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Blockchain and Deep Learning-Based Fault Detection Framework for Electric Vehicles

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Abstract: The gradual transition from a traditional transportation system to an intelligent transportation system (ITS) has paved the way to preserve green environments in metro cities. Moreover, electric vehicles (EVs) seem to be beneficial choices for traveling purposes due to their low charging costs, low energy consumption, and reduced greenhouse gas emission. However, a single failure in an EV's intrinsic components can worsen travel experiences due to poor charging infrastructure. As a result, we propose a deep learning and blockchain-based EV fault detection framework to identify various types of faults, such as air tire pressure, temperature, and battery faults in vehicles. Furthermore, we employed a 5G wireless network with an interplanetary file system (IPFS) protocol to execute the fault detection data transactions with high scalability and reliability for EVs. Initially, we utilized a convolutional neural network (CNN) and a long-short term memory (LSTM) model to deal with air tire pressure fault, anomaly detection for temperature fault, and battery fault detection for EVs to predict the presence of faulty data, which ensure safer journeys for users. Furthermore, the incorporated IPFS and blockchain network ensure highly secure, cost-efficient, and reliable EV fault detection. Finally, the performance evaluation for EV fault detection has been simulated, considering several performance metrics, such as accuracy, loss, and the state-of-health (SoH) prediction curve for various types of identified faults. The simulation results of EV fault detection have been estimated at an accuracy of 70% for air tire pressure fault, anomaly detection of the temperature fault, and battery fault detection, with R^2 Scores of 0.874 and 0.9375.

Keywords: electric vehicle; convolutional neural network; long-short term memory; fault detection; blockchain; deep learning

MSC: 68T07

1. Introduction

EVs have completely revolutionized conventional vehicles worldwide due to their benefits, e.g., decarbonization, being eco-friendly, and low maintenance costs. Immense burning of fossil fuels in conventional gasoline or diesel vehicles can generate a high amount of harmful greenhouse gases that are detrimental to the greener environments