DESIGN IMPROVEMENT OF BOOM MODULE SYSTEM FOR FIRE FIGHTING MACHINE

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APPROVAL

‘I hereby approve have read this thesis submitted to the senate of UteM and have accepted this thesis as partial fulfillment of the requirement for the degree in Bachelor of Mechanical Engineering (Design and Innovation) ’.

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DECLARATION

"I hereby, declared this thesis entitled
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is the results of my own research except as cited in the references".

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Date : .....

DEDICATION

TO MY MUM AND DAD FOR THE LOVE, PATIENCE, AND UNDERSTANDING.

TO ALL MY FRIEND WHO ALWAYS SUPPORTING ME.

ACKNOWLEDGEMENT

First of all, I want to express my grateful to Allah S.W.T. for ease the way for me to finish this thesis with achievement and enjoyment. I thankful to Allah for the strength that keeps me standing and for the hope that keeps me believing the positive possibilities for my thesis. Also, I want to express my sincere gratitude to Mr. Mohd Nazim bin Abdul Rahman, my supervisor, who have given his whelming support, guidance and consideration in helping me to finish this thesis.

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ABSTRACT

The Projek Sarjana Muda (PSM) was done in order to identify the problem and developt a new boom system that will work on properly. The report was divided into two parts. The first part of the project is about proposal and the second part is about project implementation. The report fully describes about the combination of both part, which contains six chapters starting from introduction, literature review, methodology, system design, result and discussion, and conclusion with recommendation respectively. The main objective of the project is to study and develop a hydraulic system of the boom which has a problem and have to be fixed. In this project the firefighting machine was studied, especially at the boom system area. Some circuit were reviewed as a role model as to design a new system. The hydraulic system is then design using software called MATLAB R2007a. Some hydraulic models are design and analyze using the software. The best design is then chosen as the proposed design to be implemented in the fire fighting machine.

ABSTRAK

Tujuan Projek Sarjana Muda (PSM) ini dilaksanakan adalah untuk mengenalpasti masalah dan menghasilkan sistem baru yang boleh berfungsi dengan sempurna sebagai jalan penyelesaian. Bahagian pertama PSM ini adalah mengenai pengenalpastian masalah dan langkah-langkah penyelesaian yang bakal dilakukan adalah pada bahagian kedua. Keseluruhan laporan kajian mengandungi enam bab bermula dari pengenalan, kajian literatur, kaedah kajian, rekabentuk system,keputusan dan konklusi serta idea penambahbaikan yang sesuai untuk kajian seterusnya. Objektif utama projek ini adalah untuk mengkaji serta membina sistem hidraulik yang mempunyai masalah dan perlu diperbetulkan. Di dalam projekini, mesin pengawal kebakaran dikaji terutama pada bahagian 'boom'. Beberapa litar akan dijadikan contoh untuk merekabentuk sistem yang baru. Beberapa model sistem hidraulik kemudiannya akan direkabentuk dan dianalisis dengan menggunakan program komputer MATLAB R2007a. Dengan menggunakan program komputer ini, analisa dapat dilakukan dengan mudah dan tepat. Model rekabentuk yang terbaik kemudiannya akan dipilih dan dicadangkan untuk diimplimentasikan di dalam mesin pengawal kebakaran tersebut.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This chapter will explain about the introduction of the project which covers the overview, problem statement, objectives, and scope of the project.

1.1 Overview

Firefighting is an important but dangerous occupation. A firefighter must be able to get to a fire quickly and safely extinguish the fire, preventing further damage and reduce facilities. Technology has finally bridged the gap between firefighting and machines allowing for a more efficient and effective method of firefighting. In order to help replacing firefighter with machines in the future, a company in Langkawi, Kedah which is Rizt Power Mechanic Sdn. Bhd. collaborates with the Faculty of Mechanical Engineering (FKM) to create a firefighting machine that may help human

kind. This firefighting machine is still in researh and development phase as to overtake all the problems that occur. This firefighting machine was built to do a firefighter job, thus the body of the machine must be able to sustained high temperature. It also must be able to expand and point the water spray at certain high and at certain distance. The high and the length of the machine is controlled by hydraulic systems. The 'boom' hydraulic system controls the water spray while the other two cylinders control the angle and height of the 'boom'.

1.2 Problem Statement

The boom system is a hydraulic system which connected with a controller system. The boom system shows great work and potential but it occurs to have some problems. There are errors in the hydraulic system which contributes to a malfunctioning of the system. Further research has to be done in order to find out the source of the problem. The problem must be fixed in order to developt a machine that is free from any system errors.

The 'boom' hydraulic system is found to be loaded together with the angle hydraulic actuators. The 'boom' cylinder seems to be dependent on the 'angle' cylinder. In other words, the angle hydraulic cylinder has to move first before the 'boom' cylinder moves. However, the height cylinder is working perfectly fine and does not have any errors. The situation of the problem is illustrated in Figure 1.1, Figure 1.2 and Figure 1.3 respectively. A new system design is proposed to overcome the problems.

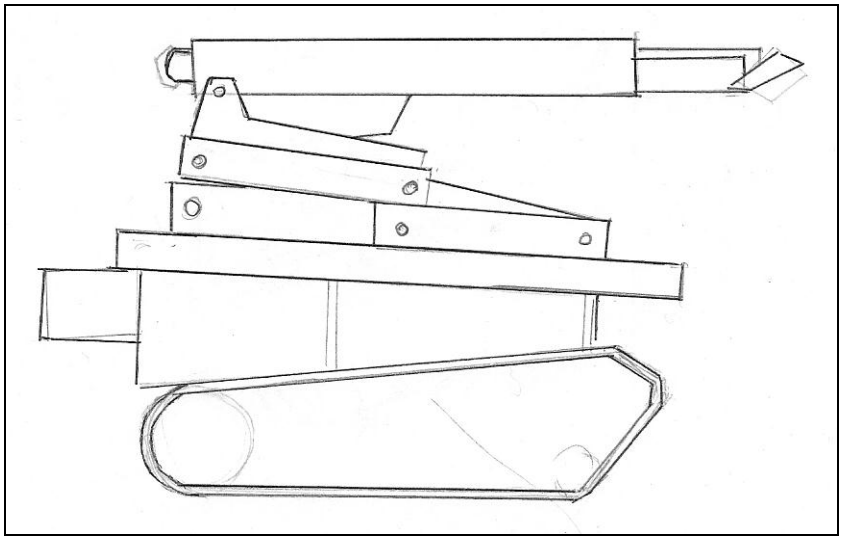

Figure 1.1: Original state of boom.

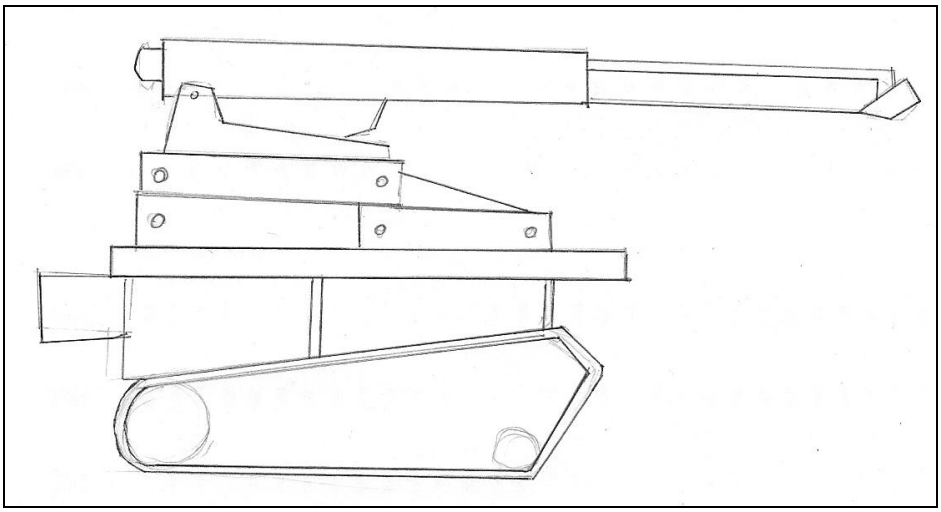

Figure 1.2: The boom started to expand

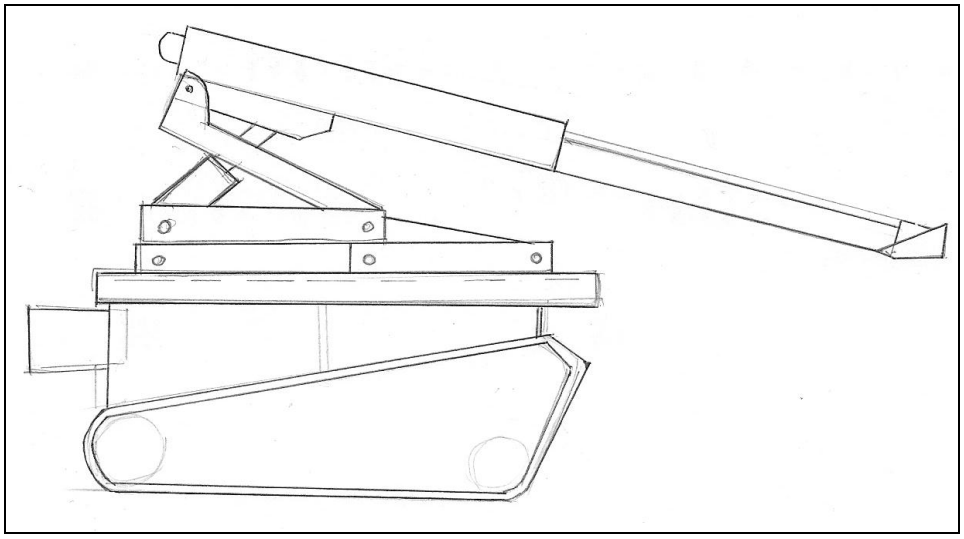

Figure 1.3: The boom cannot expand independently.

1.3 Objective

The objective of this project is to do a reverse engineering on the firefighting machine protoaip in order to fix the problematic area. At the same time, the study of hydraulic engineering works and the control system also included. The task of the study can be concluded as below:-

i. Split the hydraulic system.

ii. Study the hydraulic system of the boom.

iii. Study the control system of the boom.

iv. Designing a new system models.

v. Proposing a new system to be implemented.

1.4 Scope

This project is more to design engineering and basic reverse engineering. The scopes of the project are:-

i. The background study of the ‘boom’ system. There were two main systems that operate it which are hydraulic system and the control system.

ii. To do a reverse engineering about the firefighting machine ‘boom’ system. Did a research on other firefighting machine journal that has been done before this.

iii. To find out the causes of the problems. Details study about the ‘boom’ system problems and how to overcome the problem.

iv. Designing several system models and proposing new systems that fulfill the engineering specification requirement.

Figure 1.4: The Firefighting Machine

CHAPTER II

LITERATURE REVIEW

Literature review is a section where it explain about the researches that has been done before this depending on the topic that were studied in this 'Projek Sarjana Muda(PSM). The research sources are from books, internet articles, magazines, website, journal, and patent reports that is very usefull in order to help the research of this PSM.

2.1 Introduction to Hydraulic System

Hydraulic fluid power system may be defined as a means of power transmission in which a relatively incompressible fluid is used as the power transmitting media. The primary purpose of a hydraulic system is the transfer of energy from one location to another and the conversion of this energy to useful work. Hydraulic power is usually generated by pumps and the energy generated is converted to useful work by hydraulic cylinder or other actuators.

The basis for all hydraulic systems is expressed by Pascal's law which states the pressure exerted anywhere upon an enclosed liquid is transmitted undiminished, in all directions, to the interior of the container (Majumdar, S. R., 2003).

The simplest hydraulic circuit consists of a reservoir, pump, relief valve, 3-way directional control valve, single acting cylinder, connectors and lines. This system is used where the cylinder piston is returned by mechanical force. With the control valve in neutral, pump flow passes through the valve and back to the reservoir. With the valve shifted, oil is directed to the piston side of the cylinder, causing the piston to move, extending the rod. If the valve is returned to neutral, the oil is trapped in the cylinder, holding it in a fixed position, while the pump flow is returned to the reservoir.

A hydraulic system using a double acting cylinder and a 4-way valve differs from the single acting cylinder system in that the cylinder can exert force in both directions. With the control valve in neutral, flow is returned to the reservoir. When shifted in one direction, oil is directed to the piston side of the cylinder, causing the cylinder to extend. Oil from the rod side passes through the valve back to the reservoir. If the valve is shifted to neutral, oil in the cylinder is trapped, holding it in a fixed position. When the valve is shifted in the opposite position, oil is directed to the rod side of the cylinder, causing the cylinder to retract. Oil from the piston side passes through the valve back to the reservoir. Cylinder extend force is a result of the pressure (psi) times the piston area. Retract force is a result of the pressure (psi) times the area difference between the piston minus the rod diameter.

A hydraulic control system is used to control the speed and position of the load, with a driving force which comes from the actuators. The main parts which are essentially needed to design and construct a system may be listed as:

i. Hydraulic power pack comprising the pump, drive motor, mechanical coupling, oil resevoir, strainers, filters, coolers, etc.

ii. Hydraulic control element like various type of direction control.
iii. Power drive units comprising of cylinders, motors, etc.
iv. System accessories such as pipes, hoses, and other fluid conductors, filters, accumulators, boosters, related mechanical elements, etc.

A hydraulic designer has to decide not only the type of components to be chosen for the desired function, but he also has to analyze their mutual compatibility so that the ultimate design is comprehensive enough in terms of functional efficiency as well as reability and maintanability of the constructed system. The main objective of a hydraulic system designer is to find a specific solution to a position, power, sequence or speed problem of any mechanical such as a machine tool, a hydraulic crane or similar other mechanical electro-mechanical implements that are commonly used.

The industrial hydraulic system is a power transmission system using oil to carry the power. All system required an input and output. The power may be transmitted directly into a load, or may be transmitted in the form of control. The greater and finer the signal, the more positive, reliable, accurate and responsive is the control.

The inputs and outputs of any power and control system including the hydraulic system are mechanical such as a rotating shaft or a reciprocating plunger. Other advantage is that this system is easily adaptable to a variety of energy forms and the signals may be initiated by electrical, chemical, manual, optical, electronic/digital or occouctic means. Solenoid and torque motors are common examples of control inputs, while the output may be the movement of a piston rod or the turning of a shaft.

Another very significant advantage of a hydraulic system is that there is a tremendous possibility of force amplification or in other words a high force may be generated from a small input signal. Of course there are losses, but the total gain is