UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AIR POWERED BICYCLE USING LINEAR ACTUATOR (PNEUMATIC CYLINDER)

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

by

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DECLARATION

I hereby, declared this report entitled "Development of Air Powered Bicycle Using Linear Actuator (Pneumatic Cylinder)" is the result of my own research except as cites in reference.

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Date : 19 JUNE 2016

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APPROVAL

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

……..

(ENCIK KHAIROL ANUAR BIN RAKIMAN)

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ABSTRAK

Projek ini adalah mengenai pembangunan basikal berkuasa udara berasaskan pergerakan linear menggunakan silinder pneumatic. Objektif utama untuk projek ini iaitu untuk menghasilkan reka bentuk yang sesuai untuk kenderaan (basikal) yang boleh dikendalikan dengan tenaga udara mampat. Reka bentuk umum yang telah dipilih untuk projek ini telah melalui beberapa kaedah dan perisian Solidwork telah digunakan untuk membangunkan prototaip sebenar berdasarkan oleh reka bentuk umum terakhir. Selepas reka bentuk selesai, kerja-kerja pembangunan basikal berkuasa udara dilakukan dengan membangunkan perkakasan dengan produk. Komponen perkakasan terdiri daripada bahagian-bahagian mekanikal. Selepas proses pemasangan selesai, ujian dan analisis dilakukan. Seterusnya, analisa pergerakan mekanisme dari linear kepada putaran dan pergerakan tersebut telah dirakam dan dianalisa. Analisis ini terdiri daripada pergerakan untuk mekanisme, sama ada produk boleh bergerak dan sejauh mana produk boleh bergerak. Projek ini masih mempunyai beberapa kelemahan dan ada yang memerlukan penambahbaikan. Oleh itu, basikal berkuasa udara ini yang menggunakan penggerak linear mempunyai potensi untuk dipertimbangkan lagi.

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ABSTRACT

This project is about the development of air powered bicycle based on linear movement using a pneumatic cylinder. The main objective of this project is to produce a design that is suitable for a vehicle (bicycle) that can be operated with compressed air energy. General design that has been selected for this project has been through a number of methods and software Solidwork was used to develop real prototypes based on the last general design. After the design is completed, the development work is done by develop the hardware for the product. The hardware components consist of mechanical parts. After the development process is complete, testing and analysis are started. To achieve the second objective for this project, develop and analyse the mechanism motion from linear to rotary, the movement of the mechanism is recorded and being analyse. The analysis consists of the movement for the mechanism, whether the product can move and how far can the product move. This project still has some flaws and available for further improvement. Therefore, this air powered bicycle using linear actuator has potential to be further improved.

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DEDICATION

Specially dedicated to my beloved parents, Mohd Nasir bin Kassim and Sakina binti Shaik Ahmad Yusoff and to my supervisor, Encik Khairol Anuar bin Rakiman, and all my friends who have encouraged, guided and inspired me throughout the study process.

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LIST OF ABBREVIATIONS, SYMBOL AND NOMENCLATURE

CAV	-	Compressed Air Vehicle
LUV	-	Light Utility Vehicle
FKP	-	Fakulti Kejuruteraan Pembuatan
FYP	-	Final Year Project

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CHAPTER 1

INTRODUCTION

This chapter presents the background, the problem statement, the objectives, the scopes and the report configuration of the project entitled "Development of Air Powered Bicycle using Linear Actuator (Pneumatic Cylinder)".

1.1 Background

We are living in a mobile society so light utility vehicle (LUV) such as bicycles and cars. They are becoming very popular of independent transportation for short distance. The main sources of fuel in the history of transportation are petrol and diesel, are becoming more expensive and impractical. Due to that reason, manufactures of vehicle are leading to develop vehicles fuelled by alternative energies. Present level of technological development fuel-less flying like birds based on the use bio-energy and air power in the atmosphere seems to be almost impossible. Air- powered vehicle as one of the possible alternatives due to enormous power associated with human friendly. Mankind has been use of uncompressed air-power from centuries in different application windmills, balloon car, and hot air balloon. The use of compressed air for storing energy is a method that is not only efficient and clean, but also economical and has been used since 19^{th} century for power mine locomotives.

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In pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical wok in an appropriate controlled sequence using valve and actuator. Conversion of various combinations of motions like rotary-rotary, linear-rotary, and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic system make it suitable for mobile application. The advantage of low cost, easy maintenance, cleanliness, readily available and cheap source make pneumatic control system plays an important role in industrial system.

1.2 Problem statement

Light utility vehicle has becoming a famous of independent transportation for short distance. Cost and pollution with petrol and diesel are leading vehicle manufactures to develop vehicles fuelled by alternatives choices of energies. Air has been choosing as the alternative for the energy source to run the light utility vehicle. The method of using compress air for storing energy is not only efficient and clean, but also economical and environment friendly. Since the main source of fuel are becoming more expensive, use of air as energy source to run bikes or other vehicle for replacing the fuel for daily routine and travel will be free from pollution and cost effectives.

In pneumatics system, the pressure stored potential is converted to a suitable mechanical work in an appropriate controlled sequence by using control valves and actuators. Conversion of combination of motion like linear-rotary is possible. Cycling requires a lot of energy and it is very tiring. Energy used at the moment to push down the pedal is 50%. So, in this project, the motion use is linear motion. The purpose of this project is to change the rotary-rotary motion to linear-rotary motion. Thus, make less energy use to cycling for long distance.

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1.3 Objectives

The ultimate goal of this project is to develop air powered bicycle using linear actuator by using pneumatic cylinder.

The specific objectives that need to be achieved are:

1. To produce appropriate design of vehicle (bicycle) that can be operated with compressed air energy.
2. To develop and analyse the mechanism motion from linear to rotary by change the pedal to pneumatic cylinder use concept of linear actuator.

1.4 Scope

The purpose of this project is to develop air powered bicycle using linear actuator. The scope of the of the project are listed below:

1. To design Light Utility Vehicle (LUV) that using linear actuator as it main actuator to move the vehicle.
2. To design Light Utility Vehicle (LUV) that can operate with one driver or passenger.
3. To fabricate Light Utility Vehicle (LUV) based on the final prototype design of the vehicle.

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1.5 Expected Outcome

The end of this project, a prototype of air powered bicycle using linear actuator (pneumatic cylinder) that able to develop. The prototype must be able to function accordingly and meet the specification inline with the listed objectives.

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1.6 Overview of report.

This report consists of five chapters that are divided into two parts which are Final Year Project 1 (FYP 1) and Final Year Project 2 (FYP 2). The first part FYP 1 is structured into three chapters and the two chapters more are in FYP 2. The first chapter is about the introduction of the project. It consists of background of the study involve development of air powered bicycle using linear actuator, problem statement of the project, scope, expected outcome, and lastly the overview of the report.

The second chapter is all about literature review. In this chapter, it comprises information about works from other researchers that related with this project's tittle. This chapter also explain about Compressed Air Vehicle (CAV), Pneumatic energy, Light Utility Vehicle, and Mechanism used to develop this project.

The third chapter describes the design process to achieve the objectives for this project. It includes overall methodology flowchart, preliminary work, generating ideas, design selection, design concept and final prototype design.

As continuation from FYP 1, FYP 2 will cover the two more chapters which are Chapter 4 and Chapter 5. FYP 2 focused more in experimenting and finding the result and discussion of the result. The result will be presented in Chapter 4 while Chapter 5 will represented the conclusion for this project in form of whether it is successful or not based on the objectives achievement and in addition of future suggestion in order to improve this project.

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CHAPTER 2

LITERATURE REVIEW

Basically, this chapter provides the summary of literature reviews key points related to pneumatic energy compressed air vehicle, light utility vehicle and mechanism.

2.1 Pneumatic energy

The meaning of pneumatic in Greek is breath. Pneumatic is branch of physics applied to technology that makes use of gas or pressurized air. Pneumatic systems used extensively in industry are commonly powered by compressed air or compressed inert gases. A pneumatic system controlled through manual or automatic solenoid valves is selected when it provides a lower cost, more flexible, or safer alternative to electric motors and actuators.

In recent 20 years, energy saving has been done in many projects. However, in Pneumatic system, difficult to determine or measure the air power flow because of the compressibility of pneumatic system (Shengzhi Chen et al., 2014). According to Sivanantham et al., (2015) pneumatic energy is the readily available and low cost energy. Non-conventional energy system is very essential at this time to our nation. Air is the working substance of our machine. This system gives smooth operation and smooth movement for vehicle.

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In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile applications. Pneumatic control system plays very important role in industrial system owing to the advantages of low cost, easy maintenance, cleanliness, readily available, and cheap source. (Ranjithkumar et al., 2014).

Pneumatic drives distinguish themselves through a flexible and robust design and require only low investment and maintenance costs. There are several factors that have an influence on rise of energy consumption of pneumatic system, e.g., over dimensioning of drive as well as incorrectly implemented industrial conditions (Elvira Rakova, Jürgen Weber, 2015). On top of that, pneumatic powered vehicle requires very less time for refuelling as compared to battery operated vehicle. This is totally clean, light weight circuit, can work in hazardous environment and requires less maintenance. (Ranjithkumar et al., 2015).

According to Sivanantham et al., (2015) air engine is the new innovative concept to run the bicycle by using the compressed air system. In the field of industrial automation there are many pneumatic handling systems in use. They represent the robust and flexible design, but show the low energy efficiency. Typically, the pneumatic systems are over dimensioned concerning the required data. That leads to high energy consumption and as a consequence to high energy costs (Elvira Rakova, Jürgen Weber, 2015).

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2.2 Compressed Air Vehicle (CAV)

A compressed air vehicle (CAV) is powered by an air engine, using compressed air, which is stored in a tank. Instead of mixing fuel with air and burning it in the engine to drive pistons with hot expanding gases. Compressed air vehicles use the expansion of compressed air to drive their pistons. At the end of the 19th century, the first approximations to what could one day become a compressed air driven vehicle already existed, with the arrival of the first pneumatic locomotives. In fact, two centuries before that Dennis Papin apparently came up with the idea of using compressed air (Royal Society London, 1687). Hodges will always be remembered as the true father of the compressed air concept applied to cars, being the first person, not only to invent a car driven by a compressed air engine but also to have considerable commercial success with it (Thipse, 2008).

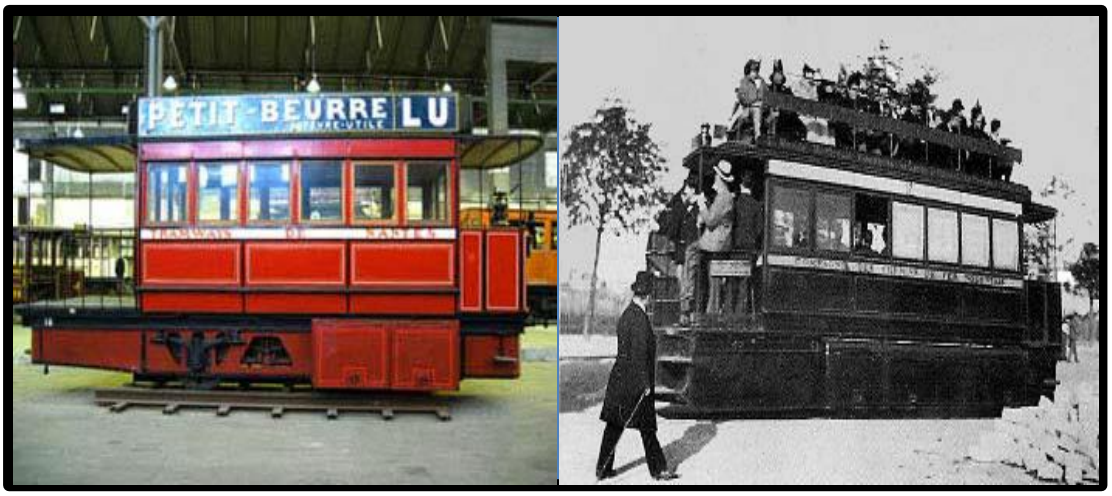

Figure 2.1: Some early Compressed Air Vehicle (CAV) (Thipse, 2008)

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The first compressed air vehicle was established in France by a Polish engineer Louis Mekarski in 1870. It was patented in 1872 and 1873 and was tested in Paris in 1876(Saurabh Pathak et al., 2014). Furthermore, Vehicles derived from the Latin word, vehiculum, are non-living means of transport. Most often they are manufactured (e.g. bicycles, cars, motorcycles, trains, ships, boats, and aircraft), although some other means of transport which are not made by humans also may be called vehicles; examples include icebergs and floating tree trunks. According to Sivanantham et al., (2015) the vehicles may be propelled or pulled by animals, for instance, a chariot, a stagecoach, a mule-drawn barge, or an ox-cart.

Today, more than a century later, CAVs are still on the drawing board. Several companies worldwide are currently in the design or development stages of producing an air car, with some manufacturers heavily promoting their vehicles despite the lack of production or prototype units. Today, CAVs take the form of lightweight passenger cars designed for slow-speed city driving (Andrew Papson et al., 2010). The alternative sources of energy available are solar, electric, atmospheric air etc. Air acts like a blanket for the earth. It is the mixture of gasses, which makes it neutral and non-polluting. It has the property to get compressed to a very high pressure and retain it for a long period of time. It is cheap and can be found abundantly in the atmosphere (Saurabh Pathak et al., 2014).

In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile applications. Pneumatic control system plays very important role in industrial system owing to the advantages of low cost, easy maintenance, cleanliness, readily available, and cheap source, etc., (Ranjithkumar A et al., 2015).

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