



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF REGENERATIVE BRAKING

SIMULATOR USING PUGH'S METHOD

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

by

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I hereby, declared this report entitled DEVELOPMENT OF REGENERATIVE BRAKING SIMULATOR USING PUGH'S METHOD is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow

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ABSTRAK

Sistem brek regeneratif adalah sistem yang digunakan dalam kenderaan hibrid dan kereta elektrik. Ramai pengguna hibrid tidak menyedari faedah dan prinsip kerja brek regeneratif di dalam kereta mereka. Sistem brek regeneratif dalam kereta sebenar terlalu rumit dan sukar untuk dipelajari. Antara isu yang membuat kajian ini dijalankan adalah penyediaan kenderaan yang hibrid mahal dan proses penukaran tenaga semasa proses brek regenerative sukar di fahami oleh pelajar. Sekiranya prototaip regeneratif telah dicipta pengguna mahu prototaip yang boleh menjalankan eksperimen di simulator untuk pemahaman yang lebih baik. Tujuan kajian ini adalah untuk mengenal pasti simulasi brek regeneratif. Di samping itu, simulasi ini dilakukan menggunakan kaedah Pugh. Sistem simulasi ini di pilih dengan beberapa kateria yang antaranya bentuk yang menarik dan simulasi yang mudah difahmi. Arduino Uno, motor dan jalur lampu adalah komponen penting bagi kejayaan projek ini. Produk ini dianalisis dengan merekod voltan yang dihasilkan daripada brek regeneratif berdasarkan 4 kelajuan yang berbeza. Voltan yang dihasilkan daripada brek regeneratif bergantung kepada kawalan kelajuan. Sebagai contoh, voltan meningkat apabila kelajuan meningkat. Ia juga, memberi kesan kepada masa untuk menghentikan aci kerana tenaga keupayaan yang besar dihasilkan kerana peningkatkan kelajuan, Kekuatan dan kelemahan juga disebutkan untuk penambahbaikan.

ABSTRACT

The regenerative brake system is a system used in both hybrid vehicles and electric cars. Many hybrid users are unaware of the benefits and working principle of regenerative braking in their car. The regenerative braking system within the real car is too complex and difficult for students to learn. Among the issues that made this study possible were the preparation of expensive hybrid vehicles, the cost of hybrid cars for exploratory regenerative braking use requiring skilled professional and to show students how kinetic energy is converted to electricity. If a regenerative prototype has been created the user wants the prototype to include a simulator for better understanding. The purpose of this study is to identify regenerative brake simulations. In addition, this simulation was performed using the Pugh method. This new criterion system is a simple, easy-to-understand form that can be handled by ordinary people. The Arduino Uno, motors and led strips are key components to the success of this project. The advantages of the products that are produced can be taken anywhere other than the ordinary ones can handle. This product is analysed by a record of voltage generated from regenerative brakes based on 4 different speeds. The voltage generated from regenerative braking depend on speed control. For example, the voltage increases as the speed control increase. It also makes time to stop the shaft increase due the larger potential energy in increase speed, Strengths and weaknesses are also mentioned for further improvement.

DEDICATION

To my beloved parents Zaimi bin Kamaruddin, Khuzafah binti Mohamed Damili. Thank you for all support, sacrifices, enduring and willingness to share with me. To my honored supervisor Profesor Madya Ts. Dr. Muhammad Zahir Bin Hassan, and all UTeM lecturers thank you for always giving me a supervision and persistent help to finish this project thesis.

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LIST OF SYMBOLS

-	-	Negative
+	-	Positive
kW	-	Kilowatt
S	-	Same
S	-	Second
V	-	Voltage

LIST OF ABBREVIATIONS

3D	-	Three dimensions
AC	-	Alternating Current
B	-	Battery
DC	-	Direct Current
EV	-	Electric Vehicle
G	-	Generator
HEV	-	Hybrid Electric Vehicle
ICE	-	Internal Combustion Engine
LCD	-	Liquid Crystal Display
MC	-	Motor Controller
MG	-	Motor Generator
MPD	-	Mechanical Power Distributer
RBS	-	Regenerative Braking Simulator
RPM	-	Revolutions Per Minute
SRBS	-	Simulation Regenerative Braking System
TAD	-	Torque Implication Device
USB	-	Universal Serial Bus

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CHAPTER 1

INTRODUCTION

1.1 Background Research

The development of regenerative braking system simulator to provide this tool is designed to help educators and visitors discover the regenerative braking process. They will apply the regenerative braking mentor theory in the regenerative braking simulator tool. This simulator is designed to enable them to quickly understand the concept of regenerative braking versus learning theory. In addition, most students who understand the theory are difficult to apply in the practical, this causes them to only memorize. Hence, the initiative to make students more understand and easy to apply them in a practical regenerative braking simulator has been made to better understand the concept regenerative braking. Pugh method is other of way from gain an information by compering and variance data (Gabriella Gustafsson and Sebastian Leo, 2018). This method evaluate by the value of scoring system on variance of important weigh of product result will show the rank for produce. Function of compare the scoring system and weight of product to expression a clear of obligation of the criteria product. Pugh matrix is conceptual strategy the common method uses because, it directly compares design against requirements criteria with the objective selecting.

Regenerative braking is heat was dissipated reason rubbing occur when braking that the heat energy is modification by change other type of energy is call energy recover mechanism or call regenerative braking. Regenerative braking occurs during wheel braking or going downhill. Most of regenerative braking apply in hybrid cars as show in **Table 1.1**.

Table 1.1: List of Hybrid Type by Different Model of Company (Atharva et al., 2017).

Company	Model	Vehicle Class	Hybrid Type
Chevrolet	Tahoe	SUV	Full Hybrid
Ford	Escape	SUV	Full Hybrid
GMC	Silverado	Pickup Truck	Micro Hybrid
GMC	Sierra	Pickup Truck	Micro Hybrid
GMC	Yukon	SUV	Full Hybrid
Honda	Accord	Sedan	Mild Hybrid
Honda	Civic	Compact	Mild Hybrid
Lexus	RX 400h	SUV	Full Hybrid
Lexus	GS 450h	Sedan	Full Hybrid
Lexus	LS 600h L	Sedan	Full Hybrid
Mazda	Tribute	SUV	Full Hybrid
Mercury	Mariner	SUV	Full Hybrid
Saturn	Aura GreenLine	Compact	Micro Hybrid