Model-Based Testing Methodology for Vehicle Battery System Controllers

Doctoral Dissertation - Abstract

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The testing methodology for electric vehicle battery system controllers developed in this doctoral dissertation utilizes advanced artificial intelligence models, particularly conditional variational autoencoders. The aim of the research was to create an innovative approach that enables efficient and fully automated anomaly detection in the safety functions of battery controllers, with an emphasis on precise timing analysis. In the face of the dynamic development of electromobility and the increasing complexity of embedded systems, it is crucial to ensure that the safety functions of these systems operate in accordance with strict timing requirements.

In the study, a conditional variational autoencoder was employed to analyze both synthetic and real data. This technique enabled accurate modeling of the response times of safety functions and the identification of deviations from the norm indicating potential anomalies. The process encompassed data analysis in various test scenarios, which allowed for assessing the effectiveness of the proposed methodology across a wide range of operational conditions. The application of artificial intelligence in this context is innovative, as it allows for the automation of the testing process and enhances its accuracy.

The research results demonstrated that the developed methodology effectively detects anomalies in battery system controllers, surpassing traditional heuristic methods in terms of efficiency. Tests conducted on real data confirmed that this method significantly reduces the risk of exceeding permissible response times of safety functions, which is crucial in designing safe and reliable control systems. Moreover, this methodology allows for precise forecasting of response times, further increasing its practical value.