CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Virtual design can be simply defined as "Design in the computer". It has taken place in many fields due to its convenient and economical aspects. However, the application of virtual design in designing robot seems to receive little attention. Although the word robot has many different definitions as seen in different dictionaries and encyclopedias, the following definition from the Robot Institute of America may reflect main features of modern robot system: A robot is a re-programmable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for performance of a variety of tasks. Since the early twentieth century, design and research in robotics have accelerated with the developments of electronics, computer, and industrial automation in America, Japan, and Europe [1].

It is use whenever there is a need to reduce the danger to a human, provide more strength or accuracy than a human, or when continuous operation is required. Motions that human beings take for granted – picking up a coin from the table, for instance – are more difficult for a robot. The human brain process thousand of data from the eyes to instruct any part of the body to picking up the coin. Even the tactile feel of the coin constantly update the brain to provide just enough finger pressure to grip the coin securely. To easy and economical program a robot that can perform the same task, many of variables must be restricted. Position, reach, weight and grasp should remain as

consistent as possible so that variation, do not result in missing or dropping the object. In these circumstances, virtual design could help to find out the crucial parts in a robot. Development of virtual design rely on the establishment of virtual physical unit including the integration and management of 3D solid model and model for the simulation of motion and the mechanical properties of the virtual physical units. To date, a number of simulation tools and object-oriented programming language have been developed for performing the variety of tasks including physical response [2].

Finite element method (FEM) is one of the programming tools increasingly used by engineers with different backgrounds. It is a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest in engineering and mathematical physics that are solvable by use of the finite element method include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. Matrix methods are a necessary tool used in finite element method for purposes of simplifying the formulation of the element stiffness equations, for purposes of longhand solutions of various problems, and, most important, for use in programming the methods for high-speed electronic digital computers. Hence, matrix notation represents a simple and easy-to-use notation for writing and solving sets of simultaneous algebraic equations [17].

The FEM has been applied to numerous problems, both structural and nonstructural. This method has a number of advantages that have made it very popular such as ability to conveniently model irregular geometries, material models, and define various types of loads without difficulty, as the element equations are handled individually. Other advantages are it can handle unlimited numbers and kinds of boundary conditions, vary the size of the element to model micro-sized computational domain wherever necessary, adaptable to model and solve variety of engineering problems including dynamic situations. As such huge amount of literature reported on finite element method and its application has been well-documented [3-7]. However, the application of FEM in modeling and dynamic analysis of multi-axes positioning has not known yet.

In this project, FEM has been applied for the first time to analyze dynamics of multi-axes positioning applicable to robot design. Taking advantage of FE codes particularly developed for large displacement elements, boundary conditions and joints, motions of multiple components in 3D space will be modeled and analyzed. This project would be important for achieving comprehensive design of not only a robot but also other dynamic systems close to reality in comprehensive, yet economical way.

1.2 PROBLEM STATEMENT

The traditional modeling methods cannot meet the needs for quantitative analysis of virtual design. In order to mimic the analysis, there is a need for developing geometrical representation method which can be delivered to CAE for computation. Other compounded problem includes the construction of 3D solid models, 3D animation, virtual reality and graphical image processing.

1.3 OBJECTIVE

The objectives of this project are:

1. To design and analyze multi-axis positioning of a robot using Finite Element Method (FEM)

2. To demonstrate effective use of boundary conditions available in FE package to model multi-axis positioning

3. To investigate the limitation of the FEM in dynamic analysis