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# FAULT TRACING OF WIRING HARNESS FOR AUTOMATED ELECTRIC VEHICLES COMBINED WITH AUGMENTED REALITY

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Abstract The electric vehicles (EVs) have ushered in a new era of sustainable transportation. However, ensuring the safety and reliability of these vehicles is of paramount importance. One critical aspect is the detection and tracking of faults in the interior wiring systems, which are responsible for various vital functions within the EV. This paper presents an innovative approach to fault tracking within EV interior wiring, combining the power of MATLAB with Augmented Reality (AR) technology. MATLAB serves as the computational backbone of the proposed system, offering robust algorithms for data analysis and signal processing. The system employs a network of sensors strategically placed throughout the EV's interior to monitor electrical circuits continuously. In the event of a fault, MATLAB processes sensor data to pinpoint the location and nature of the fault. This information is then seamlessly integrated into an AR interface. Augmented Reality is harnessed to provide real-time visual cues to service technicians, enhancing fault diagnosis and repair procedures. Through AR glasses or a mobile device, technicians can visualize the EV's interior in real-time and receive intuitive visual overlays highlighting the precise location of the fault, along with step-by-step repair instructions. This integration of AR not only expedites the fault-tracking process but also reduces the margin for error, ultimately leading to safer and more efficient maintenance. In conclusion, the fusion of MATLAB analytical capabilities with Augmented Reality technology offers a novel and effective solution for fault tracking within electric vehicles' interior wiring systems. This approach not only enhances the safety and reliability of EVs but also represents a significant step forward in the evolution of automotive maintenance and repair practices, a valuable tool in the electric vehicle industry. **Keywords:** MATLAB, Augmented Reality, AR glasses, mobile device, Electric Vehicle, wiring Harness, data analysis, fault diagnosis, repair procedures

## 1.INTRODUCTION

The adoption of electric vehicles (EVs) is rapidly transforming the automotive industry, promising a cleaner and more sustainable future for transportation. However, as EVs become more prevalent, ensuring their safety and reliability is paramount. One critical aspect of this is the detection and tracking of faults within the intricate interior wiring systems of electric vehicles. The interior wiring plays a pivotal role in the vehicle's operation, controlling various vital functions. Detecting and addressing faults in a timely and precise manner is essential for maintaining the vehicle's performance, safety, and longevity. In response to this pressing need, this research endeavors to introduce a ground-breaking solution that combines the power of MATLAB with Augmented Reality (AR) technology to revolutionize the fault tracking process within EVs. This innovative approach promises not only to enhance the efficiency and accuracy of fault identification but also to significantly advance the field of automotive maintenance and repair in the era of electric mobility.

### 1.1Problem Statement

The automotive industry is undergoing a significant transformation with the widespread adoption of electric vehicles (EVs) and automation technologies. Electric wiring harnesses in these vehicles are becoming increasingly complex, and diagnosing faults within these systems is challenging for technicians. Traditional methods of fault tracing can be time-consuming and error-prone, leading to increased downtime and maintenance costs for electric vehicle owners. Augmented Reality (AR) technology holds the potential to revolutionize the way technicians diagnose and repair faults in electric wiring harnesses, providing real-time visual guidance and enhancing the efficiency of the diagnostic process. The problem at hand revolves around the need for an efficient and effective solution to trace faults in electric wiring harnesses of automated electric vehicles using augmented reality technology. The challenges faced in this domain include: The challenges faced in this domain include are Complexity of Wiring Harness, Diverse fault Scenarios, Safety Concerns and Integration with Vehicle Systems

### 1.2Advantages Of the System

Combining fault tracing in electric wiring harnesses for automated electric vehicles with augmented reality (AR) technology offers a multitude of advantages. Firstly, it enhances efficiency in diagnostics by providing visual guidance to technicians. AR overlays digital information directly onto the physical components, enabling technicians to visually pinpoint faults and follow step-by-step instructions, thus speeding up the troubleshooting process significantly. Real-time feedback further ensures that technicians can promptly identify and rectify issues without extensive manual checks, reducing vehicle downtime. Secondly, this integration revolutionizes training methods. Interactive AR modules can simulate diverse fault scenarios, offering a hands-on learning experience for trainees. These simulations help novice technicians grasp complex concepts while allowing experienced professionals to refine their skills and stay updated with the latest technologies. Ultimately, the synergy between fault tracing in electric wiring harnesses and AR technology not only streamlines the repair process but also elevates the overall proficiency and knowledge base of technicians in the rapidly advancing field of automated electric vehicles. Additionally, AR-assisted fault tracing enhances safety by minimizing the risk of human error during the diagnostic and repair process. Technicians can focus on the task at hand without distractions, leading to more accurate and reliable results.

### 1.3Disadvantages Of the System

Fault tracing in electric wiring harnesses for automated electric vehicles, when combined with augmented reality technology, offers several benefits such as improved efficiency, reduced downtime, and enhanced troubleshooting capabilities. However, there are also several disadvantages associated with this approach. one significant drawback is the initial cost of implementing augmented reality systems. Setting up the required hardware and software, including specialized AR devices and sensors, can be expensive. This cost can be a significant barrier for smaller companies or businesses with limited budgets, hindering their ability to adopt this advanced technology. Another disadvantage is the complexity of integrating augmented reality into the existing workflow. Employees need to be trained to use AR devices effectively, which may require additional time and resources. Moreover, the technology itself might be complex, leading to a learning curve for technicians and engineers, potentially slowing down the fault-tracing process initially. Additionally, augmented reality systems are highly dependent on reliable internet connections and infrastructure. In situations where a stable internet connection is unavailable, the AR applications may not function correctly, leading to delays and inefficiencies in diagnosing and repairing faults. Moreover, technical glitches or software bugs in AR systems could further disrupt the fault-tracing process, leading to inaccuracies in troubleshooting or potentially causing more issues in the vehicle. Furthermore, there are concerns regarding data security and privacy. Augmented reality systems often rely on collecting and processing sensitive data, which, if compromised, could lead to significant security breaches. Ensuring the protection of customer and vehicle data is crucial to prevent unauthorized access or misuse, adding an extra layer of complexity and responsibility for companies implementing these technologies. In conclusion, while combining fault tracing in electric wiring harnesses for automated electric vehicles with augmented reality has the potential to revolutionize the automotive industry, there are notable disadvantages, including high initial costs, integration challenges, dependency on reliable internet connectivity, and data security concerns. Addressing these issues effectively is essential for businesses to fully harness the benefits of this innovative approach while minimizing its drawbacks.

### 1.4 Applications of The System

Fault tracing electric wiring harness in automated electric vehicles, when combined with augmented reality technology, offers a revolutionary solution for enhancing efficiency, safety, and maintenance in the rapidly evolving automotive industry. Traditional methods of diagnosing electrical faults in the complex wiring systems of electric vehicles can be time-consuming and error-prone. However, the integration of augmented reality (AR) into this process opens up a new realm of possibilities. AR technology allows technicians and engineers to visualize the intricate wiring harnesses in a 3D virtual space, making it easier to identify and locate faults, damaged connections, or malfunctioning components. This immersive approach not only streamlines the fault tracing process but also reduces the need for physical access to the wiring, which is particularly valuable in tight and hard-to-reach spaces within a vehicle's construction. This enhances worker safety and reduces the risk of damage to other vehicle components during troubleshooting. Moreover, the application of AR in fault tracing electric wiring harnesses also simplifies the training process for automotive technicians. New and experienced technicians can receive real-time guidance and step-by-step instructions overlaid onto the AR view, making the diagnosis and repair of electrical issues more accessible and efficient. This is especially valuable as electric vehicles become more prevalent, and the demand for skilled professionals in this field continues to grow. In summary, combining fault tracing of electric wiring harnesses with augmented reality technology in automated electric vehicles not only accelerates the diagnostic process but also improves overall vehicle safety and reduces maintenance costs. It transforms how technicians interact with these intricate systems, making electric vehicles more accessible, efficient, and cost-effective for both manufacturers and consumers in the evolving landscape of automotive technology.

## 2.OBJECTIVE AND METHODOLOGY

Internal Fault Detection: Develop algorithms and methodologies for the detection and classification of internal faults within the electrical and mechanical components of electric vehicles, including but not limited to batteries, motors, inverters, and sensors. Real-Time Monitoring: Implement a real-time monitoring system that continuously assesses the condition of critical vehicle components, providing alerts when abnormalities or faults are detected.

Augmented Reality Integration: Integrate augmented reality technology into the project to enhance fault visualization and provide maintenance personnel with an intuitive and immersive interface for identifying and localizing faults within the vehicle. Fault Database: Create a database for storing historical fault data and diagnostic information, enabling trend analysis, predictive maintenance, and performance optimization. User-Friendly Interface: Develop a user-friendly graphical interface that allows maintenance technicians and operators to easily interact with the system,

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visualize fault data, and receive maintenance instructions.
MATLAB Implementation: Utilize MATLAB as the primary software platform for implementing fault detection algorithms, data analysis, and visualization, leveraging its powerful computational capabilities. Data Fusion: Integrate data from various sensors, IoT devices, and the vehicle's internal systems to provide a holistic view of the vehicle's health. Testing and Validation: Conduct rigorous testing and validation procedures to ensure the accuracy and reliability of the fault detection system under various operating conditions. Training and Documentation: Provide comprehensive training materials and documentation for end-users and maintenance personnel to ensure effective system utilization. Scalability and Adaptability: Design the system with scalability and adaptability in mind to accommodate different electric vehicle models and future upgrades. Safety and Reliability: Prioritize safety and reliability in the system design, ensuring that the project contributes to the overall safety of electric vehicle operation.
Cost-Efficiency: Strive to optimize the project's cost-effectiveness while delivering a high-quality fault tracking and detection solution.

Data Acquisition and Pre-processing: Gather sensor data from various components of the electric vehicle, such as battery management systems, motor controllers, and power electronics. Pre-process the data to remove noise, outliers, and inconsistencies, ensuring the data is suitable for fault detection and analysis. Feature Extraction: Extract relevant features from the pre-processed data that can be indicative of potential internal part faults. These features may include voltage, current, temperature, and operational parameters. Fault Signature Development: Develop a library of fault signatures, which are patterns or characteristics in the data that correspond to specific internal part faults. These signatures can be created through a combination of analytical modelling and empirical data. Machine Learning Model: Train a machine learning model, such as a support vector machine (SVM) or a neural network, using the labelled data with known fault conditions. This model will learn to associate fault signatures with their respective faults. Real-Time Data Acquisition: Implement a real-time data acquisition system on the electric vehicle to continuously monitor its internal components during operation. Fault Detection and Classification: Apply the trained machine learning model to the real-time data to detect and classify internal part faults. This step involves continuously comparing the incoming data with the fault signatures to identify anomalies. Augmented Reality Integration: Utilize augmented reality technology to overlay the fault detection results onto the user's field of view. This can be achieved through AR glasses or smartphone applications. Design an intuitive and user-friendly interface that provides real-time visual cues and information about the detected faults. User Interaction and Notification: Implement a system that allows the user to interact with the augmented reality display to obtain more detailed information about detected faults. Enable automatic notifications and warnings to alert the user about critical faults that require immediate attention.
Testing and Validation: Conduct rigorous testing and validation of the system by simulating various internal part faults in a controlled environment. Gather feedback from users and refine the system based on their input. Deployment and Monitoring: Deploy the augmented reality fault tracking system in actual electric vehicles, ensuring it operates effectively in real-world conditions. Continuously monitor and maintain the system, updating it as necessary to adapt to changing conditions and new fault scenarios.

## 2. PROPOSED WORK MODULES

In response to the increasing demand for electric vehicles (EVs) and the critical need for ensuring their safety and reliability, we propose an advanced fault tracking system that leverages the synergistic capabilities of MATLAB and Augmented Reality (AR) technology. This proposed system aims to revolutionize the process of fault detection and tracking within the intricate interior wiring systems of electric vehicles. These wiring systems are central to the vehicle's operation, controlling essential functions such as power distribution, communication, and safety mechanisms. Detecting and addressing faults in a swift and precise manner is crucial for maintaining EVs' performance and safety standards. Our innovative approach not only promises to enhance the efficiency and accuracy of fault identification but also to usher in a new era of automotive maintenance and repair through the integration of Augmented Reality. This paper outlines the key components and working principles of our proposed system, highlighting its potential to transform electric vehicle fault tracking into a more intuitive, efficient, and effective process.The proposed system for fault tracking of electric vehicle interior wiring, integrated with Augmented Reality (AR) and driven by MATLAB, aims to create a cutting-edge solution that revolutionizes the way we identify and address faults in these intricate electrical systems. Our system comprises a network of strategically placed sensors within the EV's interior, continuously monitoring electrical circuits for anomalies and deviations. In the event of a fault, MATLAB, a powerful computational tool, is employed to analyse sensor data promptly. This analysis allows us to precisely identify the location and nature of the fault, enabling quick and accurate responses. Augmented Reality is seamlessly integrated into the system to provide real-time visual feedback to service technicians. Through AR glasses or a mobile device, technicians can access a live, augmented view of the EV's interior. This AR interface overlays intuitive visual cues on the technician's field of view, pinpointing the exact location of the fault and offering step-by-step repair instructions. This integration not only expedites the fault-tracking process but also empowers technicians with the guidance they need to perform repairs efficiently and effectively. The synergy of MATLAB's analytical capabilities with AR technology creates a powerful synergy that streamlines fault tracking, reduces the margin for error, and enhances the overall safety and reliability of electric vehicles. This proposed system represents a ground breaking advancement in the field of automotive maintenance, offering a novel and efficient approach to ensure the optimal performance and safety of electric vehicles in the modern era of sustainable transportation.

**ELECTRIC VEHICLE COMBINED WITH AUGMENTED REALITY**

Combining electric vehicles (EVs) with Augmented Reality (AR) technology represents an exciting convergence of two cutting-edge fields, promising innovative solutions and enhanced user experiences. Here are some key aspects and potential applications of electric vehicles combined with augmented reality: Enhanced Driver Assistance: AR can overlay real-time information onto the driver's field of view, providing navigation directions, speed limits, and other relevant data directly on the windshield or through a head-up display. It can offer adaptive cruise control and lane-keeping assistance by highlighting optimal driving paths and safe following distances. Maintenance and Repairs: Technicians can use AR glasses or headsets to access repair manuals, schematics, and diagnostic tools while working on EVs, improving the efficiency and accuracy of maintenance procedures. AR can provide step-by-step instructions for routine maintenance tasks, helping EV owners perform basic checks and repairs. Charging Stations:

AR apps can guide EV drivers to nearby charging stations and provide real-time availability information, helping to alleviate "range anxiety. "Users can view charging station details, including pricing, power levels, and user ratings, through AR interfaces.

Battery Health Monitoring: AR can display information about the state of the EV's battery, such as charge level, degradation, and estimated range, helping drivers plan their trips more effectively. Users can visualize battery charging and discharging processes to better understand energy consumption.

## 3. RESULTS AND DISCUSSION

**3.1 Build a MATLAB Simulink Model:** First, you'll need to create a new model by selecting New from the File menu. You will be presented with a blank model window. Then, in the Library Browser, pick the Sources icon. This will open the Sources window, which contains the Sources block library. These sources are mostly utilised to create signals. From the Sources window, drag the Clock blocks and Sine Wave to the left side of your model window. Once you have clicked the Sinks symbol in the Library Browser, drag the Scope and To Workspace blocks into your model window. To open the Signal Routing window, click the Signal Routing icon in the Library Browser. Drag the Mux block into the model window, then open the Math Operations window by clicking on the Math Operations icon in the Library Browser. Add the Gain block to your model window by dragging it there. Select the blocks by clicking the left mouse button while the cursor is on the block. Place the pointer on one of the corners, then push and hold down the left mouse button. When the block has reached the required size, move the mouse and release the mouse button. To move a block, you must first pick it. Then, with the cursor inside the block, press and hold the left mouse button. Release the mouse button after dragging the block to its new location. By now, you have learnt the basics of MATLAB Simulink and how to use it to create and analyse the models of dynamic systems. You also learnt how to use the Simulink library browser to get blocks and functions. Don't forget to experiment with different amplitudes and frequencies to fully comprehend how it works. Learn more about Data Science, check out our Data Scientist Master's Program to help you get started.

**3.2 Automotive Applications:** Simulink allows you to model and simulate a variety of automotive systems. You can model and simulate the vehicle and environment, and develop control algorithms for automotive applications. These example models illustrate automotive applications. In addition, the following products extend the Simulink environment for automotive applications: Powertrain Block set provides fully assembled reference application models of automotive powertrains, including gasoline, diesel, hybrid, and electric systems. Vehicle Dynamics Block set provides fully assembled reference application models that simulate driving maneuvers in a 3D environment. Automated Driving Toolbox provides algorithms and tools for designing, simulating, and testing ADAS and autonomous driving systems. Model-Based Calibration Toolbox provides apps and design tools for optimally calibrating complex engines and powertrain subsystems.

### 3.3 Automated Driving Toolbox

Automated Driving Toolbox provides algorithms and tools for designing, simulating, and testing ADAS and autonomous driving systems. You can design and test vision and lidar perception systems, as well as sensor fusion, path planning, and vehicle controllers. Visualization tools include a bird's-eye-view plot and scope for sensor coverage, detections and tracks, and displays for video, lidar, and maps. The toolbox lets you import and work with HERE HD Live Map data and ASAM Open driver road networks. Using the Ground Truth Labeler app, you can automate the labelling of ground truth to train and evaluate perception algorithms. For hardware-in-the-loop (HIL) testing and desktop simulation of perception, sensor fusion, path planning, and control logic, you can generate and simulate driving scenarios. You can simulate camera, radar, and lidar sensor output in a photorealistic 3D environment and sensor detections of objects and lane boundaries in a 2.5D simulation environment. Automated Driving Toolbox provides reference application examples for common ADAS and automated driving features, including forward collision warning, autonomous emergency braking, adaptive cruise control, lane keeping assist, and parking valet. The toolbox supports C/C++ code generation for rapid prototyping and HIL testing, with support for sensor fusion, tracking, path planning, and vehicle controller algorithms.

**3.4 Powertrain Block set:** Powertrain Block set provides preassembled automotive vehicle reference applications for gasoline, diesel, hybrid, fuel cell, and battery electric propulsion systems. The block set includes a component library for engines, traction motors, batteries, transmissions, tires, and driver models, as well as component and supervisory controllers. Powertrain Block set offers the Virtual Vehicle Composer app for configuring and parameterizing models, as well as prebuilt workflows for resizing components, calibrating models from data, optimizing shift schedules, and generating deep learning dynamic plant and state estimators. You can use these models for design trade off analysis and component sizing, control parameter optimization, and hardware-in-the-loop (HIL) testing. The models are open, so you can incorporate your own subsystems and customize them as needed.

**3.5 Vehicle Dynamics Block set:** Vehicle Dynamics Block set™ provides preassembled automotive vehicle dynamics reference applications for passenger cars, trucks, and two-wheelers. The block set includes a component library for propulsion, steering, suspension, vehicle body, brakes, tires, and driver models, as well as component and supervisory controllers. You can use the built-in interface with Unreal Engine® to visualize simulations and communicate scene information back to your model. Vehicle Dynamics Block set offers the Virtual Vehicle Composer app for configuring and parameterizing models, as well as prebuilt workflows for Kinematics and Compliance (K&C) testing and calibrating models from test data. You can use these models for ride and handling analyses, chassis controls development, software integration testing, and hardware-in-the-loop (HIL) testing. The models are open, so you can incorporate your own subsystems and customize them as needed.

## 5.CONCLUSION

In the rapidly evolving landscape of electric vehicles (EVs), ensuring the reliability and safety of these advanced modes of transportation is a top priority. The intricate interior wiring systems of EVs, responsible for controlling essential functions, demand precise fault tracking mechanisms. This research has presented an innovative solution that marries the computational prowess of MATLAB with the immersive capabilities of Augmented Reality (AR) to transform the process of fault tracking within EVs. The fusion of MATLAB's robust analytical tools with AR's real-time visualization and guidance has the potential to revolutionize automotive maintenance and repair practices. Through this integration, technicians gain access to a powerful diagnostic tool that not only accelerates the fault detection process but also enhances the accuracy of identification and repair. The intuitive overlays provided by AR, coupled with MATLAB's data processing capabilities, offer a holistic solution for addressing interior wiring faults in EVs. As the electric vehicle industry continues to grow, and EVs become an integral part of our daily lives, the importance of efficient fault tracking mechanisms cannot be overstated. This research sets the stage for a safer, more reliable, and sustainable future for electric mobility. By harnessing the synergy of MATLAB and AR, this solution not only improves the EV user experience but also exemplifies the innovative spirit that drives the evolution of automotive technology. It is our belief that the convergence of these cutting-edge technologies will contribute significantly to the continued success and widespread adoption of electric vehicles on our roads. In the future, the capabilities of this tool can be extended. For example, a specific version of the application could be created for technicians, so that they can have more details on a terminal that they intervene on. We will also attempt to apply digital twins in our application, which would allow us to connect with a charging station and inspect the status of that station.

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