Abstract. The growing popularity of electric vehicles (EVs) has highlighted the importance of developing advanced battery management systems (BMS) that focus on security and efficiency. This paper presents an overview of the latest advancements in EV BMS technology, specifically focusing on temperature and fire protection features. Temperature monitors play a crucial role in ensuring the optimal performance and lifespan of battery systems. EV BMS with advanced temperature monitoring and control capabilities are designed to minimize the risk of overheating and heat runaway. These systems integrate complex sensors and calculations to continuously monitor the battery's temperature and maintain it within safe limits. Fire protection is another vital aspect of EV BMS design. Lithium-ion batteries, commonly used in EVs, are susceptible to heat runaway events that can lead to fires or explosions.

Keywords: Voltage sensor, Temperature sensor, Current sensor, Arduino, Fire sensor, Signal.

1. INTRODUCTION

Electric cars (EVs) have gained significant popularity in recent years due to their environmentally friendly nature and potential to reduce dependence on fossil fuels. As the demand for EVs continues to rise, it is essential to address safety concerns related to their battery systems. One critical component of EVs is the Battery Management System (BMS), which plays a vital role in ensuring the safe and efficient operation of the battery pack.
Fire and temperature safety are two vital aspects of an EV BMS that are designed to mitigate any dangers related to battery malfunctions. Fire safety is of maximum significance as lithium-ion batteries, generally utilized in EVs, can undergo thermal runaway, leading to fires and explosions. Temperature safety, then again, makes a specialty of keeping most advantageous temperature conditions for the battery cells to perform efficaciously and extend their lifespan. The BMS constantly monitors the voltage, current, and temperature of each individual battery cellular, detecting any abnormalities that would cause a thermal runaway. Another essential characteristic of fire safety protection is the inclusion of flame-retardant materials and coatings inside the battery percent. These substances are designed to withstand combustion and restrict the unfold of fires in the event of an incident. Additionally, advanced BMS structures may additionally include fire suppression systems, inclusive of gaseous or foam-based retailers, to fast extinguish fires and minimize damage. Temperature safety in the EV BMS guarantees that the battery operates within secure temperature limits. The BMS employs sophisticated thermal management strategies to monitor and adjust the temperature of the battery cells. By retaining most fulfilling temperature conditions, the BMS allows preventing overheating, that may degrade battery performance and compromise safety. In conclusion, fire and temperature safety are essential elements of an EV BMS. These safety features are designed to locate and save thermal runaway activities, as well as keeping optimal temperature conditions for the battery cells. EV BMS ensure the safe and efficient operation of electrical vehicle battery packs. These protections contribute to the overall safety of EVs and inspire self-belief among purchasers, promoting the great adoption of electrical cars as a sustainable transportation solution.

UPS are good for backing up crucial gadget in addition to their information in case of power failure. Loss of statistics can be prevented by means of the usage of EV. It offers a power supply in case of predominant electricity disasters blackouts. UPS are right for backing up critical system as well as their facts in case of electricity failure. Loss of data can be avoided by using EV. It provides an energy supply in case of foremost power disasters blackouts. To screen EV constantly and manually is tough and not hustle free. To tackle this, we have got proposed our gadget You can take brief corrective actions based on insights gained from tracking. In case any EV fails or any of its parameters change, the technician may be alerted through SMS. This will not only help in detecting the faults, but also determining the condition of the EV at that specific moment.

2. LITERATURE SURVEY

Some of the recent literature to the proposed work is listed below:

- One concentrate by Zhang et al. (2020) proposed an exhaustive EV BMS design with improved fire insurance capacities. The scientists used a savvy checking framework that coordinated ongoing warm imaging and smoke location. The BMS could precisely recognize warm irregularities and smoke discharge, setting off quick wellbeing conventions to forestall fires and safeguard the battery pack.

- Along these lines, Li et al. (2019) introduced a clever way to deal with fire security in EV BMS. Their examination zeroed in on fostering a fire-resistant separator for lithium-ion batteries, which successfully stifled warm out of control and decreased the gamble of flames. The review showed that consolidating such separators inside the battery pack altogether upgraded the wellbeing and unwavering quality of EVs.

- Temperature insurance has likewise been a conspicuous area of examination. Wu et al. (2021) proposed a shrewd warm administration framework for EV BMS. The review included the development of a prescient calculation that...
streamlined the cooling technique considering battery temperature and encompassing circumstances. The outcomes showed that the astute warm administration framework successfully controlled battery temperature, working on by and large execution and broadening battery life.

3. EXISTING SYSTEM

The advancement of Electric Vehicle Battery Board Frameworks (EV BMS) with fire and temperature assurance has seen huge headways as of late. Different producers and innovation organizations have executed imaginative answers for improve the wellbeing and dependability of EV battery packs. This segment examines a portion of the current frameworks and advancements in this space. The current EV BMS frameworks additionally utilize progressed correspondence conventions to guarantee consistent cooperation between the BMS and other vehicle frameworks. This considers productive checking, control, and reaction to fire and temperature-related occasions. Coming up next are a portion of the old procedures.

1.1 Thermal administration

Warm administration is a basic part of Electric Vehicle Battery the Board Frameworks (EV BMS) that spotlights on controlling and keeping up with ideal temperature conditions inside the battery pack. Successful warm administration is fundamental for guaranteeing the protected and productive activity of the battery cells.

1.2 Cell adjusting

Cell adjusting is a significant capability in Electric Vehicle Battery the Board Frameworks (EV BMS) that means to balance the charge levels of individual battery cells inside a battery pack. It guarantees that all cells are working at comparable voltage levels, boosting the general exhibition and life span of the battery pack.

1.3 Over current insurance

Overcurrent security is a significant component in Electric Vehicle Battery the Executives Frameworks (EV BMS) that defends the battery pack and electrical parts from extreme flow stream, which can prompt harm or wellbeing risks. It includes observing and controlling the ongoing levels inside the battery framework to forestall over-burdens and guarantee safe activity.

1.4 Fault identification and isolation

In order to locate and identify issues inside the battery pack, Electric Vehicle Battery Management Systems (EV BMS) perform important functions called fault isolation and detection. These features enable prompt response and appropriate action to lessen the effects of problems, assuring the battery system's safe and dependable operation.

4. METHODOLOGY
A superior and innovative suggestion for an electric vehicle (EV) Battery Management System (BMS) with included fee temperature and fire safety device is presented. This proposed gadget goals to decorate the protection and reliability of EV batteries, addressing crucial worries related to temperature manipulation during charging and mitigating the chance of fire incidents. The fee temperature manipulation function within the BMS ensures that the battery operates within optimal temperature degrees during charging, stopping overheating or overcooling. It monitors the temperature of the battery cells and adjusts the charging parameters thus. By maintaining the suitable temperature, the proposed BMS optimizes the charging performance, extends battery life, and reduces the risk of thermal runaway. Furthermore, the fire protection system incorporated into the BMS affords an extra layer of safety. It makes use of a combination of smart sensors, advanced algorithms, and fire suppression mechanisms to locate and suppress any potential hazards. The sensors continuously screen diverse parameters such as temperature, voltage, and current, determining odd conditions that would lead to fire incidents. In the event of a fire chance, the machine triggers on-site countermeasures, including isolating the affected battery module, activating fire suppression systems, and alerting the car occupants and emergency services. The proposed BMS includes contemporary technology and components to achieve these functionalities. High-precision temperature sensors permit accurate temperature monitoring at the cell level, allowing specific control over the charging process. Intelligent algorithms examine the temperature records in real-time, dynamically adjusting charging parameters to maintain superior temperature ranges. For fire safety, the BMS employs advanced flame detection sensors capable of identifying the early signs of a fire. These sensors are strategically located inside the battery pack, ensuring comprehensive coverage. Once a potential fire is detected, the system initiates a rapid reaction, activating a combination of fire suppression methods, including gas-based or foam-based systems, to quickly extinguish the fire and reduce damage. The proposed EV BMS with fee temperature and fire protection system addresses vital safety concerns related to EV batteries. By actively coping with temperature during charging and integrating fire detection and suppression mechanisms, this device extensively reduces the danger of battery overheating, thermal runaway, and fire incidents. With the growing reputation of electrical vehicles, the implementation of such an advanced BMS might ensure more desirable protection, reliability, and peace of mind for EV owners and customers.

5. WORKING METHOD

The device when turned on uses its charging and tracking circuitry that allows the user to safely charge the 3S battery. It includes an LCD display, a modern sensor, a voltage sensor, and a temperature sensor to expand this capability. The machine is designed specifically to protect the batteries from overheating and to prevent accidents occurring due to fire or blast. While charging, the voltage sensor is used to test voltage and limit the drift of modern-day to the battery using charging circuitry. The LCD display shows the values of modern-day voltage degree of battery. When related to a load, the cut-off edge sensor maintains track of the cut-off edge drawn from the battery and presents the parameter on LCD display. The temperature sensor is used to screen the temperature of batteries during charging as well as discharging. If the battery temperature is determined to deviate from the normal values, the machine automatically cuts off input as well as output supply. A buzzer is an audio signal tool that generates a sound from an incoming electrical signal. Overall, an Electric Vehicle BMS with temperature and fire protection ambition to ensure the safe and dependable operation of the battery during its lifespan. The temperature

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sensor is accelerated to 40 degrees Celsius then the buzzer generates electrical signal inside the shape of sound. The fireplace sensor detects the hearth and generates electrical signal through buzzer.

The block diagram of an EV BMS with hearth and temperature safety represents the interconnectedness and cooperation of these components to make sure the safe and efficient operation of the battery percent, mitigating risks related to fires and thermal occasions.
6. COMPARATIVE ANALYSIS

1.1 Temperature Monitoring and Regulation:
- Both BMS options should encompass temperature monitoring to ensure the battery operates within secure temperature limits.
- A desirable BMS must have the capability to alter the battery’s temperature by means of imposing cooling or heating mechanisms as required.

1.2 Thermal Runaway Detection:
- Thermal runaway is a critical problem in EV batteries, where a self-maintaining response can occur due to overheating.
- An effective BMS must have built-in mechanisms for early detection of thermal runaway events.
- Look for BMS structures that make use of sophisticated algorithms and tracking techniques to perceive temperature anomalies and mitigate thermal runaway risks.

1.3 Regulatory Compliance:
- Consider BMS structures that observe applicable industry standards and policies regarding temperature and fire safety in EV batteries.
- Regulatory compliance ensures that the BMS has undergone rigorous checking and meets safety necessities.

7. CASE STUDY DETAILS

Temperature Sensors: A community of high-precision temperature sensors are strategically positioned throughout the battery to display individual temperatures constantly.

Thermal Management System: A superior thermal control device was developed, comprising liquid cooling channels embedded within the battery. The system applied a combination of active cooling, passive cooling, and thermal insulation techniques to alter the battery temperature.

Over-Temperature Protection: The BMS implemented algorithms to detect and respond to over-temperature situations promptly. If the temperature passed safe limits, the system activated cooling mechanisms, adjusted charging rates, and alerted the driving force or initiated appropriate safety protocols.
Fire Detection Sensors: Sophisticated fireplace detection sensors, which include smoke and heat detectors, had been included into the battery percent and BMS. These sensors constantly monitored the surroundings for symptoms of heart.

Data Logging and Analysis: The BMS recorded temperature information from characteristic sensors, as well as other relevant parameters such as voltage and modern-day. These facts became logged for further analysis and provided insights into battery overall performance, temperature developments, and capacity problems.

<table>
<thead>
<tr>
<th>Technology (Characteristic)</th>
<th>TC (Thermocouples)</th>
<th>PT RDT (Thin Film)</th>
<th>NI RTD Thin Film</th>
<th>NTC (Thermistors)</th>
<th>Diode/BJT/IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Range</td>
<td>-200 to +370</td>
<td>-70 to +450</td>
<td>-55 to +250</td>
<td>-55 to +200</td>
<td>-55 to +150</td>
</tr>
<tr>
<td>Response time</td>
<td>Very Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Voltage sensitivity</td>
<td>40 µV/K to 40 µV/K</td>
<td>3.85 mV/k</td>
<td>6.9 mV/k</td>
<td>50 mV/k</td>
<td>-2 mV/k</td>
</tr>
<tr>
<td>Best accuracy</td>
<td>±1.0 ºC + %T</td>
<td>±0.15 ºC</td>
<td>±0.15 ºC</td>
<td>±0.2ºC</td>
<td>±0.5 ºC</td>
</tr>
<tr>
<td>Life time / Durability</td>
<td>High</td>
<td>Excellent</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Stability at high temperature</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
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8. FUTURE SCOPE

1. Improved fire detection structures to quickly pick out battery overheating or hearth risks.
2. Better thermal management strategies to efficiently expend warmth and preserve top-of-the-line battery temperatures.
3. Establishment of regulatory standards and certifications for stronger fireplace and temperature safety.
4. The future scope of EV BMS involves the combination of more state-of-the-art fire detection structures. These structures thought to make use of superior sensors, such as smoke detectors or infrared cameras, to discover early symptoms of battery overheating or fire improvement. This early detection can enable prompt actions to mitigate the danger of fireplace and beautify typical protection.
9. RESULTS

The framework is intended to continually screen battery voltage, current, temperature, and in a split second removed the info or result from battery when any uncommon way of behaving is recognized.

This Framework gives the accompanying benefits:

- Battery Status Observing and Showing Charging of Battery according to required input boundaries.
- Temperature observing with auto cutoff. The framework utilizes a li particle Battery, Battery charging and screen framework, Press Buttons, LCD Show, current sensor, voltage sensor, temperature sensor to foster this framework. The framework screens as well as safeguards an EV battery consistently.
- We foster the framework according to a 3S li particle battery. The framework we configuration will not just screen the battery and charge it securely yet in addition safeguard it to stay away from mishaps from happening. The framework when turned on utilizes its charging and observing hardware that permits client to somewhere safe charge the 3S battery.
- While charging the voltage sensor is utilized to check voltage and cutoff the progression of current too to the battery utilizing charging hardware. The LCD show likewise shows the ongoing voltage level of battery. When the battery is completely energized, the framework removes the stock and shows Battery completely energized on LCD Show.
- When associated with a heap the ongoing sensor monitors current drawn from battery and presentations the boundary on LCD Show. The temperature sensor is utilized to screen temperature of battery while charging as well as releasing.
- On the off chance that the battery temperature is seen to stray from standard qualities, the framework naturally removes input as well as result supply and shows the temperature as well as a signal caution on the LCD show. In this way the framework considers a savvy and proficient battery charging as well as security framework.
10. CONCLUSION

Battery management systems (BMS) play a crucial position in ensuring the safe and efficient operation of residential energy storage systems. Two essential factors of BMS functionality are temperature monitoring and hearth protection, which can be vital for retaining the sturdiness of batteries and mitigating the threat of catastrophic occasions. In this end, we can summarize the significance of those capabilities and their effect on residential electricity storage systems. Firstly, temperature tracking is crucial for optimizing battery performance and durability. Lithium-ion batteries, commonly utilized in residential electricity garage systems, are sensitive to temperature fluctuations. High temperatures can boost up battery degradation, lessen capacity, and growth the threat of thermal runaway, leading to hearth or explosion. Secondly, hearth safety is an important attention for any electricity storage gadget. While lithium-ion batteries have an incredibly low hazard of hearth as compared to different technology, it is miles nevertheless vital to have strong fire prevention and mitigation measures in region. A BMS prepared with fire protection capabilities gives early detection of potential hearth dangers, consisting of thermal runaway or inner short circuits. It can trigger numerous protection mechanisms, including isolation of the affected battery module, activation of hearth suppression systems, and alerting homeowners or emergency services. These measures extensively reduce the danger of fire-related accidents and protect each asset and lives.

Fig. 3: Battery parameters

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**CONCLUSION**

Temperature tracking is crucial for optimizing battery performance and durability. Lithium-ion batteries, commonly utilized in residential electricity garage systems, are sensitive to temperature fluctuations. High temperatures can boost up battery degradation, lessen capacity, and growth the threat of thermal runaway, leading to hearth or explosion. Secondly, hearth safety is an important attention for any electricity storage gadget. While lithium-ion batteries have an incredibly low hazard of hearth as compared to different technology, it is miles nevertheless vital to have strong fire prevention and mitigation measures in region. A BMS prepared with fire protection capabilities gives early detection of potential hearth dangers, consisting of thermal runaway or inner short circuits. It can trigger numerous protection mechanisms, including isolation of the affected battery module, activation of hearth suppression systems, and alerting homeowners or emergency services. These measures extensively reduce the danger of fire-related accidents and protect each asset and lives.
11. REFERENCES


