



Anomaly Detection System For Internal Faults In Electric Vehicles

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Abstract: The increasing focus on the safety of lithium-ion batteries (LIBs) in electric vehicles (EVs) necessitates early detection of soft short circuits (SCs) to prevent severe faults such as fire or thermal runaway. This paper proposes an on-board soft SC fault diagnosis method using the extended Kalman filter (EKF). The EKF adjusts a gain matrix based on real-time measured voltages to estimate the state of charge (SOC) of the faulty cell. The SOC difference is then utilized for soft SC fault detection, with identified soft SC resistance values indicating the severity of the fault. Experimental validation on a series-connected battery pack confirms the method's effectiveness in promptly detecting soft SC faults and accurately estimating their resistance

While lithium-ion batteries offer advantages such as high energy density and quick charging, concerns about their thermal stability hinder their widespread use due to potential fire and explosion risks. This manuscript comprehensively reviews the thermal runaway phenomenon and fire dynamics in both single LIB cells and multi-cell battery packs. It discusses potential fire prevention measures, emphasizing the challenges associated with ensuring the safety of LIB applications in electric vehicles and energy storage

systems. Additionally, the paper provides an overview of fault detection methods for critical EV components, including Permanent Magnet Synchronous Motors (PMSMs) and lithium-ion battery packs, stressing the importance of accuracy, speed, sensitivity, and cost-effectiveness in fault detection approaches, with a focus on the latest research developments.

1. INTRODUCTION

The project idea stems from our involvement with the EV startup at our college, where we recognized the need for software solutions to enhance the efficiency and reliability of electric vehicles. This inspired us to explore the application of anomaly detection techniques in identifying internal faults in electric vehicles.

The motivation behind this project lies in our desire to contribute to the advancement of electric vehicle technology. We aim to address the limitations of existing manual techniques and traditional methods such as Kalman filters in detecting internal faults. By leveraging machine learning algorithms for anomaly detection, we aim to improve the safety and performance of electric vehicles, ultimately contributing to the growth of sustainable transportation.

The growing use of electric vehicles (EVs) has brought to light the significance of ensuring their safety and dependability. As EVs become more complex, the risk of internal faults and anomalies also increases, potentially leading to reduced performance, safety issues, and costly repairs. To address this challenge, an Anomaly Detection System for Internal Faults in Electric Vehicles has been developed.

This system utilizes advanced data analytics and machine learning techniques to identify unusual patterns or anomalies in the behavior of EV components, such as the battery, motor, and electrical systems. By detecting potential faults early, the system enables predictive maintenance, reducing downtime and improving overall vehicle reliability.

The Anomaly Detection System is designed to provide real-time monitoring and analysis of vehicle data, sending alerts to drivers or maintenance personnel when anomalies are detected. This proactive approach enhances the overall safety and efficiency of electric vehicles, reduces costs associated with maintenance, and helps to prevent accidents. The Anomaly Detection System has the potential to revolutionize the way electric vehicles are maintained and repaired by utilizing the power of data analytics and machine learning. As a result, EV owners will have a safer and more reliable driving experience.

2. LITERATURE SURVEY

" Our literature survey involved reviewing research papers and publications related to anomaly detection in electric vehicles. We identified several papers that highlighted the shortcomings of manual techniques and traditional algorithms like Kalman filters in accurately detecting internal faults. Through our survey, we gained insights into the different algorithms and methodologies used in anomaly detection and identified potential areas for improvement and innovation in this field.

Y. Zhao, J. Zhu, H. Liang and L. Chen, "Integration of Coordinate and Geometric Surface Normal for 3D Point Cloud Object Detection," 2021 International Joint Conference on Neural Networks (IJCNN), Shenzhen, China, 2021, pp. 1-7, doi: 10.1109/IJCNN52387.2021.9534281. keywords: Three-dimensional displays; Laser radar; Navigation; Robot kinematics; Neural networks; Object detection; Benchmark testing; 3D object detection; LiDAR point cloud; voxel-based methods; surface normal; feature integration

L. C. Johnson, D. K. Mansfield and G. Taylor, "Direct Narrow line Tuning of a High Power CO2 Pump Laser," 1979 International Conference on Submillimeter Waves and Their Applications, Guilford, UK, 1979, pp. 63-64, doi: 10.1109/IC-SWA.1979.9335351. keywords: Laser tuning; Laser excitation; Gratings; Laser modes; Laser beams; Pump lasers; Mirrors

A. E. Jayasinghe, N. Fernando, S. Kumarawadu and L. Wang, "Review on Li-ion Battery Parameter Extraction Methods," in IEEE Access, vol. 11, pp. 73180-73197, 2023, doi: 10.1109/ACCESS.2023.3296440. keywords: Batteries; Electrolytes; Anodes; Solid modeling; Integrated circuit modeling; Lithium-ion batteries; Power grids; Parameter extraction; Fault diagnosis; Real-time systems; Parameter estimation; Predictive modeling; lithium-ion battery; parameter extraction; battery management systems; electric vehicles.

3. BLOCK DIAGRAM:

3.1 Working Principle:

Utilizing cutting-edge machine learning algorithms, the Anomaly Detection System for Internal Faults in Electric Vehicles finds out-of-the-ordinary patterns or anomalies in the behavior of vehicle components.

The system collects data from various sensors and onboard systems, analyzing parameters such as voltage, current, temperature, and vibration.

By analyzing this data, the system can detect potential internal faults, such as issues with the battery, motor, or electrical systems. Machine learning models are trained on normal vehicle behavior, enabling the system to identify anomalies that may indicate a fault.

The system alerts the driver or maintenance staff when an anomaly is detected, allowing prompt action to prevent accidents and shorten downtime. This predictive maintenance approach improves vehicle reliability, reduces maintenance costs, and enhances overall safety.

The system provides real-time monitoring and analysis, enabling swift identification of potential faults and minimizing the risk of unexpected failures. By leveraging advanced data analytics and machine learning, the Anomaly Detection System helps ensure the safe and efficient operation of electric vehicles.

4. Hardware Requirements

Sr. No.	Parameter	Minimum Requirements	Justification
1	CPU (Processing Unit)	2 GHz	Speed
2	RAM (Memory)	3 GB	Size
3	Storage	500 GB Space	Space
4	GPU (Optional)	NVIDIA GTX 1060 Acceleration	Acceleration
5	Network	Stable Connectivity	Connectivity
6	Backup	Data Redundancy	Redundancy
7	Cooling	Efficient System	System
8	Power Supply	Reliable Source	Reliability

5. SOFTWARE REQUIREMENTS:

Sr. No.	Parameter	Minimum Requirements	Justification
1	Operation System	Windows10/macOS/ Linux	Required for running the soft-ware
2	IDE	PyCharm/Jupyter Note- book	Required for writing and de- bugging code efficiently
3	Programming Lan- guage	Python3	Required for implementing the anomaly detection algo-rithms and dat processing tasks
4	Frameworks	scikit-learn / pandas / numpy / matplotlib / seaborn	Required for implementing machine learning algorithms, c manipulation, and visu-alization

6. ADVANTAGES:

- Improved Safety: Early detection of internal faults can prevent accidents and ensure driver safety.
- Reduced Downtime: Predictive maintenance enables efficient scheduling of repairs, reducing downtime.
- Increased Reliability: Anomaly detection improves vehicle reliability and reduces the risk of unexpected failures.
- Cost Savings: Early detection and repair of faults can reduce maintenance costs.

7. APPLICATIONS:

- Electric Vehicle Manufacturers: Anomaly detection systems can be integrated into electric vehicles to improve safety and reliability.
- Fleet Management: Fleet managers can use anomaly detection systems to monitor vehicle health and schedule maintenance.
- Maintenance Providers: Maintenance providers can use anomaly detection systems to identify potential faults and perform proactive repairs.

8. CONCLUSION:

In conclusion, the proposed system is expected to yield a range of positive outcomes, including improved safety, preventive maintenance, customer confidence, and efficient system management. These results align with the broader goals of advancing electric vehicle technology and addressing safety concerns associated with internal faults

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