IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, April 2025
Impact Factor: 7.67

Anomaly Detection System for Internal Faults in Electric Vehicles

Prof. Vikram Popat Deokate, Abdul Rehman Shaikh, Arbaz Shaikh, Aftab Nazir, Mr. Kaif Mulla
Department of Electronics and Telecommunication
Al-Ameen Educational and Medical Foundations College of Engineering and Management Studies, Pune

Abstract: *The increasing focus on the safety of lithium-ion batteries (LIBs) in electric vehi- cles (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 ther- mal runaway phenomenon and fire dynamics in both single LIB cells and multi-cell battery packs. It discusses potential fire prevention measures, emphasizing the chal- lenges 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 Syn-chronous 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.

Keywords: lithium-ion batteries

I. 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 man-ual 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.

II. LITERATURE SURVEY

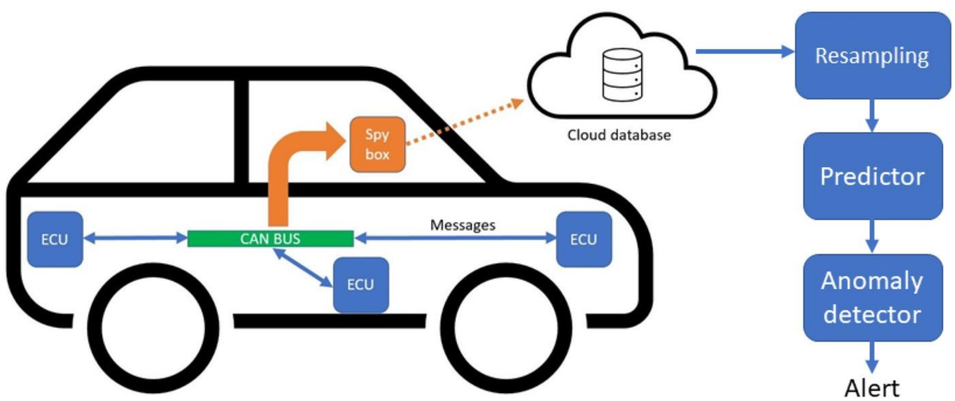
Our literature survey involved reviewing research papers and publications related to anomaly detection in electric vehicles. We identified several papers that highlighted the shortcomings of manual techniques and traditional algorithms like Kalman filters in accurately detecting internal faults. Through 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 Geomet- ric 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 test-
ing;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 mod- els;Battery modeling;lithium-ion battery;parameter extraction;battery management systems;electric vehicles.

III. BLOCK DIAGRAM



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.

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 10, April 2025

Impact Factor: 7.67

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.

IV. 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

V. 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	Python 3	Required for implementing the anomaly detection algo-rithms and data processing tasks
4	Frameworks	scikit-learn / pandas / numpy / matplotlib / seaborn	Required for implementing machine learning algorithms, data manipulation, and visu-alization

VI. ADVANTAGES

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

VI. APPLICATIONS

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

VII. CONCLUSION

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

REFERENCES

[1]. Ruixin Yang, Rui Xiong and Weixiang Shen, "On-board Diagnosis of Soft Short Circuit Fault in Lithium-ion Battery Packs for Electric Vehicles Using an Extended Kalman Filter," CSEE Journal of Power And Energy Systems, Vol. 8, No. 1, January 2022.

[2]. Da Li, Zhaosheng Zhang, Peng Liu, Zhenpo Wang, Lei Zhang, "Battery Fault Diagnosis for Electric Vehicles Based on Voltage Abnormality by Combin- ing the Long Short-Term Memory Neural Network and the Equivalent Circuit Model," IEEE Transactions on Power Electronics, Vol. 36, No. 2, February 2021.

[3]. Yunlong Shang, Gaopeng Lu, Yongzhe Kang, Zhongkai Zhou, Bin Duan, Chenghui Zhang, "A multi-fault diagnosis method based on modified Sample Entropy for lithium-ion battery strings," Journal of Power Sources, 446 (2020) 227-275.

[4]. Qingsong Wang, Binbin Mao, Stanislav I. Stoliarov, Jinhua Sun, "A review of lithium ion battery failure mechanisms and fire prevention strategies," Progress in Energy and Combustion Science, 73 (2019) 95-131.