A COMPARATIVE STUDY OF SOME TECHNIQUES FOR CONTROLLING ROBOT ARMS

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THESIS

Submitted for the Department
of
Electronics and Computer Engineering

For Partial Fullfilment of the Degree of Master of Science

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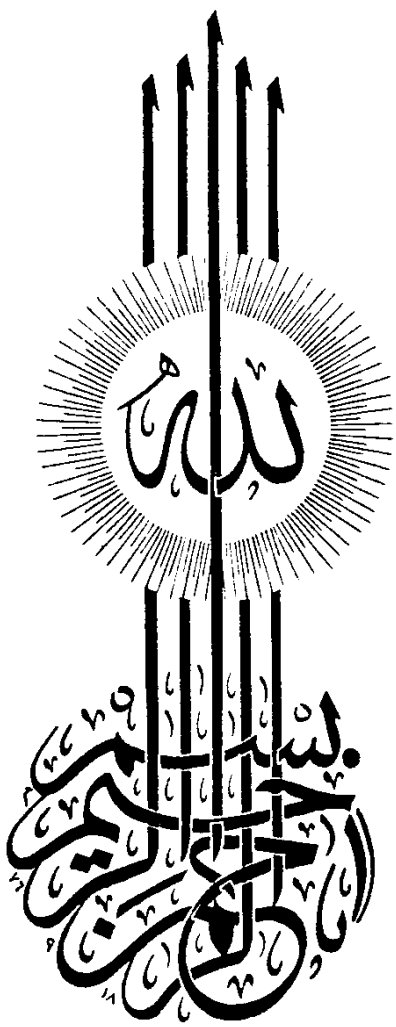
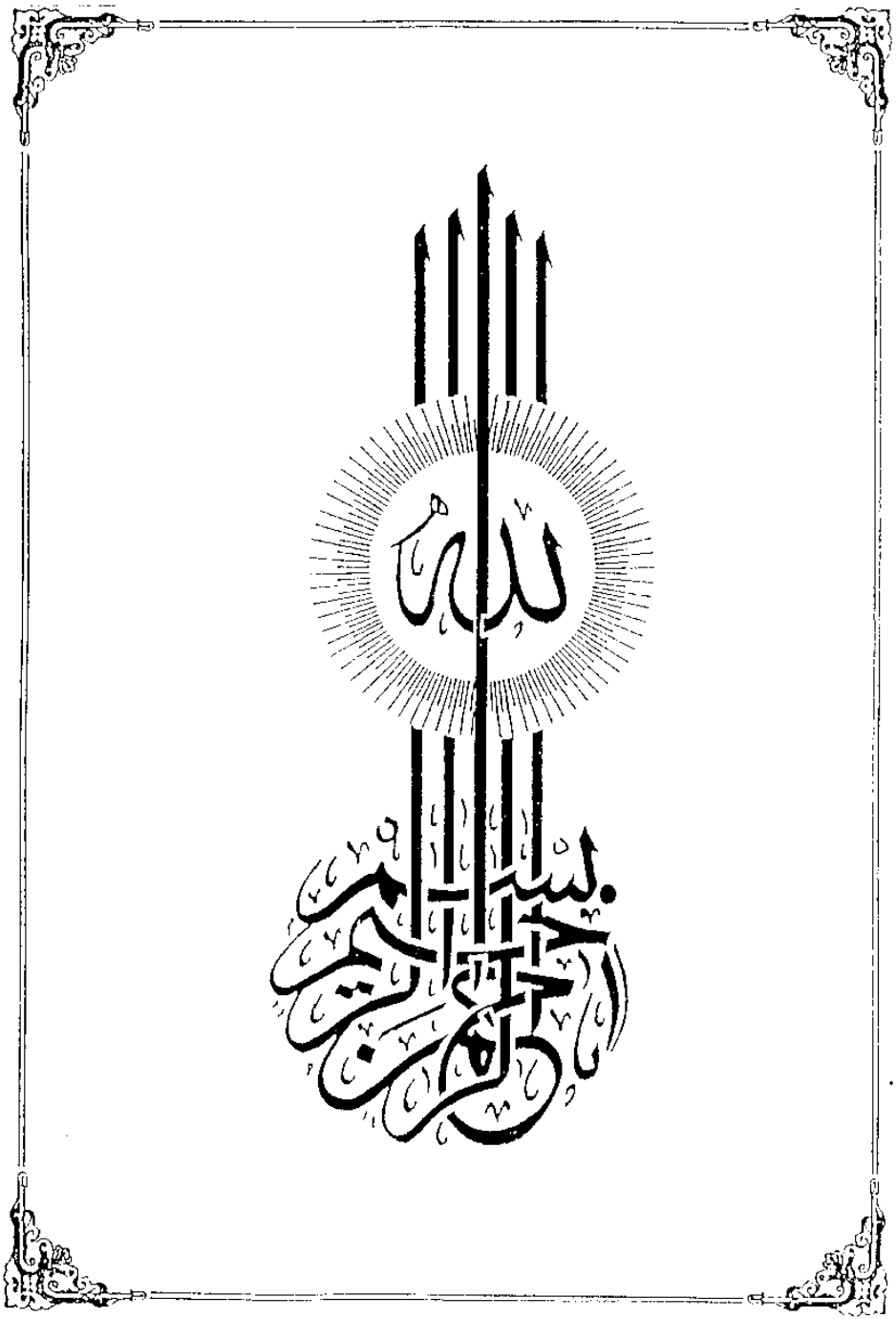
1987





ACKNOWLEDGEMENT

I would like to acknowledge my heartful thanks to Prof. Mohammed Adeeb Riad Ghonaimy head of electronic computer department , Faculty of engineering , Ain Shams University for his unceasing encouragement , invaluable advice and for providing me with the relevant literature as well as many useful discusions .

I wish to express my sincerest gratitude to Dr. Abdel-Moniem Wahdan , Faculty of engineering , Ain Shams University for his advice , guidance in the supervision of this work , and for his useful criticism and suggestions in the preparation of this work .

My deepest thanks to Dr. Ayman El-Dessouki , National Research Centre for his supervision , patience , guidance through the course of the work , encouragement endless help and discussions .

Special thanks to Prof. Nadia Hegazy head of Scientific and Statistical Consultation Laboratory , National Research Centre for her invaluable advice and for helping me to use the computer facilities .

I wish also to express my thanks to the staff of the Computers and Systems Laboratory , National Research Centre .

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ABSTRACT

This thesis introduces a comparative study for some techniques to control the robot arm . The thesis starts with a study of the manipulator kinematics and dynamics . The thesis then surveys some techniques to control that manipulator . Control techniques can be classified into three families namely ; Analytical techniques , table look-up techniques , and hybrid techniques .

Three algorithms were selected from the three previous families , programmed on the computer , and compared . The comparative study takes into account four criteria namely ; The memory size , the amount of computations , the steady state error , and the speed of response .

It was concluded that the third technique was the best as it requires reasonable memory size and relatively few amount of computations .

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INTRODUCTION
SYSTEM DESCRIPTION

1.1 Objective:

The aim of this research is the study of the movement of computer controlled arms and hands.

Both the arm and the hand function together as a general purpose manipulator which forms a subsystem of the overall robot system.

The manipulator system includes a computer which plans and executes sequences of arm and hand movements to accomplish given tasks.

The study analyzes those aspects of the problem that are related to the kinematics and dynamics of the arm movement , namely:-

1:- The arm model

2:- Kinematics of manipulators.

3:- Dynamics of manipulators.

4:- A survey of different algorithms to control robot arm.

However the study is not intended to cover all aspects of robot arm movements. Some of the remaining issues that need to be covered include:-

1:- Planning trajectories to take into consideration obstacles and avoiding collision with them.

2:- Use of sensors and potentiometers or other means to implement a data acquisition system about the environment of the movement.

3:- Applying robot vision techniques to get more feedback about the environment and to recognize different objects around the arm.

4:-Building a knowledge base about the environment and a learning model that uses A.I. techniques in planning trajectories and performs more complicated tasks.

5:-Developing languages for control and manipulation of robots and building necessary tools for their efficient interpretation and execution.

1.2 Arm model

Any manipulator can be considered to consist of a series of links connected together by joints (Fig. 1.1)

Any link (Fig 1.2) can be characterized by the following parameters:

A- The common normal distance (a_n) between the axes of the two joints at both ends of the link.

B- The angle (α_n) between the axes in a plane perpendicular to (a_n).

It is customary to call (a_n) the length and (α_n) the twist of the link .

Generally , the links are connected at each joint axis. The axis will have two normals to it , one for each link.

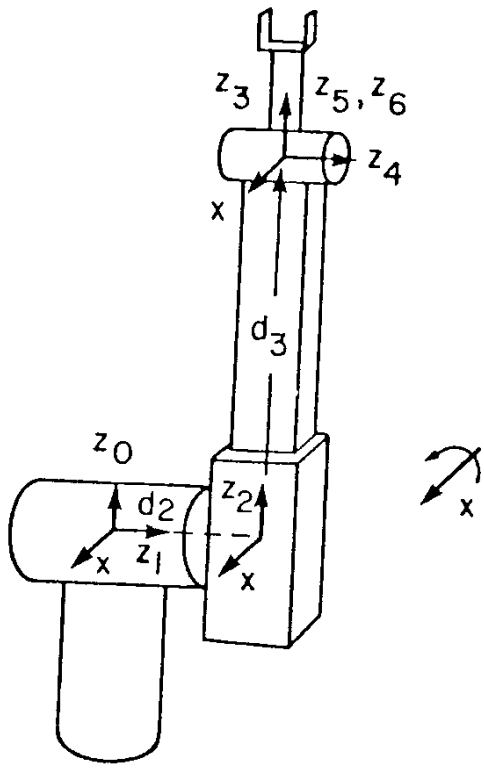

Figure 1.1 Coordinate Frames for the Stanford Manipulator

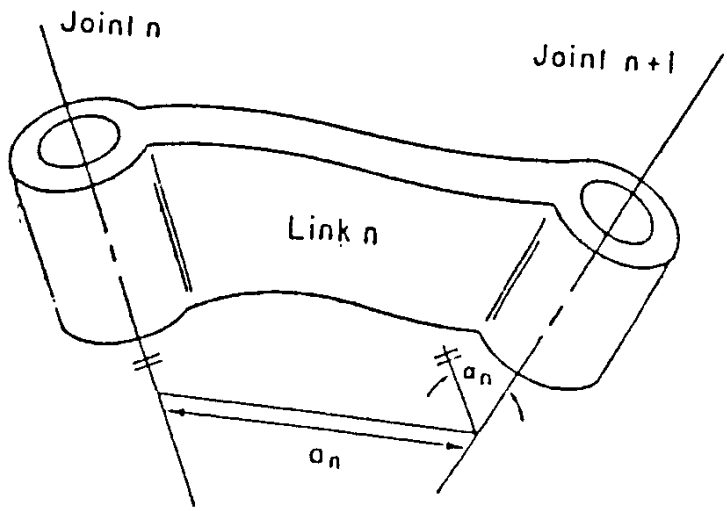

Figure 1.2 The Length a and Twist α of a Link

C- The relative position of two such connected links is given by (dn) (Fig 1.3), the distance between the normals along the joint N axis.

D- θn is the angle between the normals measured in a plane normal to the axis , dn and θn are called the distance and the angle between the links, respectively.

There are two different types of joints:

1:- Revolute joints in which (θn) is the joint variable

2:- Prismatic joint,in which (d_n) is the joint variable

The direction of the joint axis is the direction in which the joint moves (Fig. 1.3 , 1.4)

The structure of any arm and the relative position of its links with respect to each other can be described in terms of the parameters and variables of these links.

One example of the manipulators which will be analyzed is the Stanford manipulator which was shown in (Fig.1.1)

The link parameters for the Stanford manipulator are:-

LINK	VARIABLE α	α	a	d	COS(α)	SIN (α)
1	$\theta 1$	-90	0	0	0	-1
2	$\theta 2$	90	0	D2	0	1
3	D3	0	0	D3	1	0
4	$\theta 4$	-90	0	0	0	-1
5	$\theta 5$	90	0	0	0	1
6	$\theta 6$	0	0	0	1	0

TABLE 1.1

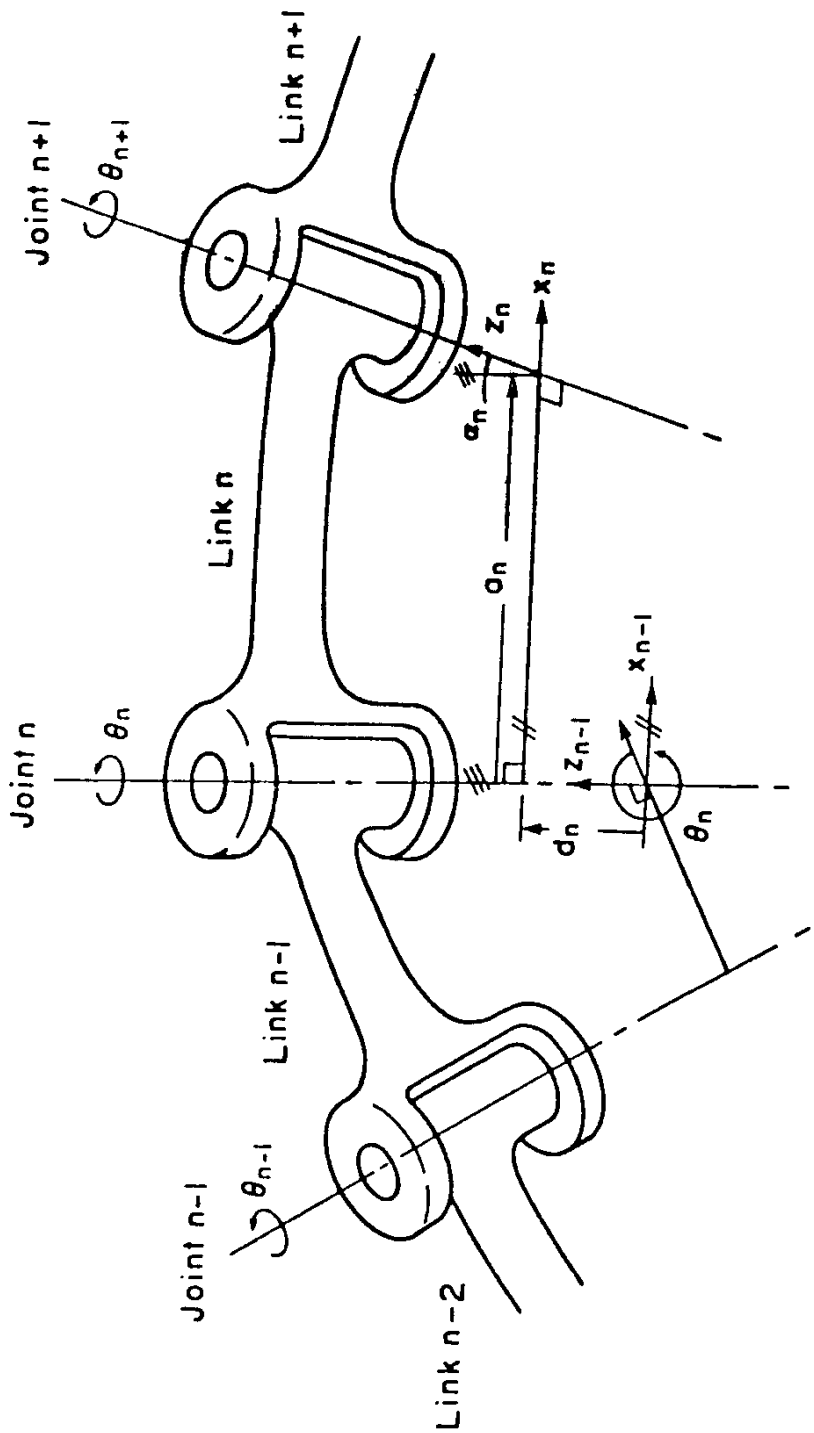

Figure 1.3 Link Parameters θ, d, a, and α