UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Reverse Engineering of a 6 Axis Robot

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Bachelor of Manufacturing Engineering (Robotic and Automation)

By

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DECLARATION

I hereby, declare this thesis entitled "Reverse Engineering of 6 Axis Robot" is the result of my own research
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ABSTRACT

Reverse engineering is the general process of analyzing a technology specifically to ascertain how it was designed or how it operates. In this report it is about reverse engineering of a 6 axis robot components. This report also briefly explains about the reverse engineering and the 6 axis robot. They are several processes that need to be follow for reverse engineering 6 axis robot components. They are many advantages of doing reverse engineering for new product development. From this project the technology behind the construction of a 6 axis robot can be appreciated. 6 axis robots is an articulated robot. It is widely used in industrial and medical field. To design the robot requires acquiring of dimension, solid modelling and simulating in a 3D Cad environment.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

CAD	-	Computer Aided Design
CIM	-	Computer Integrated Manufacturing
FMS	-	Flexible Manufacturing System
ID	-	Inner diameter
OD	-	Outer diameter
RevEng	-	Reverse Engineering
RPL	-	Robot Programming Language

CHAPTER 1
INTRODUCTION

1.1 Introduction

Technology is rapidly changing day by day in order to meet the needs of human being, to make their life less complicated and makes benefits from the technology that they invented.

Engineering is the profession involved in designing, manufacturing, constructing, and maintaining of products, systems, and structures.

Reverse engineering is one of the major factors that contributed in the rapidly changed of technology. Robotic, another engineering technology are becoming one of the main needs in manufacturing business as it helps in saving the terms of time and money. At a higher level, there are two types of engineering: forward engineering and reverse engineering. Forward engineering is the traditional process of moving from high-level abstractions and logical designs to the physical implementation of a system. In some situations, there may be a physical part without any technical details, such as drawings, bills-of-material, or without engineering data, such as thermal and electrical properties. The process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model is known as reverse engineering. Reverse engineering is the process of discovering the technological principles of a

device/object or system through analysis of its structure, function and operation. It often involves taking something apart and analyzing its workings in detail, usually with the intention to construct a new device or program that does the same thing without actually copying anything from the original. Reverse engineering is very common in other diverse fields besides robotic engineering such as software engineering, entertainment, automotive, consumer products, microchips, chemicals, electronics, and mechanical designs. For example, when a new machine comes to market, competing manufacturers may buy one machine and disassemble it to learn how it was built and how it works. This shows how the manufacturers apply the reverse engineering concept, where they learn, do research and development on their competitor product to produce a better product for their customers. (Reverse engineering,www.wikipedia.org)

Reverse engineering can be viewed as the process of analyzing a system to identify the system's components and their interrelationships, create representations of the system in another form or a higher level of abstraction and create the physical representation of that system. According to Miller and Morley (1996), reverse engineering means the recovery of design information from an existing system for the purpose of replacing that system. Reverse engineering involves the creation of abstract descriptions of the functions represented in the source code. These abstract descriptions are several levels of detail higher than source code. Reverse engineering is also called design recovery and inverse engineering.

There are pros and cons of reverse engineering to individual and business. Some may gain profit from it and some may not. This is the reality when involving in technology industry. Only the best will survive and make benefits from reverse engineering concept, that contribute a lot to the rapidly change phase of the technology.

1.2 Problem Statement

In order to be competitive in the business, the use of latest technology are highly needed to give the best solution to the customers, where at the same time will create loyal customers because as we know, the cost of retaining loyal customers is cheaper than creating new customers.

The reverse engineering or innovation of a 6 axis robot chassis is chosen to develop a new robot that can function more than its original. This can be done by manually using vernier calliper for measurement, 3D scanner, CAD application and other resources relevant.

1.3 Objectives, Aims and Scopes of the Research

1.3.1 Objectives

The objectives of the reverse engineering of a 6 axis robot are:

a) To determine the benefits of reverse engineering of a 6 axis robot components
b) To simulate the 6 axis robot
c) To recognize the facilities needed in reverse engineering of a 6 axis robot components

1.3.2 Aims

The aim of this project is to make a part of a development of a 6 axis robot components improve its capabilities and performance and widely use in business industries. This can be done by:

a) Understanding and learning the purpose and the functions of a 6 axis robot components
b) Identifying the additional functions needed from the robot
c) Identifying its strengths and weaknesses
d) Create a new robot through reverse engineering of a 6 axis robot components

1.3.3 Scopes of the Research

The scope of this research is the reverse engineering of a 6 axis robot components used commonly in our local industry. This is in order to improve the capabilities and qualities of the robot where at the same time contribute in innovation of this technology to meet the needs and wants of the business and customers. The reverse engineering of a 6 axis robot components is done by using limited resources and manually. By doing this research, hopefully it will open the eyes and generate ideas to the new generations in creating new robots in the future.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Nowadays, demand in engineering is very high as the need of engineering in technology and development are getting wider day by day. People in the engineering business are competing among themselves to be the best and to be the first in inventing new technology and innovation in engineering, as the new technology able to generate profits to the country, besides the company itself where at the same time create healthy competition among countries in the world.

Engineering is professional art of applying science to the optimum conversion of the resources of nature to the uses of humankind. Engineering is based principally on physics, chemistry, and mathematics and their extensions into materials science, solid and fluid mechanics, thermodynamics, transfer and rate processes, and systems analysis. A great body of special knowledge is associated with engineering; preparation for professional practice involves extensive training in the application of that knowledge. Engineers employ two types of natural resources, materials and energy. Materials acquire uses that reflect their properties: their strength, ease of fabrication, lightness, or durability; their ability to insulate or conduct; and their chemical, electrical, or acoustical properties. Important sources of energy include fossil fuels (coal, petroleum, gas), wind, sunlight, falling water, and nuclear fission. In its modern form, engineering involves people, money, materials, machines, and energy. It is differentiated from science

because it is primarily concerned with how to direct to useful and economical ends the natural phenomena which scientists discover and formulate into acceptable theories. Engineering therefore requires above all the creative imagination to innovate useful applications of natural phenomena. It seeks newer, cheaper, better means of using natural sources of energy and materials. The typical modern engineer goes through several phases of career activity. Formal education must be broad and deep in the sciences and humanities. Then comes an increasing degree of specialization in the intricacies of a particular discipline, also involving continued post scholastic education. Normal promotion thus brings interdisciplinary activity as the engineer supervises a variety of specialists. Finally, the engineer enters into the management function, weaving people, money, materials, machines, and energy sources into completed processes for the use of society. (www.britannica.com)

Engineering is the process of turning a specification into a product for performing to it. A full specification may not only specify what the product has to do, but also specify performance criteria it needs to meet along the way. As the complexity of IT systems grows, so does the importance of a good specification. In between the specification and the product is the engineering or implementation process, which involves some human creativity, and an increasing degree of automation.

Reverse means reverse, invert, transpose. These verbs mean to change to the opposite position, direction, or course. Reverse implies a complete turning about to a contrary position: reversed the placement of the sofa and chairs. To invert is basically to turn something upside down or inside out, but the term may imply placing something in a reverse order: inverted the glass; invert subject and verb to form an interrogative. Transpose applies to altering position in a sequence by reversing or changing the order: often misspells receive by transposing the *e* and the *i*.(www.wikipedia.com)

2.2 Reverse Engineering Definitions

Reverse engineering is the general process of analyzing a technology specifically to ascertain how it was designed or how it operates. This kind of inquiry engages individuals in a constructive learning process about the operation of systems and products. Reverse engineering as a method is not confined to any particular purpose, but is often an important part of the scientific method and technological development. The process of taking something apart and revealing the way in which it works is often an effective way to learn how to build a technology or make improvements to it.

Through reverse engineering, a researcher gathers the technical data necessary for the documentation of the operation of a technology or component of a system. In "black box" reverse engineering, systems are observed without examining internal structure, while in "white box" reverse engineering the inner workings of the system are inspected. When reverse engineering software, researchers are able to examine the strength of systems and identify their weaknesses in terms of performance, security, and interoperability. The reverse engineering process allows researchers to understand both how a program works and also what aspects of the program contribute to its not working. Independent manufacturers can participate in a competitive market that rewards the improvements made on dominant products. For example, security audits, which allow users of software to better protect their systems and networks by revealing security flaws, require reverse engineering. The creation of better designs and the interoperability of existing products often begin with reverse engineering.

Reverse engineering can be viewed as the process of analyzing a system to:

1) Identify the system's components and their interrelationships
2) Create representations of the system in another form or a higher level of abstraction
3) Create the physical representation of that system

In some situations, designers give a shape to their ideas by using clay, plaster, wood, or foam rubber, but a CAD model is needed to enable the manufacturing of the part. As products become more organic in shape, designing in CAD may be challenging or impossible. There is no guarantee that the CAD model will be acceptably close to the sculpted model. Reverse engineering provides a solution to this problem because the physical model is the source of information for the CAD model. This is also referred to as the part-to-CAD process.

Everything happened in this world are with purpose or reason behind it. The same goes to reverse engineering a part or a product. The reasons include the aspect of education, technology development, to meet the needs and wants of customers and others. Following are reasons for reverse engineering a part or product:

1. The original manufacturer of a product no longer produces a product
2. There is inadequate documentation of the original design
3. The original manufacturer no longer exists, but a customer needs the product
4. The original design documentation has been lost or never existed
5. Some bad features of a product need to be designed out. For example, excessive wear might indicate where a product should be improved
6. To strengthen the good features of a product based on long-term usage of the product
7. To analyze the good and bad features of competitors' product
8. To explore new avenues to improve product performance and features
9. To gain competitive benchmarking methods to understand competitor's products and develop better products
10. The original CAD model is not sufficient to support modifications or current manufacturing methods
11. The original supplier is unable or unwilling to provide additional parts

12. The original equipment manufacturers are either unwilling or unable to supply replacement parts, or demand inflated costs for sole-source parts
13. To update obsolete materials or antiquated manufacturing processes with more current, less-expensive technologies

2.3 Stages Involved in the Reverse Engineering Process

Since the reverse engineering process can be time-consuming and expensive, reverse engineers generally consider whether the financial risk of such an endeavor is preferable to purchasing or licensing the information from the original manufacturer, if possible.

In order to reverse engineer a product or component of a system, engineers and researchers generally follow the following four-stage process:

a) Identifying the product or component which will be reverse engineered
b) Observing or disassembling the information documenting how the original product works
c) Implementing the technical data generated by reverse engineering in a replica or modified version of the original
d) Creating a new product (and, perhaps, introducing it into the market)

In the first stage in the process, sometimes called "prescreening," reverse engineers determine the candidate product for their project. Potential candidates for such a project include singular items, parts, components, units, subassemblies, some of which may contain many smaller parts sold as a single entity.

The second stage, disassembly or decompilation of the original product, is the most time-consuming aspect of the project. In this stage, reverse engineers attempt to

construct a characterization of the system by accumulating all of the technical data and instructions of how the original product works.

In the third stage of reverse engineering, reverse engineers try to verify that the data generated by disassembly or decompilation is an accurate reconstruction the original system. Engineers verify the accuracy and validity of their designs by testing the system, creating prototypes, and experimenting with the results.

The final stage of the reverse engineering process is creating a new product after completing the third stage in reverse engineering and channel the product into the marketplace. These new products are often innovations of the original product with competitive designs, features, or capabilities. These products may also be adaptations of the original product for use with other integrated systems, such as different platforms of computer operating systems.

Often different groups of engineers perform each step separately, using only documents to exchange the information learned at each step. If the same person both reverse engineers the old product and designs the new product, and there are similarities, it is hard to avoid an assumption that some copying has taken place, and so reverse engineering "best practice" involves breaking the chain, so far as possible, at the specification stage. The specification is made as abstract and functional as possible by the reverse engineers, and is then handed over to a "clean room" design team who have no other contact with the old product, or the team who analyzed it, and who will then design the new product using as little low-level information as possible from the old product. This is to prevent duplication of the original technology, which may violate copyright. By contrast, reverse engineering creates a different implementation with the same functionality.