

SMART BICYCLE RIDER COACH

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To my beloved mother and family

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## ABSTRACT

This project aims to build a product which is can help people to control the stability of the bicycle. Nowadays, although the transportation system in Malaysia was developed from day-to-day, bicycle always be a customer's request either adult or children. The bicycle is basic transports that will be learned since age 4 or 5 year. However, there are some people especially adult still do not know how to ride bicycle. They want to learn it but they do not have much time to spend it and ashamed to ask people teach bike riding. The stability of the bicycle is an important thing to prevent fall especially in minimum speed. There are some theories, which has the faster a bicycle moved the easier it is to ride and it cannot be balanced when it is in stationary or low speed condition [1]. Clearly, the bicycle has a large measure of self-stability. Because that, to make the rider alert this kind of situation, need a product that can give a hint to the rider to steer the way correctly. The objective of this project is to solve the stability problem during riding a bicycle especially for new rider who wants to learn to ride a bicycle by signaling user through vibration. By designing this product, it can teach people to ride with an easy way by considering the stability of the rider to control the bicycle by vibrating alarm signal to the rider. By using this product, now the new user has no more use tricycle and no longer need others to help or teach in riding. It also can prevent or less of fall for the new rider during learn to ride bicycles. This product is more sophisticated and convenient to the user.

## ABSTRACT

This project aims to build a product which is can help people to control the stability of the bicycle. Nowadays, although the transportation system in Malaysia was developed from day-to-day, bicycle always be a customer's request either adult or children. The bicycle is basic transports that will be learned since age 4 or 5 year. However, there are some people especially adult still do not know how to ride bicycle. They want to learn it but they do not have much time to spend it and ashamed to ask people teach bike riding. The stability of the bicycle is an important thing to prevent fall especially in minimum speed. There are some theories, which has the faster a bicycle moved the easier it is to ride and it cannot be balanced when it is in stationary or low speed condition [1]. Clearly, the bicycle has a large measure of self-stability. Because that, to make the rider alert this kind of situation, need a product that can give a hint to the rider to steer the way correctly. The objective of this project is to solve the stability problem during riding a bicycle especially for new rider who wants to learn to ride a bicycle by signaling user through vibration. By designing this product, it can teach people to ride with an easy way by considering the stability of the rider to control the bicycle by vibrating alarm signal to the rider. By using this product, now the new user has no more use tricycle and no longer need others to help or teach in riding. It also can prevent or less of fall for the new rider during learn to ride bicycles. This product is more sophisticated and convenient to the user.



## ABSTRAK

Projek ini bertujuan untuk memreka satu produk dimana boleh membantu masyarakat untuk kawal kestabilan pada basikal. Pada masa kini, walaupun sistem pengangkutan di Malaysia sedang membangun dari hari ke hari, basikal sentiasa menjadi permintaan ramai sama ada orang dewasa atau kanak-kanak. Basikal merupakan pengangkutan asas yang dipelajari seawal umur 4-5 tahun. Namun masih ada sesetengah masyarakat masih tidak tahu menunggang basikal terutama orang dewasa. Mereka mahu untuk belajar menunggang basikal tetapi malu untuk meminta bantuan orang lain untuk mengajar menunggang basikal. Oleh yang demikian, produk ini boleh membantu mereka untuk belajar menunggang basikal dengan cara yang mudah dengan menitikberatkan kawalan kestabilan pada basikal terutama kepada penunggang yang baru belajar. Terdapat beberapa teori yang menyatakan semakin laju pergerakan basikal semakin senang ia dikawal dan apabila basikal dalam keadaan statik atau pergerakan yang perlahan, ia susah untuk mencapai keseimbangan. Ini menjelaskan bahawa untuk mengawal basikal memerlukan kestabilan yang tinggi pada diri penunggang. Disebabkan itu, untuk memastikan penunggang sedar keadaan ini, produk ini diperlukan untuk memberi isyarat kepada penunggang untuk mengawal basikal dengan cara yang betul. Objektif untuk projek ini adalah untuk menyelesaikan masalah kestabilan ketika menunggang basikal terutama penunggang baru yang mahu belajar menunggang basikal dengan menghantar kesan getaran. Produk ini boleh mengajar menunggang basikal dengan cara yang mudah dengan mempertimbangkan kestabilan pada diri penunggang itu sendiri untuk mengawal basikal melalui kesan getaran yang dihadapi. Dengan menggunakan produk ini, pengguna tidak lagi memerlukan roda tiga atau meminta orang lain untuk mengajar menunggang basikal. Produk ini juga boleh mengelakkan atau mengurangkan penunggang baru dari jatuh ketika menunggang basikal. Produk ini lebih canggih dan selesa kepada pengguna.

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## LIST OF ABBREVIATIONS

RTOS	-	Real Time Operating System
<i>u</i> C/OS-II	-	Micro-Controller Operating Sytem
OS	-	Operating System

## **CHAPTER I**

### **INTRODUCTION**

#### **1.1 Project Introduction**

Smart rider bicycle coach project is about a product which is can help people to control the stability of the bicycle. This product more suitable for people who does not know to ride bicycle and he or she has a desire to learn it. But people who do know how to ride bicycle also can apply this product to the bicycle. For those who do not know how to ride bicycles, she or he will be applying this product and learn how to ride a bicycle with easier way. In addition, the stability of the bicycle is an important thing to prevent fall especially in minimum speed. The bicycle will be balanced by the action of its rider, if it wants to fall the rider will steer into the direction of fall. There are some theories, which has the faster a bicycle moved the easier it is to ride and it cannot be balance when it is in stationary or low speed condition [1]. Clearly, that statement shows that the bicycle has a large measure of self-stability.

As a information, each bicycle has some part which is front set, wheel, frame, saddle area, pedal, front derailleur, chain, chain rings, rear brakes, cogset and rear derailleur. But the front set is an important part of the bicycle. Before the riders become a professional, they need to learn to control the front set part that has a large measure of



self-stability. In order to prevent from falling, it depends on oneself. For the new rider, they must know that to prevent from the fall, they should ride bicycles with non minimum speed. But as a starting to learn ride bicycle, they will try to ride at minimum speed and learn how to control and steer the handle bicycle in correctly way. Because of the ride bicycle in minimum speed, they will easily fall, lost control and steer the incorrect way. They difficult to control self-stability during ride a bicycle for the first time.

Due to the stability problem especially for new riders, develop this product can help them to alert this kind of situation. The product that can give a hint to the rider to steer the way correctly and to give safety to the rider when ride a bicycle especially for new beginners. By giving the vibration signal, the user will be successful to achieve equilibrium and stability during riding a bicycle easily. So that, the user clearly can prevent from falling during learn riding bicycle especially in minimum speed. This would happen when the new rider lost control and steer the handle to the right side, the vibrator will be functioning and it gives alert or warn the rider to steer the correct way. It's same as the left side, the vibrator will be functioning and it gives alert or warn the rider to steer the correct way.

Moreover, by applying this new device, the new rider has no longer need others to help or teach in cycling and no more use tricycle especially for new adult user. This product is more sophisticated and convenient to the user. The user can easily apply this product to the bicycle.

This project will focus on design a product which is can help the rider to learn riding and achieve the stable state and be balanced based on the stability problem at handlebar. Thus, to solve this problem or to achieve the objective of this project, the product is designed with two motors for giving vibration to the rider to control and steer correctly. The motor is working as giving vibration as a signal to the rider to alert the unstable state or incorrect steer by installing the motor in the right side and another one on the left side of the handle bar.

## 1.2 Problem Statement

Nowadays, although the transportation system in Malaysia was developed from day to day but some people still do not know how to ride bicycle. They want to learn it but they do not have much time to spend it, ashamed to ask people teach bicycle riding and ashamed to use tricycle. By designing this product, it can teach people to ride with an easy way by considering the stability the rider to control the bicycle. This product is more sophisticated and convenient to the user.

## 1.3 Objective of Project

The main objective of this project is to solve the stability problem during riding a bicycle especially for new user who wants to learn to ride a bicycle by signaling user through vibration.

## 1.4 Scope of Project

The scopes of work for this project are listed as below:

- (i) Literature review on dynamic bicycle, control and the forces acting on it.
- (ii) Study on the stability of the bicycle.
- (iii) Create and design a main circuit to collect the data.
- (iv) Install the circuit at bicycle and do the experiment.
- (v) Analyze the data by using MATLAB software and implement the data into the programming.
- (vi) Design and build connection to the motor which is sending a vibration signal at the right side and the left side.
- (vii) Integrate between the hardware and software after all design completed.

## 1.5 Methodology

**Stage 1:** Do a literature review for the project system by study the characteristic of the bicycle, dynamic of bicycle and control that will be used and design the circuit.

**Stage 2:** For this phase, study on how to design the circuit and identify sensor which is suitable for this project to gain data.

**Stage 3:** For this phase, it called as methodology. This part explains the steps or procedures to develop the project and how to obtain a data. After researched and discussed, create a programming to obtain data by using the MATLAB software. By using MATLAB software, all data were obtained will be plotted on the graph.

**Stage 4:** It is the final phase that called as performance test. In this phase, the main circuit was installed on the bicycle before, was added two motors on the right and left side.

## 1.6 Thesis Outlines

This thesis consists of five chapters. The following chapters are the outline of the development of the smart bicycle rider coach.

**Chapter I** Will discuss briefly the overview of this project such as introduction, objectives, problem statement, scope of work, methodology and thesis outlines.

**Chapter II** This chapter contains the research and information about the project on several important concepts of stability of the bicycle, 3 axes accelerometer sensor, micro operating system ( $\mu$ OS) and real time operating system (RTOS). Every facts and information, which found through journals or other references, will be compared and the

better methods have been chosen for the project. This chapter also includes details about the definition of bicycle, features of RTOS and also its architecture are discussed in this chapter.

**Chapter III** This chapter will discuss more about the methodology used in order to achieve the objective of the project. This chapter will explain in details on the method used to obtain the data. All these methodologies should be followed to get a better performance.

**Chapter IV** This chapter consists of the results of the experiment that will be on to get data. On the other hand, this chapter also includes analyzing the results to create a new command in the programming.

**Chapter V** This chapter will discuss about the discussion, problem, conclusion and suggestion of this project. Any comment or suggestion can be attached in order to improve the project in the future.



## CHAPTER II

### LITERATURE REVIEW

This chapter contains the research and information about the project on several important concepts of stability of the bicycle, 3 axes accelerometer sensor, micro operating system ( $\mu$ OS) and real time operating system (RTOS). Every facts and information, which found through journals or other references, will be compared and the better methods have been chosen for the project. This chapter also includes details about the background of bicycle and several types of bicycle also are discussed in this chapter.

#### 2.1 Introduction

The bicycle is a basic transportation that will be used for everyone from child until adult. The stability of the bicycle is an important thing to prevent fall especially in minimum speed. The bicycle will be balanced by the action of its rider, if it wants to fall the rider will steer into the direction of fall. There are some theories, which has the faster a bicycle moved the easier it is to ride and it cannot be balanced when it is in stationary or low speed condition [1]. Clearly, the bicycle has a large measure of self-stability. Learning to ride a bicycle is an acquired skill, often obtained with some difficulty; once mastered, the skill becomes subconscious and second nature, literally just “as easy as

riding a bike”. Bicycles display interesting dynamic behaviour. For example, bicycles are statically unstable like the inverted pendulum, but can, under certain conditions, be stable in forward motion. Bicycles also exhibit non minimum phase steering behaviour [2].

The self-stabilizing action of the front fork is best achieved by lightly gripping the handlebars. When teaching children to bike, it is important to remind them that they should not hold the handlebars too stiffly [2]. It depicts the front fork is main part to control the stability of the bicycle. Then, I need to develop this product by focusing on the front fork parts which is the product can help new riders to learn riding bicycle easily by considering the stability problem and trying to achieve the balance of the bicycle. Furthermore, this product also can be applied to the rider, who already know to ride bicycles as a safety precaution.

This chapter will cover the journals, researches, paper work and study done previously that it can be related to the stability of the bicycle, bicycle control, how the 3 axes accelerometer sensor work, and other information that relates to it.

### **2.1.1 Definition of Bicycle**

A bicycle is basic transportation which has two wheels. The rear wheel drives the bicycle, while it handlebar work as director to the bicycle. If the rider steers to the right, the bicycle is moving to the right side and if the rider steers to the left, the bicycle is moving to the left side. From that, conclude the bicycle is moving toward the direction where the rider steer is it.

## 2.2 The Stability of the Bicycle

The bicycle is assumed to be balanced by the action of its rider who, if he feels the vehicle falling, steers into the direction of fall and so traverses a curved trajectory of such a radius as to generate enough centrifugal force to correct the fall. The stability of the bicycle is an important thing to prevent fall especially in minimum speed. The bicycle will be balance by the action of its rider, if it wants to fall the rider will steers into the direction of fall. There are some theories, which are the faster a bicycle moves the easier it is to ride and it cannot be balance when it is in stationary or low speed condition [1].

According to this paper, to achieve the stability of the bicycle is depending of its rider and how the rider controls and steer the bicycle to be balanced. Besides, this paper also mentions that at minimum speed the rider easy to fall and it cannot be balanced. To prevent from falling, the rider must ride a bicycle in non minimum speed and know how to control the stability and equilibrium during riding a bicycle. But for the new rider, he will be riding bicycles at minimum speed and carefully to control and steer the bicycle in the correct way for the first time. Furthermore, he also has difficulty to control the stability and achieve equilibrium between himself with a bicycle. If he lost the stability, he also will lose control and steer the bicycle incorrect way, then he will fall from a bicycle. For the new rider, he has to face this kind of situation. As a new rider, he will be easy to fall and after a several times, finally he succeeds to ride bicycles with confidence. In order to design a product that can help or teach to ride bicycles, the stability problem need to be concerned. In addition, the stability problem will be solved by depending the rider itself because a bicycle has a large self-stability. By applying this product, it cannot solve the stability problem 100 percent, but it can help the user to reduce the stability problem by giving a signal. This signal operates as a warning sign to the user if he hasn't been stable situation. The stable situation means that, the handle of the bicycle in center position. This product also can teach the new rider to control and steer in the correct way.



A detailed model of a bicycle is complex because the system has many degrees of freedom and the geometry is intricate. Successful control and manoeuvring of a bicycle depend critically on the forces between the wheels and the ground. Acceleration and braking require longitudinal forces, whereas balancing and turning depend on lateral forces. A good understanding of these forces is necessary to make appropriate assumptions about valid models of the rolling conditions. The self-stabilizing action of the front fork is best achieved by lightly gripping the handlebars. When teaching children to bike, it is important to remind them that they should not hold the handlebars too stiffly. [2].

This article is about analyzes the dynamics of bicycles from the perspective of control. It shows that the analysis used differential equations to describe the motion of an idealized bicycle. But to develop this project, I only focus on understanding the forces involved and relate it with the objective of the project. In order to solve the stability problem, firstly need to figure out the forces against bicycle like in acceleration and braking require longitudinal forces, controlling the handlebars by applying a torque, balancing and turning depends on lateral forces and leaning effect on the rider. Furthermore, this article assumed that the bicycle consists of four rigid parts, specifically, two wheels, a frame, and a front fork with handlebars. And the front fork is an important part because the front fork consist handlebars that will be used to steer the correct way and to control the balancing and stability of the bicycle. In minimum speed, the way to control the handlebar can reduce the stability problem but the new rider will feel difficult to steer the handlebar in correctly way. By reading this article, it gained my understanding of the forces against bicycle and made me to develop the product by considering to control at the front fork parts especially at the handlebar. In addition, it also mentions that the self-stabilizing action of the front fork is best achieved by lightly gripping the handlebars. By taking this action, the rider will easily steer the handlebars.

A bike is balanced strictly by the rider, who constantly steers in the direction the bike is falling by a turning radius small enough to generate enough centrifugal force to counteract the fall. Certainly this can explain some of the story, such as how greater speed increases the bicycle's stability and requires less steering correction, since at