DEVELOPMENT OF SINGLE-WHEELED BALANCING SCOOTER

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation)(Hons.)

by

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I hereby, declared this report entitled “Development of Single-Wheeled Balancing Scooter” is the results of my own research except as cited in references.

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Date	:	28 JUNE 2013

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation) (Hons.). The member of the supervisory is as follow:

……

(DR. FAIRUL AZNI BIN JAFAR)

ABSTRAK

Projek ini bertujuan untuk membangunkan skuter beroda satu. Setiap rekabentuk dan idea adalah untuk penambahbaikan skuter beroda satu yang telah dibina. Kajian ini adalah penting untuk menyelesaikan masalah yang dihadapi oleh pencipta skuter sebelum ini. Keberkesanan dan jalan penyelesaian untuk perjalanan dari satu tempat ke destinasi lain dapat diatasi. Melalui projek ini, skuter beroda satu telah dikaji untuk penambahbaikan dari idea yang mudah sehingga siap dibangunkan menjadi satu skuter yang lengkap. Pada permulaan laporan ini, secebis maklumat mengenai skuter beroda satu akan didedahkan. Ini adalah termasuk objektif dan matlamat utama yang perlu dicapai pada pengakhiran reka nbentuk dan pembuatan skuter beroda satu. Beberapa masalah telah dihadapi pada awal pembuatan seperti rekabentuk, barang, dan kekurangan maklumat akan diberitahu. Terdapat beberapa perbandingan antara skuter beroda dua dan satu. Kelemahan dan kekuatan, kelebihan dan kekurangan kedua-dua jenis skuter akan didedahkan. Skuter beroda satu yang telah dibangunkan pada masa kini akan diberi penerangan sepenuhnya. Setiap cebisan maklumat dan keputusan serta butir-butir perincian ciptaan seperti rekabentuk, sistem elektronik, prestasi, dan pengawalan telah dikumpulkan.

ABSTRACT

The purpose of this project is to develop a single-wheeled scooter. Each design and idea for improvement of single-wheeled balancing scooter has been made. This development is important to provide problem solving from a previous unicycle scooter. In this project, the single-wheeled unicycle has been researched for enhancement from a simple idea into a complete scooter. At the beginning of the report, a piece of information regarding a single-wheeled scooter has been enlightened. This will include the main objective and goal to be achieved at the end of design and development of single-wheeled balancing scooter. Several problems in early stage of development such as design, part, and lack of information has been notified. There is a comparison between two-wheeled and single-wheeled balancing scooter. The weaknesses and strength, advantages and disadvantages of both type of balancing scooter has been enlightened. A single-wheeled unicycle that has been developed in this early day has been illustrated. Each piece of info including detail and result of the invention such as design, electronic system, performance, and controllability has been gathered.

DEDICATION

This report is lovingly dedicated to my respective parent, Radzali Bin Md. Yusof and Fatimah Wati Binti Mohd Ali. An appreciation to my Supervisor, Dr. Fairul Azni Bin Jafar, lecturers and friends that have been my constant source of inspiration. They have given me the drive and discipline to tackle any task with enthusiasm and determination. Without their love and support this project would not have been made possible.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

BLDC	-	Brushless Direct Current
C++	-	Programming Language
CG	-	Center of Gravity
cm	-	Centimetre
COG	-	Center of Gravity
DC	-	Direct Current
IMU	-	Inertia Measurement Unit
kg	-	Kilogram
mm	-	Millimeter
PIC	-	Peripheral Interface Controller
RM	-	Ringgit Malaysia
V	-	Volt
vs.	-	Versus
$	-	United State Dollar

CHAPTER 1
INTRODUCTION

The new invention, design, and manufacturing are all come from a single idea that is to generate into a bigger concept and futuristic thinking. It is not about how to invent a new product, but the idea is to improve existing product for better performance. To improve the product, it required certain stages to achieve and required a lot of budgets and times that need to be considered or it can slow down the process. The development of single-wheeled balancing scooter is an invention to improve the scooter from the aspect of performance and quality.

The goal in this project is to construct a single-wheeled transport stabilizes itself while idle. The word stabilizes means to make or keep in equilibrium (steady state). However, if the system is not balanced, it can fall off. Therefore, a simple mechanism is needed to provide an input into the microcontroller, with the program inside as a balancing algorithm.

1.1 Background

Figure 1.1: Single Wheel Future Concept

[Souto, C., (2012). http://www.chrissoutodesign.com/orbis-urban-mobility-vehicle/]

This project is an inspiration from future concept to develop a single wheel balancing mobile or scooter. An attraction with this kind of technology gives a different kind of idea and different ways of a design and an interface. Nowadays, a lot of two wheel balancing scooters and personal transporter introduced in the market. So that, in a different way, a single wheel balancing scooter is an idea that gives the different concept and design for a new interface.

Currently, there are many versions, designs that have been made, but they are with different ways of application. Some improvements are planned to be performed to stabilize and give a balance to the new design. For a future planning, this project can help to provide easy ways to travel from point A to point B for short distance travel such as indoor usage and can be upgraded for outdoor usage in future research.

1.2 Problem Statement

Figure 1.2: Two-Wheeled balancing Scooter

[FreeGo. (2012). http://freegochina.en.busytrade.com/selling_leads/info/2417200/Two-Wheel-Electric-Scooter-uv02-.html]

The innovation of balancing scooter has a progression of many stages. But, there are a few difficulties need to be considered to construct this invention. The two wheel balancing scooter product required an extra cost then producing a single wheel balancing scooter. By adding two wheels, gear system, body frame structure, etc. required a lot of time for production and required additional cost to invest so that it meet the design requirement. Furthermore, the two wheeled design required more space, hence, it required big area to keep it.

1.3 Objectives

The objectives of a single-wheeled balancing scooter are;

a) To develop a single-wheel balancing scooter.
b) To analyze the performance of the developed scooter.

1.4 Scope

This project consists of body frame, single wheel, microcontroller, and a motor. The concept of single-wheel transporter initiate from a drawing and a simple design to illustrate a rough sketching of the scooter. This is a crucial part where all the components must be placed at the right position so that it has a smooth and comfortable interface for usage. All the design and drawing has been gathered and a selection has been made. The finest design has been improved so that it can be the requirement needs.

After that, all the parts can assemble and a single-wheeled scooter can produce. Each part of the scooter has been analyzed to check the performance, strength, durability, and the important is can carry the load size of an adult person and stabilize when idle. The torque and motor performance, shaft connected between tire and a body frame, microcontroller are important to be tested so that, the performance must be at the optimal state.

Another significant part in developing a single-wheel scooter is about how the user can attracted to ride the invention concept of the single - wheel scooter. This is able to allocate problem issue regarding the project. Improvement has been made to achieve a better result considering the problem issue raise through testing.

1.5 Report Structure

In the beginning of this report, it is categories into three main chapters which are the introduction, literature review, and methodology. For an introduction, it is explained in this chapter. Firstly, a background which tells the motivation that generates an idea for this project is described. The project inspiration has been stated in this section. Secondly, it is a problem statements brief description of the issues that need to be addressed before solving the problem. Similar products are compared to the single wheel transporter in this project. Thirdly is objectives that are something which are intended to be attained or accomplish, purpose, and goal. In this section, the aim is to fulfill the requirement needed. Fourthly, it is a scope that covers the extent or range of view. The project brief has been explained in this chapter. Lastly, for report structure, each chapter has been explained.

In chapter 2, literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical that contribution to a particular topic. The comparison of product, technique used, limitation and etc. have been clarified in this chapter.

In chapter 3, methodology is a guideline system for solving problems. The flow of the process from beginning to the end of the project has been illustrated in a chart. It has been an explanation regarding a process of making this project.

In chapter 4, it is about result and discussion. Required information such as testing part and problem take place within the time taken to build this scooter has been discussed. The result can be used for further research and improvement.

Lastly, chapter 5 is a conclusion and future works. In general, the outcome of the research from beginning till the end has been discussed. Any value of information such as advantages, disadvantages, and any relevant point of view have been stated.

CHAPTER 2

LITERATURE REVIEW

This chapter is discussing the related works on double and single-wheeled scooter. The advantages and disadvantage of each model are discussed, while the basic concept of the scooter is introduced.

2.1 Two-Wheeled Scooter

Figure 2.1: The Segway

The basic idea for a two-wheeled balancing scooter is a simple concept by moving the motor in a direction to counter the direction of fall. A two wheeled balancing scooter such as the Segway invented by Dean Kamen (Kamen. D, 2001) is an example of this type of product (Figure 2.1). It uses such as computers and motors in the base of the device to keep the Segway upright when powered on and balance while a user is standing on top of it. Moreover, this product used a simple command to move forward by shifting their weight forward and moving backward by shifting their weight backward. To turn, the user can manipulate a control on the handlebar whether left or right. The Segway had driven using a two electric motor and a speed of 20.1 km per hour. The battery is made of lithium ion batteries. The battery need to be checked regularly and recharge it timely. By using two drive electric motors, it consumes extra power for a single battery. The lithium ion batteries should be suitable for this application, but the effect is totally on the price tag.

2.2 Single-Wheeled Scooter

Apart of the development of the two wheeled scooter as explained in sub-chapter 2.1, there were also a few developments of single-wheeled scooter, in which only one tire is used rather than two tires.