APPLYING MODEL BASED TESTING APPROACH IN ELECTRIC VEHICLE CHARGING SYSTEM: MyEV CHARGING SYSTEM CASE STUDY

ATIQAH BINTI AZLAN

UNIVERSITI TEKNOLOGI MALAYSIA

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To my beloved family and friends

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ABSTRACT

One of the major aspect in embedded system is the design itself. However, it is usually being neglected through consideration even in conception phase where in later part causing discovery of fault and error to the system This report discusses the current issue that have been arousing the embedded system testing specifically during design phase. Currently, there are few model based testing approach that have been introduced in embedded system field using model diagram. Existing technique of model based testing approach were studied and analysed to come out with the best testing approach to be implemented in electric vehicle charging system. MyEV system has been selected as case study of this approach.

ABSTRAK

Salah satu aspek penting dalam ‘embedded system’ adalah peringkat reka bentuk system. Walaubagaimanapun, peringkat ini sering diabaikan melalui pertimbangan pada peringkat awal di mana ia akan mengakibatkan penemuan kesalahan dan ralat pada system. Projek ini membincangkan tentang masalah utama masa kini yang terjadi dalam proses pengujian ‘embedded system’ terutama sekali dalam proses reka bentuk system. Pada masa kini, beberapa kaedah menggunakan pengujian berdasarkan model telah diperkenalkan dalam bidang ‘embedded system’. Teknik pengujian system yang sedia adadikaji dan dianalisa untuk menghasilkan prototaip dengan kaedah pengujian system terbaik yang akan diimplementasi dalam ‘embedded system’ yang dikomersialkan serta cadangan untuk menambah baik teknik yang sedia ada bagi menambah mutu kualiti dalam proses pengujian system.

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LIST OF ABBREVIATION

i-MiEV	-	Mitsubishi Innovative Electric Vehicle
EV	-	Electric Vehicle
ICE	-	Internal Combustion Engine
MBT	-	Model Based Testing
UML	-	Unified Modelling Language
CFG	-	Control Flow Graph
PIM	-	Platform Independent Model
PIT	-	Platform Independent Test
MiLEST	-	Model in Loop for Embedded System
SUT	-	System under Test
V2G	-	Vehicle To Grid
MDE	-	Model Driven Engineering
FSM	-	Finite State Machine
QML	-	Qtronic Modelling Language

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Electric vehicle is no longer a foreign word in our community as it has grown popular and environmental friendly demand in this urban society. The latest update from Road Transport Department has shown statistics that over the past three years around a thousand electric vehicle were sold including cars and motorcycles. In conjunction to promote this new eco-friendly technology, a government agency Green Tech Malaysia under Energy, Green Technology and Water Ministry is pushing for electric powered mobility. The first was the Mitsubishi Innovative Electric Vehicle (i-MiEV), followed by the world's bestselling electric car, the Nissan Leaf. Consumer uptake has yet to be significant here but interest in electric cars is certainly growing and there are good reasons for this.

An electric vehicle can be assumed as alternate fuel automobile that uses electric motors and motor controllers for propulsion, as opposed to more common propulsion methods such as the internal combustion engine (ICE). Electricity can be used as a transportation fuel to power battery EV's where it stock electricity in an

energy storage device, like a battery. By using electric motor, the vehicle's wheels will

generate the electricity power. However due to limited energy storage capacity, EV must be replenished by plugging into an electrical source.

As electric vehicle depending solely on charger facilities, it has to these major key requirements such as charging system, charger, charging station and battery. It is really crucial for these elements to work together to ensure the reliability and usage of the vehicle. This is where the significance of EVs charging system come into picture where it has to be reliable in term of connection between the charger and vehicle system and also interaction between the system and the end user themselves.

Assuring the correctness of such demands, that is ensuring that it functions correctly within specified time constraints with minimal error, is a challenging and complex undertaking. Furthermore, debugging and correcting the error will increase the cost as the project undergo the lifecycle process. This is where the importance of testing approach come into the picture. From the aspect of software engineering, verification and validation activities focus on both the quality of the software product and the engineering process. In practice, developers usually find it more productive to enact testing and debugging together. Identifying faults and error at an early stage would be a large advantage of system output as many instances of these failures started as early as in the conception stage. It could be related to computational model, design model, informal specification and many others.

This concern that circling on EV charging system field are one of aspect highlighted in this research paper. Various model based testing strategies are chosen as subject of analysis and derived a comparison study. Model based testing relates to a process of test generation from models relates to system under trial by applying a number of sophisticated methods where the universal concept is deriving test specification from both system requirement and model that describe the functional and non-functional aspect in system testing. Furthermore, model based testing has been shown to provide good coverage of all the behaviours of the system under test and to reduce the effort and cost for testing.

1.2 Background of the Problem

EVs charging system comprises of both element, software and hardware, where in much opinion, software is claimed to be the dominant part of embedded, either as final product or in development life cycle. In both instances, it has to be thoroughly verified to assure product quality and dependability. This type of application mostly brings additional issue rather than normal system as there are lot of instances need to be taken care of. We have selected two main issues to be addressed which are testing process rarely become the main priority in whole development process despite the time constraint and the tools used does not satisfy functionalities coverage of the system.

Among the common issue that lead to neglecting testing process are the instability and complex specifications of target programs, different computational platform dependent constraints and chasing deadline for faster time to market. The pattern as can be seen through research on regression testing of a model software, major part of the application does not depend directly on hardware, and one can argue that only a small percentage requires to be tested together on target platform, and even so, this test is considered as part of platform design, not the system design.

The failure in detecting it in design phase lead to incorrect or unsuitable requirement being implemented. While requirement being imprecise, this could add up to new issue, where the focus area of testing wrongly chosen thus causing unsatisfied coverage in term of functionalities of the system. One needs to know the key functionalities requirement of the system to perform a good coverage while conducting testing. If this concern can be catered, it could assist in carrying out testing with the help of beneficial and effective testing tool.

Besides that, time is also one of the crucial aspect in marketing the new technology as it is never enough time to test the overall system especially when we are dealing with manual testing process. Different documents often describe almost identical test sequences that need to be carried out on different modules with similar functionalities. This will delay in modelling the whole testing process and process it further like constructing test plan, strategy and test documents. With this interruption, it not only impact on the product time delivery but also less confidence being presented to the end users.

1.3 Problem Statement

The key issues as highlighted in the previous section bring one major highlight that need to be taken seriously that is finding the most relevant model based testing approach that is best suited for EVs charging system.

While conducting this research, these are some important key points:

a) What are the capabilities of model based testing tools in handling issue of time constraint in testing process and incomplete coverage of testing functionalities of EV system?

b) Which model based testing approach is best suited to be implemented on EVs charging system?

c) What is the best method to show the relationship between the testing tools capabilities and functionalities of EVs charging system?

1.4 Project Objectives

There are three main objectives of this research which are:

a. To identify the capabilities of the current selected Model Based Testing (MBT) tools

b. To identify a set of common functionalities of Electric Vehicle(EV) Charging Systems

c. To generate a traceability matrix that demonstrates the relationship between the capabilities of the selected MBT testing tools and functionalities of EV system.

1.5 Project Aim

The aim of this research project is to analyse the key functionalities of EV Charging System and how current model based testing tools can accommodate in the testing process by using the capabilities that the tool own. A number of model based testing tools and EV charging system have been carefully chosen to carry out the analysis. In our case, we have selected MyEV project to be the EV charging system for this project case study.

1.6 Project Scopes

The main deliverable of this project would be the implementation of model based testing approach based on study done on selected EV system and model based testing approach. Therefore, the scope of this project focuses on:

a. There are eight EV charging project selected in this study. MyEV project from Universiti Teknologi Malaysia has been selected as a case study for this project. We will use this project as a reflection of current EV charging system.

b. There are eight testing tools that have been selected which are Conformiq Designer, fMBT, Graphwalker, MaTeLo, Model Junit, RT-Tester, TestCast and TestOptimal. A technique from Model Based Testing (MBT) is chosen from the analysis of various testing process. Two type of MBT tools are considered for this analysis which are licensed and open source tools where few tools from each category have been selected as main focus of the analysis

c. We do not perform technical or dynamic testing to propose improvement on the selected current technique. We will be using static analysis or based on our literature analysis to propose the improvement

1.7 Summary

This chapter identifies a general scheme of this research paper by making a brief introduction and issue that circulated in this field. From there, problem statement were identified, includes the research questions that formulate the objectives of this project. The project aim and scope that cover this research have also been pointed out. This research project will be successfully accomplished by successfully implementing the aims and objective of the task.

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