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CLOUD-INTEGRATED ELECTRIC VEHICLE SPEED CONTROL WITH BATTERY PARAMETERS MONITORING

Dr. K. Gnanambal, Devadharshini. B, P.K. Gopikaa, K. Harini, R.S. Harini

Department of Electrical and Electronics Engineering
K.L.N. College of Engineering, Pottapalayam, Sivagangai District
Professor, Department of Electrical and Electronics Engineering, K.L.N. College of Engineering, Tamil Nadu, India

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Abstract - *New solutions to environmentally friendly transport are on the up; nevertheless, efficient management of batteries is a major issue. This article proposes a cloud system for battery monitoring aimed at maximising battery efficiency, increasing duration of operation, and promoting safety. Real-time monitoring of SoC and SoH is facilitated by sensors before the data gets transmitted to the cloud platform where predictive analytics as well as exception detection occur. In addition, an adaptive speed control is implemented with a closed-loop buck-boost converter to maximize energy consumption without overcharging the battery. The performance of the system is proven with MATLAB simulations. The outcome shows its ability to determine battery parameters accurately, control speed, and provide remote access via cloud. Real-time diagnostics and remote battery management through integration with the cloud efficiently mitigate important challenges in EV battery sustainability. The results ensure that this system enhances battery performance, safety, and sustainable transportation.*

Keywords: *Battery Monitoring System (BMS), Cloud Storage, State of Charge (SoC), State of Health (SoH), Electric Vehicles (EVs), Buck-Boost Converter, Predictive Maintenance.*

1.INTRODUCTION

This paper introduces a cloud-based battery monitoring system aimed at real-time State of Charge (SoC) and State of Health (SoH) monitoring, predictive maintenance, and adaptive speed control in electric vehicles. The system is integrated with voltage, current, and temperature sensors that continuously monitor the battery status. The information collected by these sensors is processed using a microcontroller unit (MCU) and sent to a cloud platform, facilitating remote monitoring and predictive maintenance. This method improves battery health management while avoiding the operational risks that are involved in battery aging. Adaptive speed control is achieved through a closed-loop buck-boost converter that dynamically adjusts power output, maximizing energy utilization and avoiding battery overload. Through the integration of real-time data capture, cloud-based analytics, and smart speed regulation, the system accurately solves problems concerning battery degradation, safety, and efficiency. Its data-driven and scalable architecture dramatically enhances performance, reliability, and battery longevity in electric vehicles.

To assess the system's performance and efficiency, MATLAB simulation modelling is performed, which shows its capability for real-world implementation. The combination of cloud computing, high-end battery diagnostics, and adaptive speed control places this system in the next level of sustainable electric vehicle technology, addressing the increasing demand for data-driven and green transportation solutions.

2.LITERATURE SURVEY

[1] Battery Management System with Cloud for Electric Vehicles, This article suggests a novel Battery Management System (BMS) combined with cloud computing for electric vehicles. The system seeks to maximize battery performance, life, and safety by harnessing cloud infrastructure for real-time monitoring and data analysis. The integration allows battery parameters to be monitored continuously and improves user experience through IoT-cloud methods.

[2] Cloud-Based Artificial Intelligence Framework for Battery Management Systems, This paper introduces a cloud-based Battery Management System (BMS) that leverages artificial intelligence to improve battery safety, performance, and economy. The system gathers information from electric vehicles and energy storage systems, using sophisticated algorithms for state-of-charge estimation and health monitoring. The cloud-based system allows for the management of complex calculations and large data sets, enhancing the accuracy of battery state prediction.

[3] Battery Life Estimation Based on Cloud Data for Electric Vehicles, This study concentrates on the analysis of the lifecycle and safety of electric vehicle batteries using cloud-stored driving records. The paper suggests capacity and internal resistance estimation using charging records with algorithms such as the ampere-hour integral approach and Kalman filtering. The addition of fuzzy logic control increases the reliability of battery lifespan forecasts, confirming the value of cloud-based information in battery life.

[4] Cloud-Based Monitoring of Lithium-Ion Battery Management Systems, This article reviews the application of cloud monitoring systems to enhance lithium-ion battery health estimation and management in electric vehicles. He proposes a digital twin model that merges sensor measurements with past usage histories to forecast battery degradation precisely. The research showcases how cloud computing enables predictive maintenance approaches, promotes operational effectiveness, and increases battery life using superior data analysis.

[5] A Comprehensive Review of Cloud-Based Lithium-Ion Battery Management Systems for Electric Vehicle Applications, This article discusses the integration of cloud computing and Battery Management Systems (BMS) in electric vehicles. It presents how cloud-based BMS can overcome the limitations of conventional systems by providing high computational capacity, real-time observation, and better data analysis. The research presents the capabilities of cloud platforms to analyze big datasets for precise State of Charge (SOC) and State of Health (SOH) estimates, improving the battery performance and lifespan.

[6] A Smart External Influenced Speed Control of Electric Vehicles, This paper introduces a smart speed control system for electric vehicles that incorporates external environmental conditions. The application entails the utilization of throttle sensors and actuators under the control of a smart controller, which allows for effective speed control based on real-time external inputs. The method is focused on improving vehicle performance, safety, and responsiveness to changing driving conditions.

3.EXISTING SYSTEM

Current Battery Monitoring Systems (BMS) in electric vehicles are capable of monitoring and controlling important parameters like State of Charge (SoC), State of Health (SoH), voltage, current, and temperature. These systems strive to optimize battery performance, efficiency, and life while providing safe operation. Voltage-based techniques are employed by these systems to estimate SoC through the correlation of open-circuit voltage (OCV) with charge levels. Yet, the method is not reliable under dynamic loads because temperature and battery aging affect voltage. To enhance precision, most systems employ Coulomb Counting, which computes SoC by adding the current entering and leaving the battery. Although more precise than voltage-based techniques, Coulomb Counting is plagued by sensor drift and charge-discharge inefficiencies that cause errors to build up over time. To circumvent this problem, some sophisticated systems employ Kalman Filtering, which blends data from both approaches, compensating for errors in real-time and reducing noise, hence giving more precise SoC estimation. For SoH estimation, current systems use Impedance Spectroscopy to monitor internal resistance, since a rise in resistance signifies battery aging.

Moreover, capacity tests analyze the present capacity against the initial capacity to find out how much life is left in the battery. These systems also monitor the charge-discharge cycle count to observe long-term performance and forecast battery aging. Electric vehicle speed control is generally controlled with Pulse Width Modulation (PWM), which varies the power delivered to the motor. Advanced systems employ Field-Oriented Control (FOC) for accurate speed and torque control, which maximizes motor efficiency and minimizes power loss. This allows for battery optimization to maximize driving range and battery life.

Safety features in standard systems involve turning on cooling fans if temperatures go over a predefined level and overcurrent or overheating buzzers. The systems provide real-time battery information on an LCD screen, allowing users to see battery health from within the vehicle. But these systems also have a few shortcomings.

They employ local microcontrollers with modest processing power, limiting complex data analysis for proper SoC and SoH estimations. They also lack integration with clouds, disallowing remote monitoring and predictive maintenance, thus making it less convenient and more costly to maintain. Voltage-based estimation of SoC is unreliable with dynamic loads, and Coulomb Counting integrates errors over a period. Their safety features only depend on primitive threshold triggers that could be suboptimal during high-dynamics conditions. Last but not least, their energy optimization is shallow, impacting performance of the vehicle and the lifetime of the battery. The proposed Cloud-Integrated Electric Vehicle Speed Control and Battery Parameters Monitoring System eliminates these shortcomings using cloud computing to facilitate improved data processing, remote monitoring, predictive maintenance, real-time SoC and SoH estimation with error correction, improved safety, and energy optimization, and thereby renders it more reliable and efficient for new-age electric vehicles.

4. SYSTEM DESCRIPTION

The Cloud-Integrated Electric Vehicle Speed Control and Battery Parameters Monitoring System is intended to improve electric vehicle performance and safety. It tracks important battery parameters such as voltage, current, temperature, State of Charge (SOC), and State of Health (SOH) through sensors. The system also regulates vehicle speed by varying the motor output according to real-time information. With cloud integration, data is remotely stored and analyzed, facilitating predictive maintenance and effective energy management. The system guarantees safe operation through the activation of cooling systems for excessive temperatures and alerts for unusual current consumption, improving battery life and overall vehicle efficiency. In addition, the system provides remote monitoring and control via an intuitive mobile app. It optimizes energy consumption by dynamically adapting power delivery to driving conditions and cloud-based analytics provide insights into driving habits.

5.PROPOSED SYSTEM

The system developed for the Cloud-Enabled Battery Monitoring System for SOC, SOH, and Speed Control for Electric Vehicles utilizes efficient hardware and cloud solutions in order to ascertain the battery reliably, control motors, and maintain vehicle efficiency. It unifies real-time checking with cloud processing to ensure safe electric vehicle management.

For State of Charge (SoC) estimation, the system makes use of a hybrid model combining Coulomb Counting with voltage estimation and Kalman Filtering. This blend avoids errors due to temperature changes, sensor drift, and different loads, providing precise SoC monitoring. This accurate estimation enables users to comprehend the amount of battery charge remaining, thus maximizing the vehicle's range and overall energy efficiency.

State of Health (SoH) estimation is attained with capacity testing and electrochemical impedance spectroscopy (EIS). These techniques deliver precise information about battery aging, internal resistance, and patterns of degradation so that accurate prediction of possible failures can be made. This predictive monitoring strategy extends battery life and enables preventive maintenance, guaranteeing the electric vehicle's reliability in operation over the long term.

Speed control is attained by a dual-layer control mechanism. Pulse Width Modulation (PWM) provides coarse speed control, allowing effective motor power output control. Field-Oriented Control (FOC) is utilized for fine torque-based control. FOC gives real-time control based on dynamic load conditions, allowing effective energy use and fast response to speed changes. This method enhances motor performance, optimizes battery utilization, and extends the vehicle's driving range.

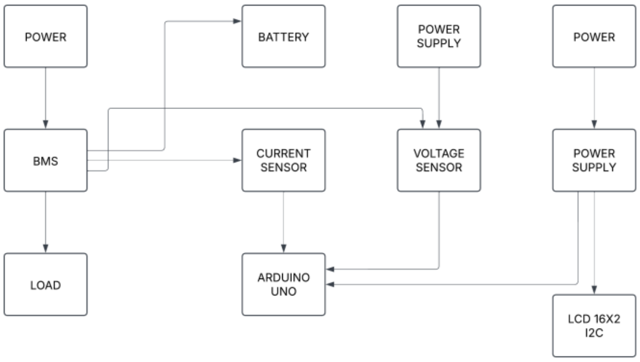

Fig -1: Existing system

Cloud connectivity is an essential feature that facilitates real-time monitoring, remote diagnostics, and predictive maintenance. Information on critical parameters like SoC, SoH, temperature, and speed is gathered and presented on an LCD interface, giving users real-time information. Cloud integration facilitates historical data analysis, anomaly detection, and early fault warnings, improving safety and lowering maintenance costs. This capability also supports long-term battery health analysis, enabling users to maximize energy efficiency by analyzing previous performance data. Safety features are incorporated to avoid dangerous conditions and ensure system integrity. A cooling fan is turned on automatically when battery temperature reaches a specified level, avoiding overheating. Moreover, a buzzer is activated in overcurrent or overheating conditions to notify users. The system relies on real-time sensor feedback for fault detection, allowing protective measures such as disconnecting the load or turning on cooling mechanisms during abnormal conditions like overvoltage, undervoltage, or high temperature.

Overall, this Cloud-Enabled Battery Monitoring System integrates precise SoC and SoH monitoring, accurate speed control, advanced safety features, and comprehensive fault protection with sophisticated cloud-based analytics. The combination of real-time monitoring, predictive maintenance, and remote diagnostics greatly enhances electric vehicle efficiency, reliability, and safety. Through optimized battery usage and motor performance, this system enables sustainable and intelligent electric mobility.

6.WORKING PRINCIPLE

The electric vehicle (EV) battery monitoring system monitors key battery parameters continuously to provide safe and efficient operation. It employs a set of sensors to monitor voltage, current, and temperature, allowing precise estimation of the State of Charge (SoC) and State of Health (SoH).

A voltage sensor is employed to monitor the voltage across a single cell or the whole battery pack. This assists in establishing the SoC from the voltage changes, which reflect the battery's capacity remaining. The charging and discharging current is measured using a current sensor like the ACS712. This information is critical in computing the charge and discharge rates, helping to gain a better insight into energy flow in the battery. Thermal sensors continuously check the thermal state of the battery to avoid overheating, ensuring the safe charge and discharge processes. The system is driven by an Arduino microcontroller that receives real-time data from these sensors. The Arduino digitizes analog signals from the sensors into digital data. It processes the data with algorithms to estimate the SoC and SoH. The SoC is estimated with a hybrid approach that combines Coulomb Counting and voltage-based estimation for increased accuracy. SoH estimation is done by observing capacity and internal resistance, which can predict battery aging and degradation.

Safety features are incorporated into the system to guard the battery as well as the vehicle. Whenever the SoC falls below a certain level or the temperature level goes beyond a set limit, the Arduino institutes safety features. It can shut off the power supply through a 5V relay to guard the battery from over-discharging or overheating. Moreover, in case abnormal current or voltage levels are identified, a buzzer signals the user, leading to immediate action. The system also includes an automatically activated cooling fan when the battery temperature rises above safe levels, avoiding thermal runaway. This maintains the battery in an optimal temperature range, improving safety and prolonging battery life. For improved user experience and remote monitoring, the system sends the data gathered to a cloud platform. This allows for real-time and historical data analysis, enabling predictive maintenance. Users can track the performance of the battery, identify anomalies early, and optimize energy consumption, making the electric vehicle more efficient and safe overall.

In general, the battery monitoring system facilitates efficient and stable operation by constantly monitoring essential parameters, engaging safety features when necessary, and delivering useful data insights to achieve maximum energy management and maintenance.

7. MATLAB SIMULATION

The MATLAB Simulink model of a cloud-based electric vehicle (EV) battery monitoring system tracks significant parameters like voltage, current, and State of Charge (SoC). It utilizes a MOSFET switch, voltage sensors, and current sensors along with a lithium-ion battery pack to control the ON/OFF status of the circuit. This setup helps test the performance of batteries under different conditions with accurate health assessment. The system identifies failures like overvoltage, undervoltage, and improper flow of current, enhancing safety and reliability. Charging and discharging cycles are controlled by the MOSFET switch efficiently, improving energy usage and extending battery lifespan. Cloud integration enables remote monitoring and predictive maintenance through real-time data access. This approach ensures energy management and minimizes downtime. Overall, the simulation improves battery safety, efficiency, and performance, allowing advanced electric vehicle technology.

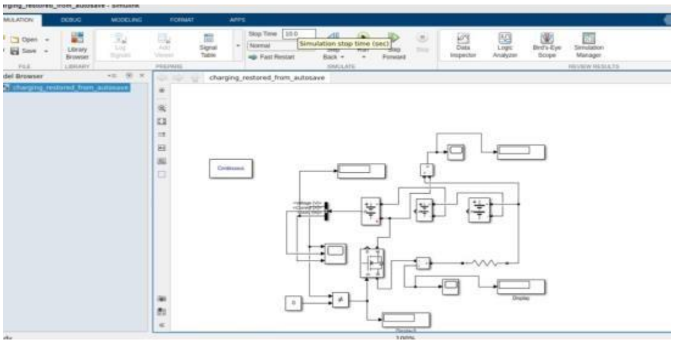

Fig -2: MATLAB Simulink of the proposed system

Furthermore, the system includes dynamic load management to maximize power distribution under changing driving conditions. It maximizes energy efficiency through the control of charging cycles in accordance with battery health information. The model also assesses thermal performance, promoting efficient heat dissipation and averting overheating. Real-time notifications for battery critical conditions assist in proactive maintenance. This makes the solution more sustainable and intelligent for electric mobility.

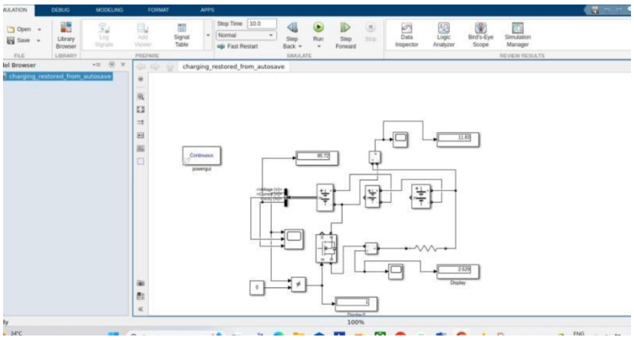

Fig -3: MATLAB Simulink of the proposed system after running

7.1 Voltage Analysis

Voltage analysis in the MATLAB Simulink simulation examines the battery's voltage response under varying load conditions and discharge rates. This analysis helps detect irregularities, such as unexpected voltage drops caused by high loads or aging-related degradation, which can impact battery performance and stability. By closely monitoring voltage fluctuations, the system enhances operational safety and extends the lifespan of the battery pack. In addition, current analysis tracks energy consumption and charge-discharge cycles, providing valuable insights into power usage patterns. Analyzing current flow aids in optimizing power distribution, maximizing battery efficiency, and minimizing energy losses. This integrated approach to voltage and current analysis ensures effective battery management, contributing to improved performance and longevity in electric vehicle applications.

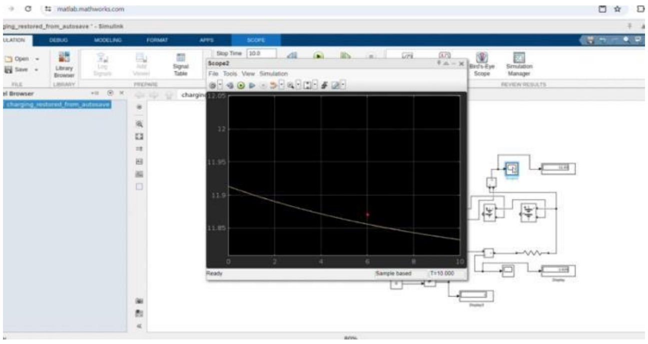

Fig -4: Output waveform of the voltage

7.2 Current Analysis

The existing simulation tests patterns of energy use and charge-discharge in the batteries of electric vehicles. As a matter of normal conditions, the current will be stable but fluctuate depending on variations in load conditions. The examination of these changes helps the system measure energy needs and distribute power to achieve effective use of the batteries. Identifying unusual current surges is key to identifying fault or overloading of power that can lead to overheating and battery damage. Through tracking of these fluctuations, users can take remedial action to optimize battery performance and security. This simulation is beneficial for understanding current behavior, enabling effective energy management, and prolonging the life of the battery.

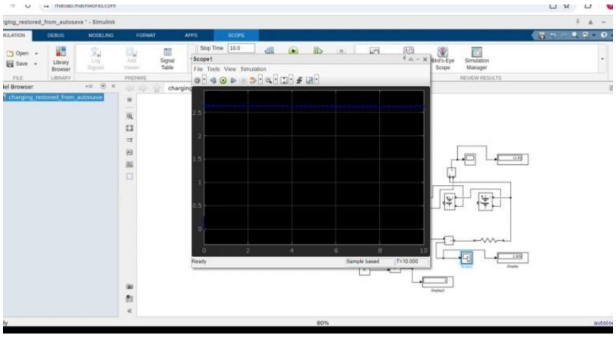

Fig -5: Output waveform of the current

7.3 State Of Charge Analysis

State of Charge (SoC) is an important battery management parameter that reflects available battery capacity. The SoC is at the highest level in the beginning but decreases gradually because of power utilization. The simulation monitors this reduction in real time, emphasizing its effect on voltage and current levels, which have implications for system efficiency. To avoid over-discharge and damage to the battery, the model initiates preventive measures such as disconnection of load or notifications once the SoC crosses a critical value. Real-time monitoring maximizes battery utilization, prolongs battery lifespan, and ensures vehicle performance. Early detection of potential battery malfunctions is possible based on SoC variations. Optimal SoC management guarantees efficient energy use and a stable power supply, thereby improving reliability and safety. Precise SoC estimation also aids in planning charging cycles properly, minimizing battery stress and enabling diverse driving situations through adaptation of power output according to SoC levels.

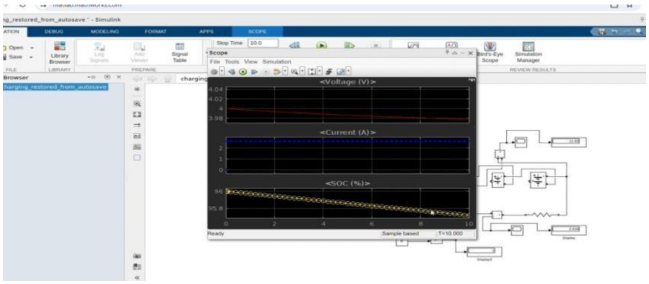

Fig -6: Output waveform of the SoC

Precise SoC monitoring enables prediction of the remaining driving range, increasing user confidence and trip planning. It avoids deep discharge, protecting battery health and preventing expensive replacements. Real-time SoC information enables smart energy distribution for essential vehicle functions. Effective SoC management also minimizes charging times, lowering energy expenses and grid load.

Table -1: Battery monitoring parameter values

Parameters	Values
State Of Charge (SoC)	97.5%
Voltage	11.83V
Current	2.62A

7.4 Overall Analysis

The MATLAB Simulink simulation clearly illustrates real-time battery management through the tracking of voltage, current, and State of Charge (SoC). The model facilitates fault detection, optimization of power consumption, and system stability improvement without actual hardware. The findings confirm the ability of the system to estimate battery health, reduce energy loss, and improve efficiency in electric vehicles. The method promotes informed decision-making and predictive maintenance to provide efficient and reliable battery use. In addition, it is a useful tool for creating sophisticated battery management systems, helping to achieve better performance and life of electric vehicles.

7.5 Speed Control Using Buck – Boost Converter In A Closed Loop Analysis

The MATLAB simulation also uses a closed-loop buck-boost converter for accurate motor speed control. It constantly measures the motor speed and varies the output voltage to drive the motor within the set value. If the motor speed goes below the specified value, it raises the voltage to speed up the motor. If the motor speed goes over the specified level, it drops the voltage to ensure stable speed. The real-time feedback scheme guarantees precise speed control even at changing load and input conditions. Simulation results verify the effectiveness of the converter in reducing speed oscillations, improving motor responsiveness and efficiency. Moreover, the system maximizes energy use by dynamically adjusting power delivery, maximizing battery life and improving system performance. Utilizing pulse-width modulation (PWM) further improves voltage control, permitting smooth motor operation. This sophisticated control technique minimizes power losses, increases energy efficiency, and ensures system stability, leading to better electric vehicle drivability.

Closed-loop control also increases safety by stopping motor over-speed and overheating. It adjusts to any driving conditions automatically, providing consistent behavior and provies real-time information from the speed control.

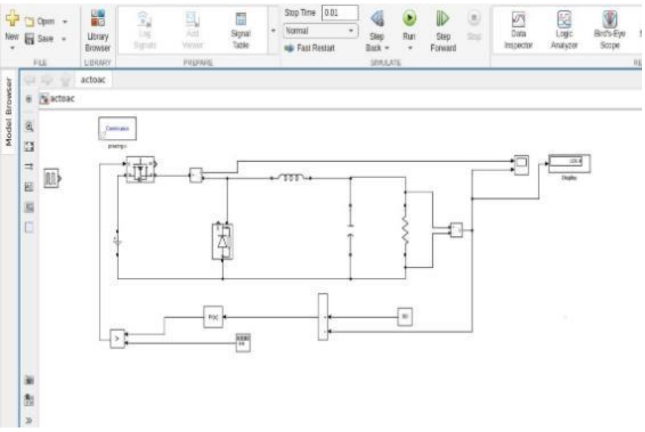

Fig -7: Simulink of the speed control using buck – boost converter

Table -2: Speed controller readings

Content	Input	Output
Buck Converter	150V	122.2V
Boost Converter	100V	118V

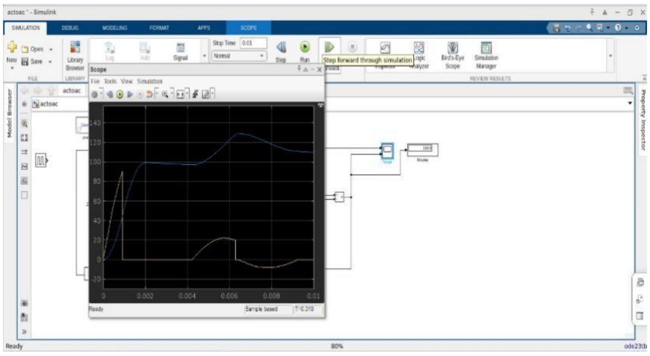

Fig -8: Output of the speed control using buck – boost converter

8.SYSTEM SETUP

The Cloud-based battery monitoring system is critical to guaranteeing the safety, efficiency, and reliability of electric vehicles. The process is extremely complex, requiring sophisticated sensors, real-time data analysis, and accurate control mechanisms. The cloud-based battery monitoring system for State of Charge (SoC), State of Health (SoH), and speed control of electric vehicle's operation can be classified into four parts:

8.1 Battery Parameter Monitoring and Data Collection

8.2 Data Transmission and Cloud Integration

8.3 Dynamic Speed Control Based on Battery Health

8.4 Power Management and Safety Mechanisms

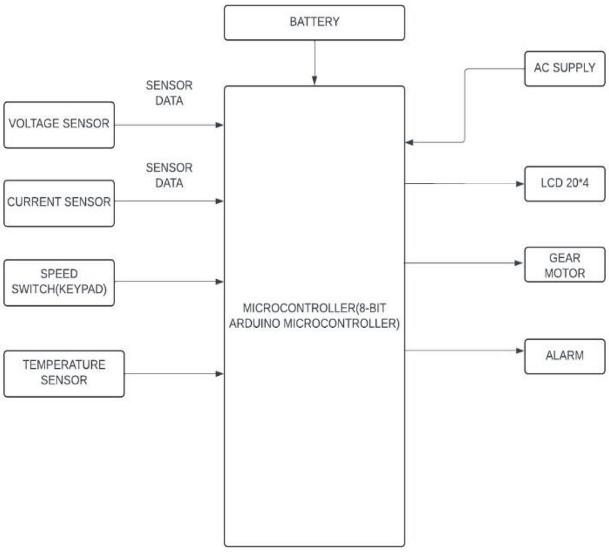

Fig -9: Block diagram of the system

8.1 Battery Parameter Monitoring And Data Collection

The system constantly monitors critical battery parameters to provide safe and efficient operation. A voltage sensor is employed to monitor the voltage of the battery pack, which is necessary for determining the State of Charge (SoC) and abnormal voltage fluctuations. An ACS712 current sensor monitors the charging and discharging currents, offering information on power consumption patterns and assisting in assessing battery efficiency. A temperature sensor regulates the thermal health of the battery, and an automatic cooling fan is initiated with a relay should temperatures reach above safety thresholds to avoid overheating and heat destruction. The sensor information is fed into the Arduino Uno microcontroller to determine SoC and has it displayed in real time via an LCD. Moreover, the system determines the State of Health (SoH) through monitoring voltage, current, and temperature readings in real time, providing precise estimates of battery degradation and remaining lifetime. By using this data acquisition method, there is accurate monitoring, effective energy management, and safe battery operation. Data gathered is also ready for transmission to the cloud for centralized monitoring and analysis.

8.2 Battery Parameter Monitoring And Data Collection

Once data is processed locally, the system sends it to the cloud for centralized data management and monitoring. A communication module like Wi-Fi or GSM securely transmits real-time voltage, current, temperature, and motor speed data to the cloud platform. This data is stored and organized for historical analysis so that users can monitor battery performance over time. The cloud platform offers remote access via an easy-to-use dashboard on mobile phones or laptops, enabling users to check battery health and vehicle status remotely. Real-time notifications are also provided for serious conditions like low State of Charge (SoC) or excessive temperatures, allowing preventive measures to be taken in time. This integration with the cloud adds functionality to the system by providing remote monitoring, centralized data storage, and user access. It also enables improved decision-making through the provision of detailed insights into vehicle performance and battery health. This strategy optimizes operational efficiency, user convenience, and safety through constant battery health monitoring and remote system management.

8.3 Dynamic Speed Control Based On Battery Health

Based on the observed battery data, the system adaptively varies motor speed for the purpose of optimal energy consumption and battery longevity. The motor speed is managed by the system based on SoC and SoH. For instance, during low SoC, the system decreases the motor speed to save energy so that the vehicle travels farther on the current charge. On the other hand, when battery is charged full and healthy, the motor delivers maximum efficiency to provide better performance. This smart speed control helps avoid over-discharge and harsh battery strain for its longevity and safety. It recalculates SoC and SoH dynamically to adjust speeds in real-time, providing balanced driving. Through real-time battery health-based optimized power consumption, the system maximizes performance efficiency and battery life. This adaptive method improves energy efficiency while ensuring a smooth and safe ride, making electric vehicle technology more sustainable.

8.4 Power Management And Safety Mechanisms

The system incorporates strong power management and safety measures to operate reliably. A DC-DC converter regulates constant voltage levels for the Arduino, sensors, and communication modules. Safety features involve a relay that turns off the motor during emergency situations, like overheating or low State of Charge (SoC), to avoid over-discharge and motor burn-out. Overcurrent protection is always on the lookout for current flow, shutting power off when there are short circuits or high draw. Thermal management has a cooling fan that is powered on to avoid overheating. Voltage is also controlled to avert electrical variation. These elements, combined with cloud monitoring, give real-time warnings and protection, allowing electric vehicles to run safely and effectively.

In addition, the cloud platform retains historical information, allowing predictive maintenance to avoid failures before they occur. It also allows remote diagnostics, minimizing the need for manual checks. The system dynamically adjusts power flow, enhancing energy efficiency and prolonging battery life and enables quick response to potential issues.

9.HARDWARE SETUP

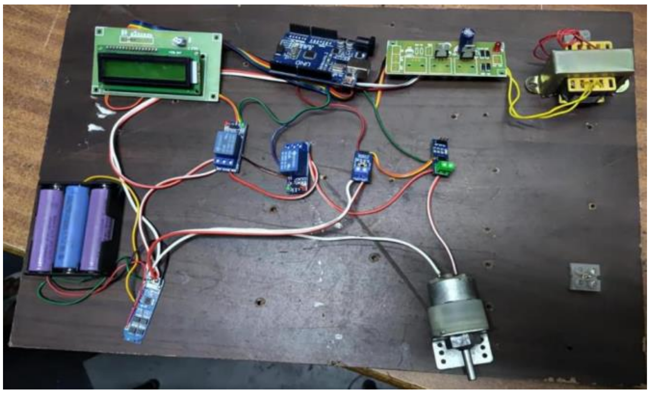

Fig -10: Block diagram of the system

When the system is powered on, the lithium-ion battery pack supplies power to the microcontroller, while the buck-boost converter provides a stable voltage to all components, including sensors, the LCD display, and the communication module. The microcontroller initializes the sensors and starts monitoring key battery parameters such as voltage, current, temperature, and State of Charge (SoC).

The voltage sensor measures the battery level, the current sensor tracks charging and discharging currents, and the temperature sensor monitors for overheating. Real-time data is displayed on the LCD, allowing the microcontroller to assess safety conditions. If the voltage drops below a safe level, the system alerts the user and disconnects the load to prevent deep discharge. If high temperatures are detected, the cooling fan is activated. In case of excessive current flow, the relay disconnects the load to protect the battery from damage. The processed data is transmitted to the cloud for remote monitoring via a web interface or mobile app.

Fig -11: Hardware implementation results of the system

The cloud platform stores battery metrics and alerts users through notifications if critical faults are detected. A MOSFET switch controls power distribution, ensuring normal operation under safe conditions and disconnecting the load during faults. When the SoC falls below a set level, the system conserves energy by shutting down non-essential components. This systematic operation maximizes battery life, ensures real-time monitoring, and enhances safety, making it ideal for electric vehicles.

Table -3: Battery monitoring parameter values

CURRENT (I)	VOLTAGE (V)
1.46 Amps	10.48V
4.88 Amps	10.31 V
2.93 Amps	10.26 V
2.44 Amps	10.29 V

10.RESULTS AND DISCUSSION

The cloud-based battery monitoring system effectively combines hardware and software components to achieve real-time monitoring, precise control, and fault-free data management for electric vehicles. It precisely monitors important battery parameters, such as voltage, current, temperature, State of Charge (SoC), and State of Health (SoH), for optimal battery performance and safety. Hardware implementation employs sensors to monitor continuously the parameters of interest, with the Arduino microcontroller calculating data to determine SoC and SoH in real time. Through experimental testing, the system provided accurate monitoring and fast response under critical conditions. For instance, upon voltage drop below a level deemed safe or upon temperature above the threshold, the relay correctly switched off the load to avert deep discharge and overheating. User alerts displayed on the LCD provided real-time feedback, enhancing safety and operational reliability.

The MATLAB simulation successfully simulated battery performance under different load conditions, mimicking actual charging and discharging cycles. It successfully tracked voltage, current, and SoC trends, maintaining precise monitoring of battery capacity variations. The closed-loop speed control system effectively controlled motor speed by dynamically adjusting output voltage in response to feedback, sustaining the target speed while maximizing energy efficiency. This strategy reduced power losses and improved motor efficiency. The smooth blend of hardware and cloud connectivity provided hassle-free data transmission and remote monitoring using a simple web-based interface.

The cloud platform stores battery data securely and offeres real-time access to historical data for users to analyze performance patterns and make informed choices. The remote monitoring feature improved operational efficiency and safety by allowing ongoing monitoring of battery health. The results validate the system's effectiveness in maximizing battery lifespan, improving vehicle safety, and optimizing energy usage. This makes the system a reliable and efficient solution for modern electric vehicle applications. Additionally, with cloud analytics, the system can predict maintenance needs before issues occur, reducing unexpected breakdowns.

11.CONCLUSION

The cloud-hosted electric vehicle speed management and battery monitor system provides an intelligent, real-time solution for maximizing battery performance and vehicle efficiency. Monitoring critical battery parameters, it precisely estimates State of Charge (SoC) and State of Health (SoH), guaranteeing safe and efficient use. Real-time data transmission to the cloud facilitates remote monitoring and smart decision-making, optimizing battery life and safety. The buck-boost converter optimizes power delivery with efficient power distribution, steady speed, and performance during different loads. The system's ability to maximize energy consumption and ensure battery health was confirmed by MATLAB simulations. Cloud analytics combined with hardware components ensures proactive battery management, minimizing failure risk, and increasing electric vehicle reliability. This advanced solution maximizes energy efficiency and ensures safe, long-lasting battery performance, contributing to sustainable electric vehicle technology and paving the way for smarter, more efficient transportation solutions.

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