INTERNATIONAL JOURNAL OF ADVANCED INNOVATIVE TECHNOLOGY IN ENGINEERING

Published by Instigative Research Private Limited Home page: www.ijaite.co.in

IoT-Enabled Real-Time Fire Detection and Safety System for Electric Vehicles

[1]Dr. Lowlesh Nandkishor Yadav, [2]Prof. Shubhangi Satdeve, [3]Prof. Akshata Kumbhar

[123]Department of Computer Engineering, Suryodaya College of Engineering and Technology, Nagpur, Maharashtra, India

[1]lowlesh.yadav@gmail.com [2]satdeveshubhangi@gmail.com
[3]akshatakumbhare26@gmail.com

Article History

Received on: 20 July 2026
Revised on15 Aug 2026
Accepted on: 20 Sept 2026
Keywords: Fire Situation, Controller, Emergency Alert, Accident Prevention, IOT Technology.

e-ISSN: 2455-6491

DOI: 10.65809/IJAITE/26/v03sp02/037

Production and hosted by
www.insightiveinc.org

©2026|All right reserved.

ABSTRACT

People cause fire incidents which occur in residential and commercial areas because climate change creates predictable weather patterns. The proposed prototype protects fire-fighters because it enables them to identify fire outbreaks and extinguish fires from a distance. This concept's primary goal is to put forward a paradigm that emphasizes the economical planning and execution of an automated fire safety system for electric cars. The fire extinguisher with this system automatically puts out a fire when it senses smoke or flame in the automobile's fire area. A fire mishap can occur in an electric car because various factors can create dangerous situations. Electric vehicle fires start mainly because of battery problems. Vehicles have combusted multiple times because of the aforementioned reasons which resulted in complete vehicle destruction. The implementation of an automatic extinguish system improves vehicle safety standards while protecting occupants and pedestrians from fire hazards and decreasing potential fire-related financial damages.

1. INTRODUCTION

The nation experiences fire accidents as common events throughout its territory. The situation endangers multiple lives and valuable assets. The current firefighting problem exists because our nation lacks advanced technologies which developed countries possess. Firefighting requires basic capabilities which need to be developed. The military forces and law enforcement agencies provide their support through weapon usage at particular times. The existing resources do not meet our needs. The process of creating electric vehicle batteries introduces new safety risks which require testing to ensure minimal fire hazards. Research identified electrical systems as one of the four main reasons which caused vehicle fires.

The system which we propose will establish a streetable vehicle that functions in residential and commercial properties because it needs to alert users when fire breaks out. The driver can use their mobile device to operate the vehicle which will travel to the fire location while they use their phone to activate the water spraying system. The user has the ability to control both the spraying process and the water flow speed and total spray volume. The user has the ability to control vehicle movement through their mobile device which enables them to battle the fire with

the developed vehicle system. The guided car lets users make real-time decisions because IoT (Internet of Things) technology enables it to organize and assess information while processing data.

The extinguishing crew challenges the problem because their presence increases danger, which should be avoided to protect against potential fire damage until the extinguishing unit arrives for their mission. Typical vehicular fires become safer through an automated door opening system that reduces the chances of people sustaining injuries or dying in such incidents. Firefighters dedicate their professional existence to extinguishing active fires. The research aims to reduce human involvement because it protects against fire hazards.



Figure 1: Electric Vehicle on Fire situation

2. Problem Definition

Studies show that electrical systems cause vehicle fires together with three other main fire sources. People think that only electric and hybrid vehicle batteries create dangerous situations which lead to fires. The electric Tesla Model S, which the media had declared to be the safest vehicle in the world, took fire a few years ago at the culmination of 2013. Electric and hybrid vehicles continue to present operational challenges which create safety hazards for their users. The risks increase with each new model or design. The public requires considerable time to move past these famous events which they know well.

- Battery overcharging
- Battery electrolyte leakage
- Short circuit in electric components
- Road crash



Figure 2: Buses caught fire and totally buried

3. LITERATURE REVIEW

The movement of the vehicle depends on the combination of user control and sensor-based inputs. The controller receives the signal as soon as the fire detection sensor senses a fire. The IOT components activate to notify the user about a fire incident. After receiving the alarm, the user can operate the Blynk application together with the built-in video system to direct the vehicle to its correct location for fire extinguishing. A servo motor which connects to the extinguishing hose enables users to control both the water spray direction and its spray volume. The user comes with the controllers for the servo motors. The user can operate the fire truck because it uses Internet of Things technology which enables remote access to all equipment from any location.

Z. Xie et al., 2024, provide a multiple-parameter fusion early-warning framework for lithium-ion cells that combines gas, temperature, and voltage indicators. In order to eliminate false alarms & better capture uncertainty, the research employs a model of clouds and Dempster-Shafer evidence theory to fuse heterogeneous data after experimentally determining threshold range and risk levels via controlled overcharge/TR temperature runaway testing. Compared to single-sensor approaches, the results provide earlier and more dependable alerts, particularly in cases where pre-runaway indications are unclear. The authors stress that evidence-theory fusion and multi-modal sensing enhance robustness for practical battery packs where single-factor thresholds are ineffective.

W.C. Tam et al., 2024, create an early-stage detecting model to spot impending thermal runaway by combining deep learning with acoustics. Acoustic signals recorded during aberrant cell behavior were generated in single-cell assays conducted across different SOCs and orientations. The model effectively distinguishes early-stage TR signals from regular operations with minimal delay following information enhancement and a deep classifier. According to the study, acoustics is a non-invasive, supplementary sensing technique that can identify failure modes before significant temperature changes or gas leaks.

J.D. Oh, 2024, focuses on upward spraying from underneath a vehicle and examines mechanical & nozzle design techniques to enhance liquid spray control of EV battery fires. In comparison to generic above sprays, focused upward chilling can more efficiently penetrate module and cool propagating cells. The findings support design decisions for automatic extinguisher actuation.

J. Zhao et al., 2024, examines machine learning prognostics in battery safety, with a focus on meta-learning to manage limited failure data and multiple modes of input (voltage, current,

temperature, and impedance). Hybrid physics-informed machine learning models perform better than pure data-driven methods for remaining-useful-life estimation and thermal-runaway prediction.

A. Alawi et al., 2025, examines air, liquid, or phase-change cooling techniques in active, passive, and mixed BTMS systems. The study emphasizes temperature uniformity in packs to avoid localized hotspots that cause propagation and supports linking BTMS triggering with real-time sensor feedback.

X. Li et al., 2025, summarize developments in distributed thermal control and make the case for integrated subsystem design. Coordinated control can lower peak temperatures and shift loads without significant hardware changes. IoT telemetry and digital twin are highlighted as facilitators of real-time closed-loop optimization.

S. Lee et al., 2024, contrast the suppression effectiveness, emissions, and heat-release rates of several extinguishing techniques. The study demonstrates that water-cooling can suppress propagation while suggesting rapid detection, targeted water chilling and module isolation.

Nizar Al Bassam & S.A. Hussain, 2020, present an embedded IoT prototype combining flame/smoke sensing with GPS/Internet notifications and actuator control to suppress vehicle fires. The experimental system demonstrates that microcontroller-based logic can coordinate alarms, local suppression deployment and remote owner notifications.

C.H. Lee et al., 2023, develop and field-test an IoT real-time fire detection system using Raspberry Pi and a fisheye camera for early forest-fire detection. The work demonstrates the value of edge devices for immediate actuation while cloud services handle logging and alerts.

Jerome Workman, 2025, summarizes optical/infrared sensor advances for non-contact thermal monitoring in EV applications. Optical sensing complements thermistors and gas sensing by revealing surface hotspots and thermal gradients, supporting multi-sensor fusion strategies.

Table 1: Comparative analysis of existing approaches and the proposed EV fire safety system.

Approach / Study	Main focus	Sensing / Data	IoT / Remote Alert	Main limitation / Gap
Single-sensor fire detection	Detect fire using one main parameter	Temperature or smoke	Limited / not integrated	Single parameter can miss early or uncertain fire conditions.
Z. Xie et al. (2024)	Early warning of lithium-ion thermal runaway	Gas, temperature and voltage	Supports IoT-enabled EV safety	Evidence fusion improves robustness, but the work focuses on battery early warning rather than a complete vehicle safety prototype.
W.C. Tam et al. (2024)	Early thermal-runaway detection	Acoustic signals + deep learning	Not the main focus	Acoustic sensing is supplementary and requires a trained model and suitable test data.
J.D. Oh (2024)	Improve EV fire suppression	Spray/nozzle and cooling design	Not the main focus	Focuses on suppression hardware rather than complete sensor-to-alert control.
J. Zhao et al. (2024)	Battery prognostics and thermal-runaway prediction	Voltage, current, temperature, impedance + ML	Cloud/edge concept	Needs failure data and model validation; prediction is not itself a complete suppression system.
Proposed system	Real-time detection, alert and automatic response	Temperature, smoke and photoelectric/flame sensing	IoT alerts + remote monitoring	Prototype requires further full-scale EV validation and field testing.

4. Research Gap

Current fire safety measures for electric vehicles depend on two methods which include passive extinguishers and manual monitoring because they lack IoT systems which provide automatic fire detection and fire control capabilities. Most studies focus only on temperature or smoke detection but do not integrate multi-sensor fusion which combines temperature and smoke and flame detection for better accuracy. Conventional systems detect fire only after significant damage has begun because they lack early-warning systems and automatic suppression methods which remain undeveloped. Few works connect vehicle-level fire detection directly to cloud platforms for remote alerts to authorities and stakeholders. Theoretical and simulation-based models exist because most models have not yet developed working prototypes which researchers can test in real EV environments. Existing advanced security systems require high expenses for implementation while their design makes them

unsuitable for widespread electric vehicle use throughout developing nations.

5. Block Diagram

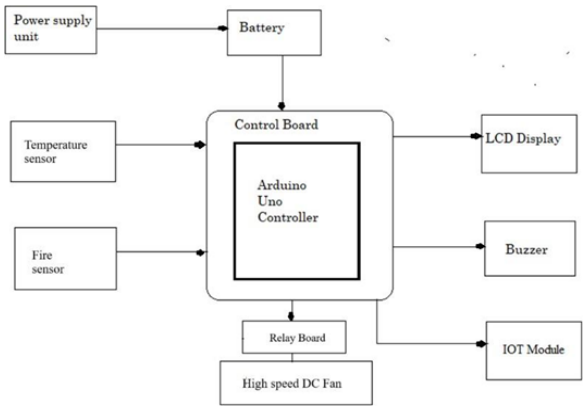

Figure 3: Block Diagram of system

6. Working

The system is designed to monitor and manage the temperature of the battery inside an Electric Vehicle (EV) to prevent overheating and potential damage. It uses a combination of sensors, a microcontroller, and cooling mechanisms for efficient operation.

When the battery temperature rises, sensors such as a smoke sensor, photoelectric sensor, and temperature sensor detect the situation. The smoke sensor and photoelectric sensor monitor the presence of smoke, while the temperature sensor continuously measures the thermal condition of the battery. If any abnormalities are detected, the sensors send their readings to the Arduino microcontroller for processing.

The microcontroller, programmed with specific logic, evaluates the data received from the sensors. Based on the input, it determines the appropriate response. If smoke or signs of overheating are detected by the smoke or photoelectric sensor, the microcontroller activates a buzzer to alert nearby users, displays warnings on the LCD screen, and triggers the IoT module to send remote notifications to the system or user for immediate action.

In cases where the temperature sensor indicates overheating, the microcontroller initiates the high-speed DC fan in addition to the buzzer, IoT module, and LCD display. The DC fan starts operating at high speed to generate increased airflow around the battery, rapidly dissipating heat and reducing the temperature to safer levels.

This system ensures real-time monitoring and rapid response to battery overheating. The IoT module facilitates remote tracking and alerts, allowing for timely interventions and improved safety and efficiency of the EV.

7. Main Features

Multi-Sensor Monitoring: Integrates temperature, smoke, and flame sensors to continuously track battery and cabin conditions for early detection of fire hazards.

Real-Time Alerts: Provides immediate notifications to the driver through a buzzer, LCD display, and indicator lights when abnormal conditions are detected.

Automated Cooling System: High-speed DC fan activates automatically to reduce battery temperature and prevent thermal runaway.

Automatic Fire Suppression: Relay-controlled fire extinguisher system triggers instant suppression in case of detected flames or smoke, minimizing potential damage.

IoT-Enabled Communication: Cloud-connected module transmits real-time alerts to vehicle owners, emergency responders, and authorities for rapid intervention.

Remote Monitoring and Control: Allows users and authorities to monitor vehicle safety remotely and take necessary actions via IoT applications.

Cost-Effective and Compact Design: System is designed for easy integration into various EV models without affecting vehicle performance or increasing maintenance costs.

Low Power Consumption: Optimized circuitry ensures minimal energy usage while maintaining continuous monitoring and rapid response capabilities.

Scalable Architecture: Can be adapted for different EV types, battery sizes, and fleet applications.

Enhanced Safety and Reliability: Reduces risk to passengers, protects property, and boosts confidence in EV technology adoption.

8. Components Features

A. Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, USB connection, power jack, ICSP header and reset button.

B. Liquid Crystal Display

LCD stands for Liquid Crystal Display. LCDs are widely used because they can display numbers, characters and graphics and are available at declining prices.

C. IOT Module

IoT refers to connected machines and devices that can communicate remotely through wireless communication media.

D. Brushless DC Pump

Brushless DC pump series have 12V. The series can be based on customer specifications, pressure/flow and the required electrical design and water pipe.

E. Relay

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. It allows a low-power signal to control another circuit.

F. Smoke sensor (MQ2)

MQ2 gas/smoke sensor is used for sensing gases such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide. Its sensing material changes resistance in the presence of gas.

G. Flame Sensor

The Flame Detection Sensor Module is sensitive to flame and can also detect ordinary light. It detects a flame or light source in the 760 nm–1100 nm range, with adjustable sensitivity and 5V operating voltage.

9. Calculation

The main aim of the fire fighting robotic arm is to facilitate the function of fire man. The fire fighting robot is capable of providing forward and backward, left and right side motions when the operator presses the key via a zigbee communication system. The jib also provides left, right, up and down motion to aim the water to the fire source to extinguish it. Its movement is also connected by remote control. The support resists back pressure and provides stability for the robot system.

$$R = (1.57 \times P \times d^2)/10 \quad (1)$$

$$H = V^2/2g \quad (2)$$

$$He = 2/3(H - 0.113H^2/d) \quad (3)$$

$$Q = 2/3 \times d^2 \times (p)^1/^2 \quad (4)$$

Where P is the pressure in bar at the nozzle and d is the diameter of the nozzle in mm. H is height in meters; V is velocity in m/s and g is acceleration due to gravity. He is the effective jet in meter. Q is the discharge in litre/minute; d is diameter of nozzle in mm; p is pressure in bar.

The firefighting robotic arm consists of a 5 mm diameter nozzle and pressure of 2 bar. By substituting in equation (1), the reaction force due to water hammer is $R = (1.57 \times 2 \times 5^2) = 7.85$ newton. The theoretical height of water jet is $H = 19.82/(2 \times 9.81) = 20\ m$. The effective height is $He = 2/3(20 - 0.113 \times 20^2/5) = 7.3\ m$. The rate of discharge is $Q = 2/3 \times 5^2 \times (2)^1/^2 = 23.57\ litre/hr$.

10. Results and Discussion

The proposed Smart Fire Safety System for Electric Vehicles (EVs) was successfully implemented as a working prototype using an IoT-based framework. The system was integrated with temperature, smoke, and photoelectric sensors, an Arduino microcontroller, a high-speed DC fan, a buzzer, an LCD display, and an IoT module to perform real-time monitoring and autonomous response to thermal hazards. The prototype was modeled on a miniature electric bus using plastic and metal sheets to simulate realistic conditions.

The smart fire safety system for Electric Vehicles (EVs) was successfully implemented on a small-scale bus prototype constructed from sheet materials. The system was tested under various controlled environmental conditions to evaluate its real-time detection, notification, and response performance using temperature, smoke, and photoelectric sensors.

The sensor readings were transmitted to the cloud platform via an IoT module (such as ESP8266), allowing remote monitoring on mobile devices. During testing, simulated heat and smoke conditions were created. When the temperature exceeded 45°C, the DC cooling fan was automatically triggered. Simultaneously, alerts were sent via the IoT dashboard, and the buzzer was activated. When smoke concentration crossed 250 ppm, the photoelectric sensor and smoke sensor sent signals to activate the warning system.

Table 2: Sensor Reading vs. System Response

Time (s)	Temperature (°C)	Smoke Level (ppm)	Photoelectric Intensity (lux)	Buzzer	DC Fan	IoT Alert
0	32	80	250	OFF	OFF	OFF
10	38	120	270	OFF	OFF	OFF
20	45	200	300	ON	ON	ON
30	47	260	320	ON	ON	ON
40	41	150	280	OFF	ON	ON
50	35	100	260	OFF	OFF	OFF

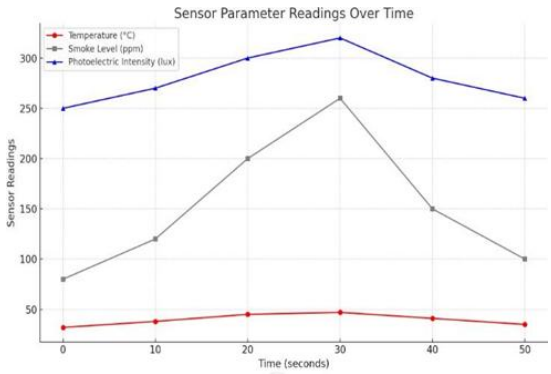

Figure 4: The graph displaying the sensor Readings (temperature, smoke level, and photoelectric intensity) over time

The graph displays the sensor readings (temperature, smoke level, and photoelectric intensity) over time. It clearly shows how the system detects abnormalities around the 20–30 second mark and helps visualize the conditions that trigger the safety mechanisms.

Internet of thing has several of applications and here we had applied in the field of fire safety and monitoring. Especially in AC buses. IOT has a broad application background in the field of real time

applications mainly in security systems. This proposed system mainly focuses on reducing the human loss and property loss when accident had happened. The preventive measures are implemented automatically, so the time to implement them is very less, so the loss can be reduced.

During testing, the system was able to accurately detect increases in temperature and the presence of smoke in the battery compartment. When the temperature exceeded a pre-set threshold such as 45°C, the temperature sensor relayed the data to the Arduino, triggering the DC fan to operate at high speed. Simultaneously, the buzzer alarm was activated, warning nearby users, while real-time data was sent to the cloud using the IoT module.

The graphical output illustrates real-time sensor readings—temperature, smoke concentration, and surrounding heat levels. The data was plotted over time, showing the sensor's quick response to changes in environmental conditions. These readings helped demonstrate the system's efficiency in detecting and responding to hazardous conditions within seconds. Additionally, the photoelectric and smoke sensors effectively identified combustion particles, even in low-visibility scenarios. The LCD display continuously updated the user with current readings and alert messages.

An important finding was the system's potential use in public transportation buses, especially AC buses that are prone to overheating in confined compartments. Night-time operation was also addressed, with the buzzer alert system acting as a critical feature to wake or alert drowsy drivers, thereby contributing not only to fire safety but also to accident prevention due to driver fatigue.

From a cost and implementation perspective, the system proved to be affordable, compact, and low-maintenance, allowing for scalability across various EV models. With further R&D, integration of drowsiness detection, AI-driven predictive analytics, and automatic extinguishing modules can enhance the safety suite. In conclusion, the smart fire safety system demonstrated excellent responsiveness, operational simplicity, and strong applicability in real-world EV use cases, particularly in preventing thermal runaway and reducing human and property loss during fire-related incidents.

11. Scope of the Study

- The scope of this study focuses on the development of a smart fire and safety protection system integrated into electric vehicles using IoT technology.
- It covers continuous monitoring of temperature, smoke, and short-circuit conditions in the EV battery compartment.
- Real-time data transmission and early warning alerts are included through IoT-based communication systems.
- The project addresses automatic activation of cooling fans, water sprinklers, and buzzer alarms during hazardous conditions.
- It aims to enhance driver and passenger safety, as well as protect vehicle components from fire hazards.
- The study also explores energy efficiency, cost-effectiveness, and compact integration for practical EV applications.
- Provisions for automatic battery power cutoff during emergencies are considered to prevent further damage.
- It focuses on increasing the reliability, safety, and operational lifespan of EVs.
- The project can be extended to public transportation, logistics fleets, and two-wheelers.
- The scope supports innovation in sustainable and safe mobility solutions.

12. Significance of Study

- Enhances EV passenger and vehicle safety through real-time fire and temperature monitoring.
- Reduces risk of thermal runaway by triggering automatic cooling, sprinkler, and alarm systems.
- Provides early alerts to users and fleet managers through IoT connectivity, ensuring rapid response.
- Promotes confidence in EV technology, encouraging faster adoption of electric mobility.
- Minimizes damage to vehicle components and prevents costly repairs or replacements.
- Supports the development of a sustainable, reliable, and safer transportation ecosystem.
- Demonstrates the integration of cost-effective electronic components for practical implementation.
- Contributes to research and development of EV safety standards in India and globally.
- Encourages innovation in combining IoT with safety-critical automotive systems.
- Facilitates scalability to multiple vehicle types, making it suitable for commercial and personal use.

13. Advantages

- Real-time Monitoring: Continuous monitoring of battery temperature ensures proactive detection of overheating issues.

- Enhanced Safety: Prevents potential hazards like thermal runaway, fire, or explosion in EV batteries.
- Efficient Cooling: High-speed DC fans effectively dissipate heat, maintaining battery health and extending its lifespan.
- Remote Notification: IoT integration allows users and maintenance teams to receive alerts in real-time, enabling swift action.
- User-Friendly: The LCD display provides clear information about the system's status, making it accessible to all users.
- Cost-Effective: Prevents costly damage to the EV by ensuring timely interventions.
- Low Maintenance: The system is robust, requiring minimal maintenance over time.

14. Applications

- Electric Vehicles: Battery temperature management in EVs to ensure safety and performance.
- Renewable Energy Systems: Cooling batteries in solar or wind energy storage setups.
- Data Centers: Managing heat in battery backups for uninterrupted operations.
- Portable Electronics: Thermal regulation in high-capacity battery-powered devices.
- Industrial Systems: Monitoring and cooling batteries in automated machinery or robotics.
- Aerospace: Ensuring safe battery operations in drones, aircraft, and space applications.

Conclusions

The integration of a Smart Safety System for Electric Vehicles (EVs) using IoT is crucial for enhancing the safety, performance, and longevity of EV batteries. This innovative system monitors key battery parameters like temperature and smoke, providing real-time alerts through IoT connectivity. In case of overheating or potential fire hazards, the system automatically activates safety mechanisms such as high-speed cooling fans or extinguishing units, effectively preventing accidents. This system's simplicity ensures minimal maintenance, making it a practical and cost-effective solution. Its compact design allows seamless integration without causing any discomfort to drivers or passengers. IoT connectivity enables remote monitoring and instant notifications to users, ensuring prompt action. With continued research and development, this smart safety system could revolutionize EV safety, offering scalable solutions adaptable to various battery types and sizes. It represents a significant step forward in ensuring EV reliability and user confidence in modern transportation.

References

[1] Z. Xie, Y. Liu, H. Zhang, and L. Chen, "The Multi-Parameter Fusion Early Warning Method for Lithium-Ion Battery Thermal Runaway," Batteries, MDPI, 2024.

[2] W.C. Tam, J. Park, and M. Singh, "Development of a Robust Early-Stage Thermal Runaway Detection Model for Lithium-Ion Batteries," NIST Publication, 2024.

[3] J.D. Oh, "Improving Fire Suppression Efficiency in Electric Vehicles," Fires, MDPI, 2024.

[4] J. Zhao, X. Wang, and H. Li, "Battery Safety: Machine Learning-Based Prognostics," Energy Storage, ScienceDirect, 2024/2025.

[5] A. Alawi, M. Khan, and S. Ali, "A Comprehensive Review of Battery Thermal Management Systems (BTMS) for EVs," Energies, MDPI, 2025.

[6] X. Li, Y. Zhang, and P. Kumar, "Towards Integrated Thermal Management Systems in EVs: Review and Perspectives," ScienceDirect Review, 2025.

[7] S. Lee, J. Kim, and H. Park, "Assessing Fire Dynamics and Suppression Techniques in Lithium-Ion Battery Fires," Fire Safety Journal, ScienceDirect, 2024.

[8] N. Al Bassam and S.A. Hussain, "IoT Based Autonomous Fire Suppression System for Vehicles," IC-ETITE Conference, IEEE, 2020.

[9] C.H. Lee, K. Choi, and S. Lim, "Development of IoT-Based Real-Time Fire Detection System," Applied Sciences, MDPI, 2023.

[10] "Smart Optical Sensors for Thermal Management in EVs," Spectroscopy Online (summary of Energies review), 2025.

[11] J. Chen, H. Wang, H. Yin, Y. Luo, and H. Zhang, "A real-time monitoring system for lithium-ion battery based on Arduino platform," 2017 IEEE 3rd International Conference on Energy Engineering and Information Management (EEIM), 2017, pp. 105-108.

[12] M. Z. Rahman and A. I. Al-Odienat, "Real-time monitoring system for electric vehicle battery management using Internet of Things (IoT)," 2019 IEEE 5th International Conference on Control, Automation and Robotics (ICCAR), 2019, pp. 853-858.

[13] Raza and M. H. Zafar, "Design and development of an intelligent battery management system for electric vehicles using Arduino," 2019 2nd International Conference on Electrical, Communication, Electronics, Instrumentation and Computing (ICECEIC), 2019, pp. 1-6.

[14] R. Kumar and S. K. Sharma, "IoT based real-time monitoring system for electric vehicle battery management using Arduino," 2020 2nd International Conference on Inventive Research in Computing Applications (ICIRCA), 2020, pp. 1035-1041.

[15] K. Balan, V. Subramaniyaswamy, and M. Muthukumar, "Design and implementation of electric vehicle battery monitoring and management system using Arduino," 2019 IEEE International Conference on Innovative Research and Development (ICIRD), 2019, pp. 1-5.

[16] N. I. Badruddin, N. J. Nawawi, M. Y. Yusof, M. A. H. Aziz, and A. Ahmad, "Design of battery monitoring system for electric vehicle using Arduino Uno," 2017 IEEE Conference on Energy Conversion (CENCON), 2017, pp. 260-263.

[17] S. O. Hjelle, P. Romano, and L. Solheim, "Real-time monitoring and control system for electric vehicle battery packs," 2018 IEEE International Conference on Industrial Technology (ICIT), 2018, pp. 1271-1276.

[18] K. E. H. Lai, K. C. Ng, W. T. Chan, C. H. T. Lee, and J. D. D. Eng, "Real-time monitoring system for electric vehicle battery management using Internet of Things (IoT) and machine learning techniques," 2020 IEEE International Conference on Consumer Electronics (ICCE), 2020, pp. 1-6.

[19] R. Suresh Kumar, S. Elango, M. Vijayan and, and S. A. Vijay, "Development of battery management system for electric vehicle using Arduino," 2018 International Conference, 2018.