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Smart internet of things driven vehicle safety and battery management system

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ABSTRACT

The proposed system design, the essential results obtained, and its relevance to modern automotive applications. The updated version now begins by identifying the dual challenge of increasing road accidents and the performance degradation of electric vehicle (EV) batteries, emphasizing the lack of integrated solutions that address both safety and battery reliability in a unified manner. Then, this study concisely describes the system design, highlighting the use of an internet of things (IoT)-enabled architecture incorporating an ADXL345 accelerometer for collision detection, global positioning system (GPS)/global system for mobile communications (GSM) modules for emergency alerting, and voltage, current, and temperature sensors for real-time battery monitoring, all interconnected through Arduino and ESP8266-based cloud communication. The abstract now summarizes key experimental results, including the system's demonstrated accuracy in impact recognition, reduced alert latency, and reliable battery-parameter tracking supported by effective cloud visualization. Finally, this study strengthened the automotive relevance by emphasizing how this integrated platform enhances emergency responsiveness, supports predictive maintenance, and offers practical value for EVs, commercial fleet operations, and broader intelligent transportation applications. The revised abstract now provides a balanced, complete, and technically informative overview aligned with academic and automotive industry expectations.

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1. INTRODUCTION

The internet of things (IoT) has risen as a progressive innovation that empowers a arrange of physical gadgets interconnected in such a way that they communicate and trade information consistently without human mediation. IoT has as of now been executed in down to earth life, such as in the field of domestic mechanization, shrewd water metering, and vehicle security, which demonstrates its position as the "framework of data community." Things that have sensors, Arduino programming, organizing equipment, and internet protocol (IP) addresses permit this thing to transmit information proficiently [1], in this way amplifying conventional web functionalities to a more extensive run of gadgets. With the development in IoT selection, its utilization in street security and administration of electric vehicles (EV) gets to be of vital importance. Road mischances, being one of the primary causes of passing in cities [2], require the establishment of modern mischance location and anticipation frameworks. IoT sensors introduced in inclined ranges can track activity patterns, distinguish peculiarities, and communicate with vehicle-mounted IoT gadgets to caution drivers approximately up and coming risks. In case of a mishap, the framework may send alarms to crisis administrations for quick offer assistance, subsequently impressively lessening the reaction time and sparing lives.

Moreover, IoT-driven arrangements for EV battery checking have come into conspicuousness since EVs have ended up an biological substitute for customary fuel-run vehicles [3]. Lithium-ion batteries, commonly utilized in EVs, offer points of interest like vitality proficiency and natural benefits but confront challenges such as cheating, profound releases, and restricted run due to battery estimate. Existing battery observing frameworks fundamentally inform clients through in-vehicle markers [4], but IoT innovation presently empowers real-time information sharing with clients and producers, improving security, execution, and maintenance. This paper proposes an coordinates IoT-based arrangement to address basic challenges in both vehicle security frameworks and battery administration [5]. The framework would minimize the rate of street mischances by proactive location and caution components, whereas keeping up battery wellbeing and security in EVs through real-time checking and notices. By leveraging IoT's tremendous potential, this approach advances more secure transportation and feasible vitality administration [6].

The growing adoption of EVs and the need for enhanced road safety have introduced new challenges in the domain of intelligent transportation systems (ITS). Despite advances in vehicle design and safety mechanisms [7], road accidents remain a significant cause of fatalities globally. Moreover, the performance of lithium-ion batteries—commonly used in EVs—can degrade over time due to factors like overcharging, excessive discharge, and thermal stress. These issues not only compromise the reliability of EVs but also pose risks to driver safety and system performance.

IoT technology has emerged as a transformative tool in addressing such problems by enabling real-time communication, data acquisition, and decision-making. Previous studies have demonstrated the use of IoT for accident detection through global positioning system (GPS) and global system for mobile communication (GSM) modules, as well as for EV battery monitoring through sensor-based diagnostics. However, most existing solutions treat vehicle safety systems and battery management as separate entities. This lack of integration can limit the effectiveness of emergency response and predictive maintenance strategies [8].

This study addresses this gap by proposing a smart IoT-driven vehicle safety and battery management system that combines accident detection and battery health monitoring into a unified architecture. This integrated system not only identifies collisions using accelerometers and GPS modules but also monitors key battery parameters such as voltage, temperature, current, and state of charge (SoC). By utilizing microcontrollers (Arduino Uno) and communication modules (ESP8266 and GSM), the system provides real-time alerts and performance data through cloud platforms like ThingSpeak [9].

This work improves upon earlier approaches by offering dual functionality in a single embedded framework, minimizing system complexity while maximizing operational reliability. Compared to traditional vehicle safety systems and standalone battery monitoring platforms, this study's integrated solution supports both preventive and reactive measures, enhancing the safety and sustainability of EVs [10]. The contributions of this paper are demonstrated through hardware implementation, sensor calibration, cloud integration, and visual analytics, all of which are discussed in subsequent sections.

The subsequent sections of this manuscript are organized to clearly demonstrate the development, implementation, and relevance of the proposed smart IoT-driven vehicle safety and battery management system. The literature review section discusses existing studies and highlights the limitations of current solutions, thereby justifying the need for an integrated approach. The system implementation section provides a detailed description of the hardware and software components used, along with the data flow and system architecture. This is followed by the hardware and software requirements and calibration techniques, which validate the technical feasibility and accuracy of the system. In the visualization and analysis section, this study present real-time monitoring results using dashboard interfaces, including accident alerts and battery parameter readings, to demonstrate system effectiveness. The results and discussion segment interprets these outputs to show how the system enhances emergency responsiveness and battery reliability. Finally, the conclusion and future scope sections summarize the key contributions and propose potential advancements such as artificial intelligence (AI) integration, vehicle-to-everything (V2X) communication, and autonomous rescue operations, reinforcing the broader impact and future relevance of our solution.

2. LITERATURE REVIEW

The developing request for EVs has highlighted the significance of effective battery administration frameworks to keep up the security, execution, and lifespan of lithium-ion batteries. Various considers have investigated IoT and progressed checking innovations to address these challenges successfully. IoT-enabled battery management systems gives real-time checking of basic parameters such as voltage, temperature, and SoC, advertising critical focal points over conventional in-vehicle indicators. Zhai *et al.* [11] recognized communication challenges in ITS frameworks and proposed joining IoT and 5G innovation to upgrade information transmission effectiveness. Table 1 gives the comparative details for the study in existing methodology to the proposed system, along with implementation results.

Table 1. Literature survey for the study

Reference	Study	Implemented/proposed system	Result of the implementation
[12]	ITS + IoT + 5G integration	Proposed combining IoT with 5G to address data transmission challenges in ITS.	Enhanced communication efficiency is crucial for real-time EV battery and traffic monitoring.
[13]	GSM and GPS-based accident detection	Implemented a GSM and GPS-based system to detect and report accidents.	Immediate alerting system improves emergency response and reduces fatality rates.
[13]	Cloud-based IoT monitoring for EV batteries	Used cloud IoT platforms for centralized data collection and maintenance alerts.	Enabled predictive maintenance and improved EV battery lifespan and safety.
[14]	IoT with machine learning for battery prediction	Integrated machine learning with IoT to predict battery degradation patterns.	Early warning of battery faults leads to proactive maintenance and better performance.
[15], [16]	Dynamic charging systems with IoT	Investigated IoT in real-time EV charging and energy demand prediction.	Smart charging minimizes energy waste and supports stable battery operation.
[17], [18]	Optimized charging and real-time diagnostics	Developed optimized charging algorithms and monitoring tools for EV batteries.	Reduced energy consumption and improved overall battery health and lifespan.
[19]	AI and IoT in battery thermal management	Reviewed AI-based battery management systems integration for thermal and performance management.	AI-enhanced battery management systems improve safety, efficiency, and adaptability in EV environments.

In spite of the fact that centered on ITS, their discoveries underline the significance of solid communication systems, which are fundamental for real-time EV battery observing. Essentially, Lee and Wu [20] emphasized the utilize of GSM and GPS modules for mishap discovery, exhibiting their potential pertinence in IoT-based battery status checking systems. Das *et al.* [21] investigated the utilization of cloud-based IoT stages for centralized information collection and proactive support of EV batteries. Their study illustrated how such frameworks can inform clients and producers of breaking down battery conditions, subsequently diminishing dangers and expanding battery life. Mohammed *et al.* [22] advanced illustrated the utility of IoT systems coordinates with machine learning calculations to anticipate battery debasement designs, empowering preventative upkeep, and progressed safety. Inspected the part of IoT in energetic EV charging frameworks, centering on real-time vitality request determining and network [23]. Their investigate highlighted how optimized charging designs can diminish vitality squander and keep up battery wellbeing. Collectively, these considers emphasize the transformative potential of IoT in moving forward EV battery administration by upgrading security, proficiency, and client encounter [24].

To address the limitations in existing systems, this study introduces a novel, integrated IoT-driven framework that simultaneously manages vehicle safety and EV battery health—an area not comprehensively addressed in prior research. Unlike previous solutions that treat accident detection and battery monitoring as separate systems, our approach merges both functionalities into a unified architecture [25]. The proposed system incorporates an accelerometer-based crash detection mechanism, real-time GPS tracking, and automated emergency alerts via GSM, enhancing post-accident response time. In parallel, it continuously monitors key battery parameters such as voltage, current, temperature, and SoC, and uploads data to a cloud platform (ThingSpeak) using an ESP8266. What sets this system apart is its predictive capability—using data analytics to detect potential battery faults before failure occurs—and its ability to notify users through a mobile interface [25]. This dual-purpose system represents a new contribution to the field by offering a holistic, real-time, and user-friendly solution for both vehicle safety and EV battery reliability.

This comparative discussion highlights the proposed system improves upon current approaches in terms of responsiveness, fault detection, and energy efficiency. Unlike conventional accident detection systems that rely on manual reporting or delayed onboard diagnostics, our integrated architecture automates crash identification using an ADXL345 accelerometer and immediately transmits location-specific alerts via

GSM and GPS, thereby significantly reducing emergency response time. Furthermore, compared with traditional battery management systems platforms that typically offer only localized indicators, the IoT-enabled battery monitoring provides continuous cloud-based data analytics, allowing early identification of abnormal voltage, temperature, or current deviations—improving predictive fault detection and preventing thermal or electrical failures. In terms of energy efficiency, existing systems often operate as isolated modules with redundant sensing and processing, while the unified IoT-driven framework minimizes hardware duplication, optimizes data transmission, and supports adaptive control strategies that enhance battery performance and reduce unnecessary power consumption. These comparative insights clearly establish that the proposed system offers measurable advancements beyond prior standalone vehicle safety or battery management systems solutions.

3. IMPLEMENTATION OF THE SYSTEM

3.1. System hardware and functioning

A keen IoT-driven vehicle security and battery administration framework combines cutting-edge innovation to guarantee a more secure, more effective, and ecologically neighborly driving encounter. The framework joins progressed sensors such as light detection and ranging (LiDAR), radar, ultrasonic, and cameras for comprehensive collision location and avoidance, nearby real-time cautions and independent crisis braking for upgraded security. Driver behavior is checked through AI-powered frameworks that identify weakness, diversions, or abnormalities, activating alarms to avoid mishaps. Natural sensors and GPS-enabled IoT integration give real-time overhauls on street conditions, activity, and climate, guaranteeing educated decision-making amid ventures.

Despite notable advancements in vehicle safety technologies and battery management systems, several challenges remain unresolved. Existing accident detection systems often lack integration with emergency response mechanisms and rely on manual intervention, which delays timely assistance. Similarly, many EV battery monitoring systems operate in isolation, providing limited real-time data and lacking predictive capabilities for performance degradation. These fragmented solutions fail to offer a comprehensive and proactive safety net for drivers and vehicle health.

Furthermore, interoperability between different IoT components and the seamless transmission of data to cloud platforms are often inconsistent, leading to reliability concerns. The current study addresses these gaps by developing an integrated smart IoT-driven vehicle safety and battery management system. It combines real-time accident detection with predictive battery health monitoring in a unified framework, utilizing cloud-based analytics and wireless communication. This holistic approach aims to improve emergency responsiveness, enhance battery performance, and promote a safer, more efficient driving experience. Figure 1 presents a block diagram of the smart IoT-driven vehicle safety and battery management system.

On the battery administration side, the framework leverages IoT to persistently screen basic parameters like voltage, current, temperature, and SoC, guaranteeing the battery works inside secure limits. Prescient analytics fueled by IoT cloud administrations evaluate battery wellbeing, optimizing upkeep plans and amplifying life expectancy. Versatile charging calculations upgrade effectiveness, decrease vitality wastage, and back integration with renewable vitality sources. Besides, the framework encourages over-the-air upgrades for firmware and information sharing, advancing nonstop enhancement and consistent client encounters. Together, these highlights make a strong, cleverly vehicle administration system that prioritizes security, execution, and supportability.

3.2. Hardware and software requirements

The complete hardware and software requirements can be discussed in this chapter. Figure 1 shows the block diagram. It illustrates the smart IoT-driven vehicle safety and battery management system.

3.2.1. Hardware requirements

The hardware requirements of the proposed system are described as follows:

i) Battery (11.2 V): powers the whole framework and the vehicle's electronic components. The voltage is reasonable for small-scale IoT applications.
ii) Switch: controls the system's control state, guaranteeing manual supersede capabilities.
iii) Sensors
   - Voltage sensor: screens the battery voltage to anticipate cheating or profound discharge.
   - Temperature sensor: tracks battery and natural temperature for secure operations.
   - Current sensor: measures the current stream to optimize control utilization and avoid overloading.

– ADXL345 (accelerometer): identifies sudden vehicle developments, crashes, or tilts for mischance detection.

iv) Direct current (DC) engine (as vehicle): simulates the vehicle's impetus framework in small-scale prototypes.
v) GPS module: tracks the vehicle's real-time area, supporting in-route and mishap alarm systems.
vi) LM2596 voltage regulator: ensures a steady control supply for delicate components like microcontrollers and communication modules.
vii) Arduino Uno: serves as the essential microcontroller for handling information from sensors and controlling outputs.
viii) Liquid crystal display (LCD) with driver
   – Displays framework status, counting battery levels, alarms, and area data via GSM module.
   – Facilitates SMS communication for alerts, such as sending crash notifications or battery health updates.
ix) ESP8266 Wi-Fi module: enables wireless connectivity to upload data to cloud platforms like ThingSpeak.
x) LED indicators: provide visual cues for system status, such as charging, discharging, or fault conditions.
xi) Smartphone: acts as a user interface to receive notifications, monitor system parameters, and control functions remotely.

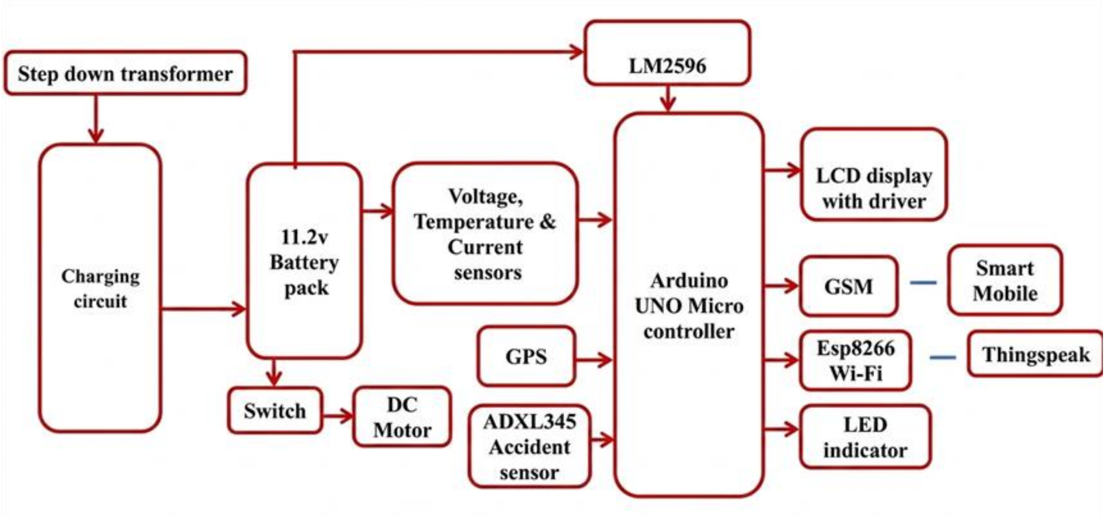

Figure 1. Block diagram of the smart IoT-driven vehicle safety and battery management system

3.2.2. Software requirements

The software requirements essential for implementing the smart IoT-driven vehicle safety and battery management system are outlined as follows:

i) Arduino IDE: used for programming the Arduino Uno to oversee sensor inputs, yields, and framework logic.
ii) ThingSpeak platform: cloud-based IoT stage for real-time information visualization, capacity, and analytics.
iii) Embedded code for sensors: specific libraries and calculations for meddle with components like ADXL345, GPS, and GSM.
iv) IoT communication protocols: message queuing telemetry transport (MQTT) or hypertext transfer protocol (HTTP) for sending information from the ESP8266 to ThingSpeak or other cloud servers.
v) Mobile App or dashboard: a smartphone app or web interface to show cautions, framework measurements, and control functionalities.
vi) Data analytics scripts: algorithms for handling sensor information on ThingSpeak to produce bits of knowledge such as accident detection or battery health predictions.

3.3. Integration workflow

The integration workflow of the system includes:

i) Sensors collect real-time information on battery wellbeing, area, and natural conditions.
ii) Arduino Uno forms this information, showing it on the LCD and activating alarms by means of LEDs or GSM.
iii) ESP8266 sends information to ThingSpeak for real-time checking and analytics.
iv) Alerts (e.g., moo battery and mishaps) are pushed to the client through GSM or a versatile app.
v) Users can see nitty-gritty information and patterns on ThingSpeak or control the framework remotely through Wi-Fi.
vi) This combination of equipment and computer program guarantees a dependable, versatile, and user-friendly arrangement for vehicle security and battery administration.

3.4. Calibration techniques

The calibration techniques applied in the smart IoT-driven vehicle safety and battery management system are outlined as follows:

i) Sensor calibration: ADXL345 accelerometer: position the sensor in a stationary position to degree zero acceleration. Make the crucial changes for offsets and scale utilizing calibration software. Try subjecting known powers or expanding speeds, if conceivable, and compare the result for verification.
ii) Voltage, temperature, and current sensors: get the reference values from a multimeter or any other standard estimation contraption. Program changes for genuine sensor readings.
iii) GPS calibration: affirm the GPS module utilizing the zone data of any known reference point. Update the firmware or adj. setups, if fundamental, for exact following.
iv) Battery checking calibration: charge the battery to its full capacity and take the estimation of voltage as the higher oblige. Exhaust the battery completely to degree the lower limit. Cross-check live estimations against standard equipment.
v) Communication modules calibration:
   - GSM module: transmit test messages to the flexible contraption through SMS. Make past any question that it persistently shows up arrange without any bugs in communication.
   - ESP8266 Wi-Fi module: affirm data sent by cross-checking sent data with cloud-stored data. Check for organize arrange issues and optimize affiliation settings.
vi) Light emitting diode (LED) pointer calibration: program the microcontroller to test each driven state, such as on, off, and squinting, for alert feedback.

4. VISUALISATION AND ANALYSIS

The dashboard shows the vehicle's execution, with the client choosing an alternative, which makes the framework practical in any given driving condition. Vehicle in genuine time, such as speed, battery rate, temperature, and security notices. Prepared with progressed highlights such as pothole notices, battery state-of-health (SoH) checking, and save our souls (SoS) notices. The findings from the implementation of the smart IoT-driven vehicle safety and battery management system reveal significant advancements over conventional, single-purpose solutions.

Unlike existing accident detection systems that depend on manual alerts or limited onboard diagnostics, the system automates crash identification and immediately dispatches emergency notifications using GSM and GPS modules, potentially reducing response time and improving survival rates. In comparison to traditional battery monitoring systems that only provide visual alerts, this framework offers real-time data transmission to the cloud and predictive analytics, allowing users to identify potential battery failures before they cause breakdowns. This dual functionality not only simplifies system integration but also improves user safety, system reliability, and energy efficiency.

The ramifications of this research extend beyond technical improvements. In the long term, such an integrated system could be standardized across EV platforms to enhance road safety infrastructure and contribute to smart city initiatives. Future advancements could include the integration of artificial intelligence for driver behavior prediction, expansion to V2X communication for collaborative traffic safety, and deployment in autonomous rescue operations via drones. These enhancements would collectively support a safer, smarter, and more sustainable transportation ecosystem.

Figure 2 presents an overall system architecture illustrating the integration of IoT components used for vehicle safety and battery management. It likely includes sensors, microcontrollers, and communication modules. Figure 3 shows the LCD used in the system to display various real-time parameters such as temperature, voltage, current, or alerts. Figure 4 depicts the Arduino microcontroller, which serves as the central processing unit for managing sensor data and controlling system operations. Figure 5 illustrates how the motors are arranged and connected in the system, likely showing their role in vehicle actuation or motion.

Figure 2. Schematic diagram of smart IoT-driven vehicle safety and battery management system

Figure 3. LCD used in the system

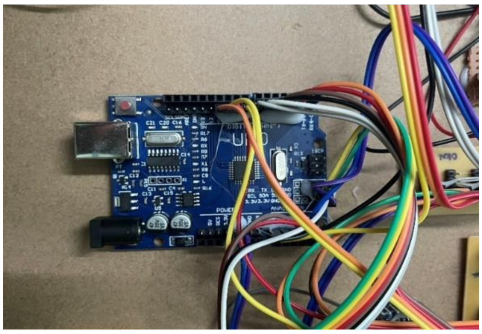

Figure 4. Arduino microcontroller

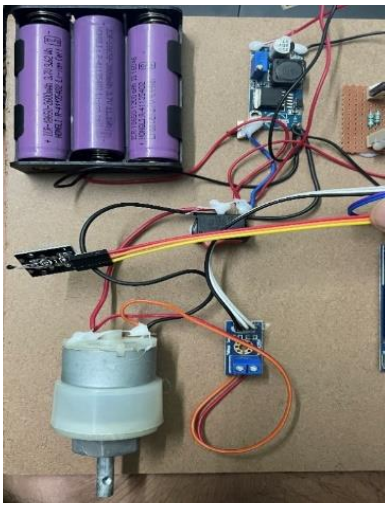

Figure 5. Motor arrangement

Figure 6 visualizes the accident detection and alerting mechanism, possibly showing how the system notifies a remote server or user upon detecting a crash. Figure 7 provides a tabulated or graphical view of the measured values of temperature, current, and voltage from the system under different conditions. Figure 8 is a graph or data chart showing the temperature readings over time, demonstrating how the system monitors thermal conditions. Figure 9 shows the voltage output from the battery or system, helping analyze voltage stability and performance. Figure 10 is a chart or reading showing the current flowing through the system, indicating load conditions and power draw.

Figure 6. Accident alert

Figure 7. Values of temp, current, and voltage

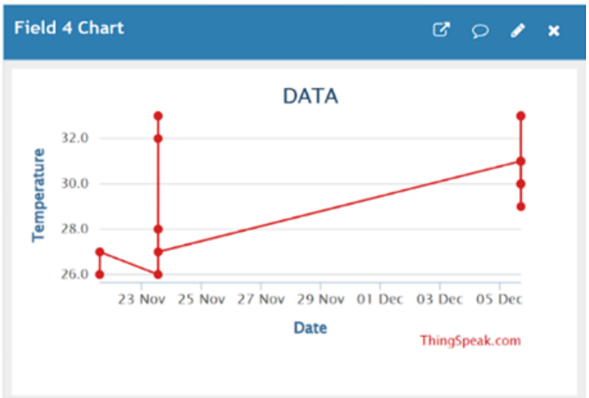

Figure 8. Temperature output

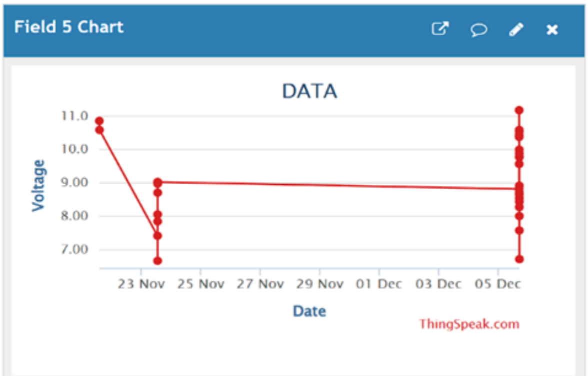

Figure 9. Voltage output

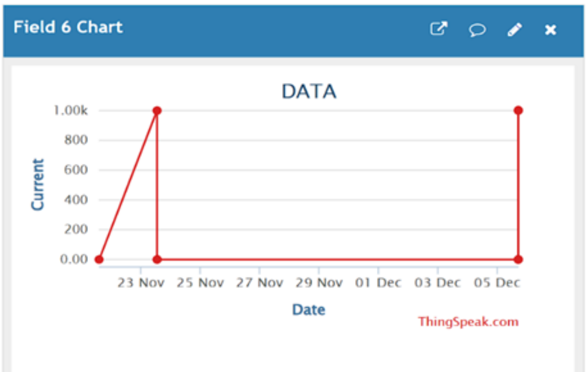

Figure 10. Current flowing through the system

A savvy IoT vehicle security and battery administration framework combines IoT innovation to upgrade security and optimize battery execution. By coordinating real-time checking, the framework identifies vehicle irregularities, cautions drivers to hazardous conditions, and anticipates collisions utilizing sensors, cameras, and mechanized reactions. It moreover underpins crisis administrations by giving moment notices and location details in case of mishaps. On the battery front, it screens key measurements like SoC and SoH, guaranteeing productive vitality utilize and amplifying battery life expectancy. Progressed analytics optimize charging plans and empower further diagnostics for preventive support, advancing vitality effectiveness and unwavering quality.

5. NOVELTY OF THE SYSTEM

The primary novelty of the proposed system lies in the integration of vehicle safety mechanisms and EV battery management into a single, unified IoT-driven architecture, which is not comprehensively addressed in existing literature. While prior studies typically handle accident detection and battery monitoring as independent modules, our system uniquely fuses these two critical functionalities, enabling simultaneous real-time crash detection, emergency alerting, and battery health analytics within one framework. Additionally, the novelty extends to the system workflow and data fusion approach, where sensor data from accelerometers, GPS, current/voltage sensors, and thermal sensors are processed collectively to support both proactive safety responses and predictive battery fault diagnosis.

Although this study utilizes standard IoT protocols such as MQTT/HTTP and widely used components like the ESP8266 and GSM modules, the innovation is not the individual technologies but rather their coordinated integration, enabling dual-purpose operation, cloud-based visualization, and automated rescue support. This holistic architecture enhances system reliability, reduces hardware redundancy, and demonstrates practical value for smart transportation and EV ecosystems. Southeast Asia’s tropical climate—with consistently high temperatures and humidity—significantly affects lithium-ion battery performance by accelerating thermal degradation, increasing internal resistance, and elevating the risk of overheating. This system's continuous monitoring of temperature, voltage, and current, along with its cloud-based predictive analytics, provides early detection of thermal stress and enables proactive management of battery health, which is highly relevant for EVs operating under such climatic conditions.

Additionally, the region faces persistent road safety issues, including dense traffic, varied road infrastructure, frequent two-wheeler interactions, and high accident rates. The integrated accident detection mechanism using accelerometer-based crash sensing and GPS-linked emergency alerts offers improved responsiveness in areas where emergency services often experience delays. Moreover, the system’s capability for real-time tracking and condition monitoring is especially valuable for public transport fleets, ride-hailing services, and logistics vehicles that operate in congested urban corridors common across Southeast Asian cities. By supporting predictive maintenance, rapid emergency notification, and continuous operational visibility, the proposed system aligns well with the transportation needs and safety priorities of Southeast Asia, while contributing to regional efforts toward sustainable, reliable, and smart mobility solutions.

6. CONCLUSION

The proposed smart IoT-driven vehicle safety and battery management system successfully integrates real-time accident detection and EV battery health monitoring into a unified framework. By combining sensors, microcontrollers, wireless communication, and cloud platforms, the system offers automated emergency alerts and predictive battery maintenance. Hardware implementation and data analysis confirm the system’s ability to improve driver safety, reduce emergency response time, and extend battery life. This dual-purpose solution addresses existing gaps in vehicle safety and energy management, demonstrating its potential for enhancing smart transportation and supporting sustainable mobility initiatives.

7. FUTURE SCOPE

The future scope of this research holds immense potential for technological advancements and societal benefits. With the integration of AI and machine learning, the framework can advance to anticipate battery wellbeing and failures, ensuring real-time optimization of vitality utilization and amplifying battery life. The consideration of progressed IoT systems will empower consistent communication between vehicles and infrastructure, encouraging mischance expectation and avoidance through collaborative information sharing. Future improvements can center on V2X communication to move forward activity management, enhance security, and decrease congestion. Incorporating renewable vitality sources, such as solar-powered charging, will encourage advanced supportability in EV systems. Autonomous protect rambles coordinates into the framework might give prompt help amid accidents, reducing reaction times and possibly sparing lives. Advanced sensors for observing driver's wellbeing and vehicle execution can improve client security and reliability. Expanding cloudbased information capacity and analytics will empower more comprehensive information logging, improving system diagnostics. Finally, the framework can be adjusted for utilization in independent vehicles, guaranteeing vigorous security conventions and battery efficiency. Such progressions will clear the way for a more astute, more secure, and more proficient transportation frameworks, contribution significantly to feasible advancement.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

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