focus on expanding its capabilities to include predictive maintenance through machine learning algorithms. By analyzing historical data and recognizing patterns, the system could predict potential failures before they occur, allowing for timely interventions. Additionally, integrating vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication could enhance the system's ability to optimize traffic flow and provide real-time information to other EVs and traffic management systems. Further development could also focus on making the system more energy-efficient, reducing its reliance on external power sources, and improving the scalability for deployment in larger fleets of electric vehicles. These advancements could significantly improve the system's effectiveness and the overall user experience.

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