FEASIBILITY STUDY ON ROBOT OFF-LINE PROGRAMMING AND SIMULATION USING MATLAB TOOLS; SIMMECHANICS AND SIMULINK PACKAGES

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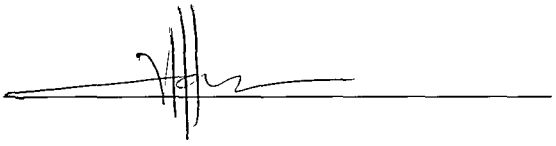
Signature : 

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FEASIBILITY STUDY ON ROBOT OFF-LINE PROGRAMMING AND SIMULATION USING MATLAB TOOLS; SIMMECHANICS AND SIMULINK PACKAGES

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"I declared that this thesis entitled 'Feasibility Study of Robot Off-Line Programming Using MATLAB Tools; SimMechanics and Simulink Packages' is the result of my own research except as cited in references.

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بسم الله الرحمن الرحيم

In the Name of Allah, the Most Gracious, the Most Merciful

DEDICATION

To my beloved wife, sons and my whole family

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ABSTRACT

Since 19th century, the development of robot in manufacturing industry have been increased rapidly, thus require the need to track down the historical development of robots by robot manufacturers that brings the robot function like todays. Due to demand, robot is said to be replacing human labour because of some factors such as its capability to do work effectively, reducing cost and task that human cannot do. In this research, a feasible study on robot off-line programming and simulation using MATLAB SimMechanics and Simulink packages will be the main objective. This project will be addressing about the development of robot modeling and simulation in the SimMechanics. It is aimed that this approach will be helping the academician and researchers in the related field because MATLAB is widely used in the world in various application.The result of this project shows that it is possible to do programming and 3D simulation using SimMechanics in order to obtain mechanical variables such as joint angle, angular acceleration, reaction force, and torque including draws the respective 3D robot motion that are programmed. SpaceLib program is then used to obtain the desired location and program each robot link to the respective coordinate system in matrix form.

ABSTRAK

Sejak kurun ke 19, pembangunan robot di dalam industri pembuatan telah meningkat secara drastik dan ini memerlukan penjejakan kembali sejarah pembangunan robot oleh pembuat robot bagi melihat bagaimana robot berkembang sehingga ke hari ini. Berdasarkan kepada keperluan, robot dikatakan akan mengambil alih tugas pekerja disebabkan oleh beberapa faktor seperti kebolehannya melakukan kerja dengan efektif, mengurangkan kos dan melakukan tugas yang tidak dapat dilakukan oleh manusia. Objektif kajian ini adalah untuk mendapatkan pembelajaran dan pengetahuan mengenai '*off-line programming*' dan simulasi menggunakan perkakasan MATLAB iaitu lebih spesifik kepada SimMechanics dan Simulink. Adalah diharapkan kajian ini dapat membantu para pengajar dan pengkaji di dalam bidang yang berkaitan terutama robotik kerana MATLAB digunakan secara meluas di dunia di dalam pelbagai bidang. Hasil daripada kajian ini menunjukkan bahawa MATLAB SimMechanics boleh melakukan '*off-line programming*' dan simulasi 3D untuk mendapatkan faktor mekanikal seperti sudut cantum, pecutan sudut, daya reaksi dan kiraan tork di samping memberikan gambaran 3D sebenar pergerakan robot semasa operasi. Manakala SpaceLib kemudian digunakan untuk mendapatkan kedudukan dan program bagi setiap bahagian robot berdasarkan kepada satu sistem koordinat di dalam bentuk matriks.

TABLE OF CONTENTS

CONTENTS

TABLE LIST

FIGURE LIST

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION: ROBOT AND PROGRAMMING

1.1 Research Background

Robots are believed to take the human work task in the future due to the demand and safety they offer. This phenomenon can be predicted if we take a look in our environment especially in manufacturing and industry. Movie industry for an example had launched a new action series, "I, Robot" that showing us the future that we will be living with the help of robot, have going beyond our expectation. Equipped with artificial intelligence that can be easily being mounted into a robot, this is not impossible because numerous researches are rapidly increased on the specified subject.

The term of the robot was first been introduced by a Czech dramatist, Karel Capek in 1921 of "Rossum's Universal Robots" that referring to a perfect and tireless worker performing manual labor jobs for human beings. Since Asimov raised the word robotics in his science fiction stories about robot 1940's, people began to think and design robot. Japanese defined robot as an all-purpose machine equipped with a memory device and a terminal and capable of rotation and replacing human labor by automatic performance and movement. Another good definition was made by the Robot Institute of America, that robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized device, through variable programmed motions for the performance of a variety of tasks [Antti, 1989][Fu K.S et al, 1987].

That is in short, a robot is a reprogrammable general-purposes manipulator with external sensors that can perform various assembly tasks, possessing intelligence associated with its control and sensing system [Fu K.S et al, 1987].

According to Joseph, there are Three Laws of Robotics remain worthy design standards [Engelberger, 1983]:

1. A robot must not harm a human being, nor through inaction allow one to come to harm.

2. A robot must always obey human beings, unless that is in conflict with the first law.

3. A robot must protect itself from harm, unless that is in conflict with the first and second laws.

Future robots are likely to have a greater number of attributes similar to human such as having greater sensor capabilities, more intelligence, higher level of manual dexterity and also limited degree of mobility. Although today robot does not behave like humans, there is no denying that the technology is moving in a direction to provide those machines with human capabilities.

Industrial robots are now being focused due to its capabilities and advantages especially in the aspect of how factories run. Yet too many robots are become too expensive and too complicated. There is no doubt that the use of robots will be the key to growth in manufacturing in the next decade and more companies using robots will boost their productivity.

It is seems that in the last twenty years, the cost of a universal robot has hardly increased, yet labor cost have quadrupled. In year 1981, Unimation Inc claimed that the hourly cost of a robot was about 30% of labor cost in the US automotive industry whereas in 1966 the costs were similar [Harley, John, 1983].

Why do we use robot in industry? The principle advantage of a robot is its flexibility such as;

1. Able to cope with different products on one line as market demand changes

2. Able to be re-programmed to suit minor modifications or when a completely new model been introduced

This availability offers the high-volume manufacturers in a way of coping with change in volume or type, and for the small manufacturers for the chance of a big jump in productivity while continuing to produce in small batches, such that in some cases, he may be able to compete with much larger companies. Table 1 shows the main advantages of robots.

Table 1.1 Main advantages of robots [Harley John, 1983]

1	Improvement in productivity through the use of robots	94.00%
2	Stabilization of product quality and improved job efficiency	69.70%
3	Improve labor safety	52.80%
4	Changing workers attitudes	51.40%
5	Shortage of laborer and skilled workers	45.00%
6	Increased flexibility of production system	39.70%
7	Progress of engineering and technology of robot	37.30%

Modern industrial arms have increased in capability and performance through controller and language development, improved mechanisms, sensing, and drive systems. In the early to mid 80's the robot industry grew very fast primarily due to

large investments by the automotive industry. The benefits of robots to industry include improved management control and productivity and consistently high quality products.

As manufacturing moves to become more responsive environment with products having shorter life cycles and batch quantities reducing in size, robot programming times become critical, and hence an area to be addressed in order to seek improved productivity. *Off-line programming* is an approach that could reduce the required skill levels of a programmer, reduce the programming times, allow the operator a 'natural' interface with which the operator would conduct the task in the real world, and reduce the boredom factor [Boud, A.C. Steiner, S.J. ,1997][Naylor, A et. al, 1987].

Although that in the beginning *on-line programming* is mainly used but due to *on-line programming* have some deficiencies factors, *off-line programming* become popularly used in the industries and MATLAB is able to provide it. We can find one of the developments using the MATLAB® software in robot technology in the "Simulink-Based Robotic Toolkit for Simulation and Control of the PUMA 560 Robot Manipulator" [Dixon, W.E. et. al, 2001]. The PUMA 560 robot manipulator is developed by using the MATLAB®/Simulink based platform that can be easily executed on the LINUX or Win32-based operating system. The toolkit represents a graphical user-friendly nature that allowing the toolkit can be customizing in real-time simulation without writing any code. It is also give the users to easily incorporate additional functionality and hardware through the simple block diagram interface that Simulink provides thus providing the flexibility for easily modifying component for increased functionality.

There is also some off-line programming software available whether made individually by research or provided by the robot manufacturers. Some of the software developed by the researchers is as mentioned above, SRTK, ROBOSIM, SPACELIB, RRS, WorkSpace, RoboWorks etc. Table 1.2 shows the example of robot manufacturers that provided along the off-line programming software that are compatible only with their robots.