PERFORMANCE STUDY AND EVALUATION OF ELECTRIC VEHICLE SYSTEM

SAM MAHMODICHERATI

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To my parent, wife, beloved
brothers, sister

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ABSTRACT

Due to the limitation of fossil fuels and the high consumption rate of this energy for transportation, inclination of vehicle industry toward other sources of energy is inevitable. Electric vehicles and hybrid vehicles could be one of possible solution. Thanks to the state-of-art electric motors, power electronics, embedded power train controller, energy storage systems such as batteries and ultra capacitors, the performance of the vehicle could become more and more energy efficient. Since the integrating of all these components in a drive train configuration could be a challenge for the manufacturer, computer simulation and modeling before prototyping could be really beneficial in terms of cost, safety and design performance. In this thesis some of the principles of modeling and simulation are discussed. Some tests in order to find the internal parameters of the battery are explained and based on the data from the tests a Lithium-ion battery and electric vehicle performance is evaluated by using model which is whuch us dveloped using Simulink/Matlab. The dynamics of the vehicle in terms of longitudinal and lateral forces are discussed and a model representing the aerodynamic and rolling resistance are developed in Simulink. Given the data obtained from the test data from a Proton SAGA manufactured by the PROTON Company, the performance of the vehicle in terms of battery consumption, acceleration and maximum cruise speed is analyzed.

ABSTRAK

Disebabkan oleh sumber tenaga dari bahan bakar jenis *fossil* yang terhad dan kadar penggunaan tenaga yang tinggi bagi sistem pengangkutan, peralihan sumber tenaga bagi industri kenderaan tidak dapat dielakkan lagi. Antara jalan penyelesaian yang boleh diguna-pakai adalah dengan menggunakan kenderaan elektrik atau kenderaan *hybrid*. Dengan berkembangnya teknologi motor elektrik, elektronik kuasa, sistem kawalan keretapi kuasa, system penyimpanan tenaga seperti bateri dan ultra-kapasitor, prestasi kenderaan adalah menjadi lebih baik dan mempunyai kecekapan tenaga yang tinggi. Oleh kerana penggabungan secara terus kesemua komponen didalam sistem pemacuan keretapi adalah agak sukar bagi industri pembuatan, permodelan dan simulasi komputer bagi sesebuah sistem sebelum sistem sebenar dibina adalah kaedah yang amat efisyen dari segi kewangan, keselamatan dan prestasi sistem yang direka. Dalam tesis ini, beberapa prinsip permodelan dan simulasi dibincangkan. Beberapa ujikaji yang dijalankan untuk mengenalpasti parameter dalaman bagi bateri berdasarkan *Lithium-ion* bateri ada diterangkan. Prestasi bagi model kenderaan elektrik juga dinilai dan dikaji dengan menggunakan perisian Simulink/MATLAB. Dinamik bagi sesebuah kenderaan sepertri *Lateral Forces* dan *Longitudinal* turut dibincangkan dan model yang mewakili *aerodynamic* dan rintangan putaran telah dibina didalam Simulink. Data yang diperolehi adalah hasil daripada ujikaji yang menggunakan kenderaan Proton SAGA keluaran syarikat PROTON. Daripada data tersebut, prestasi kenderaan seperti penggunaan bateri, kadar pecutan dan maksimum jarak pada kelajuan sederhana turut dianalisis.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The increase of depletion of fossil fuels for multiple purposes like generation of other forms of energy (electricity, heating and transportation) is growing. Along with this increased global demand for power comes the increased pollution from consuming fuels. Both the decreasing supply of fossil fuels and the increasing level of pollutants in our environment are becoming very significant concerns. This growth is much faster than the time it takes to aggregate the energy stored in new oil and coal, so As a result, electric vehicles become a center of attraction for researchers and government to overcome this problem.

Modeling and simulation of various hybrid and electric vehicle plays major role before the design and manufacturing process, so simulation environment which includes different models for components used in drive train could be really helpful [1]. Many researchers have been used different simulation program for performance study and evaluation of electric vehicle [1],[2]. Different components in the drive train of electric vehicles are modeled with different methods [5], [1], [3], [4]. The importance and benefit of having a simulation environment is discussed in [5], [6]. Internal combustion engines model is explained in [14]. Batteries as a main part of EV, was simulated by different methods in [8], [9], [10], [11]. Reference [7] presented about energy management and control strategies used in hybrid drive trains. In [3], [12], [5], [13], [9] some methods for modeling of electric machines are

given. As the whole drive train of hybrid vehicles is a combination of electric and mechanical components, the dynamic modeling of the vehicle and mechanical parts is in the aspect of interest.

1.2 Significance of Study

Pure Electric vehicle has important role in green transportation in which the selection of appropriate propulsion system for better dynamic performance needs to be focused The main efforts for manufacturer are simulation and modeling before prototyping, to make design of EV be more beneficial in terms of cost, safety and design performance. This paper proposes a simulation results on vehicle's dynamic performance, which predicts the energy consumption from lead-acid battery and range possibility of vehicle after every recharging battery. Perusahaan Otomobil Nasional (PROTON) is the first company in Malaysia that has decided to produce electric vehicle to reduce air pollution caused by internal combustion engine. The simulation result obtained from this study is used to predict the performance of an EV converted from ICE PROTON SAGA, which is part 7 the Proton-UTM research collaboration program.

1.3 Objective of Study

The purpose of this thesis is to provide some tools and methods for modeling and simulation of components used in drive trains of electric vehicles. A goal is to introduce the principles of simulation and methods used for simuling vehicular power systems. It is desired to create a simulation model for different components used in vehicle drive train. Different methods used to model vehicle dynamics, batteries and electric motors, engine is given. Altogether, making a simulation environment to show the importance of modeling and simulation of vehicular power systems is the main objectives of this thesis.

1.4 Scope of Study

The scope and limitation of the study are as follow:

1) Evaluating dynamic performance of electric vehicle that include of simulating all resistance forces applied on the vehicle.
2) Evaluating Running range of vehicle per battery full-charge.
3) Evaluating maximum gradibility and acceleration time of vehicle is evaluated.

1.5 Organization of the Report

This report is divided into six chapters. Chapter 2 discusses on the literature review and classification of electric vehicle. Chapter 3 describes about dynamic of electric vehicle. The methodology and simulation process is explained in Chapter 4.The results and discussions will be presented in Chapter 5. The last chapter provides the conclusion of the study and future work.

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APPENDIX A: DATASHEET