Sudan University of Science and Technology

College of Engineering

School of Electronics Engineering

Implementation of

Handling Arm Robot Using Programmable Platforms

A research submitted in partial fulfillment for the requirements of the Degree of B.Sc. (Honors) in Electronics Engineering

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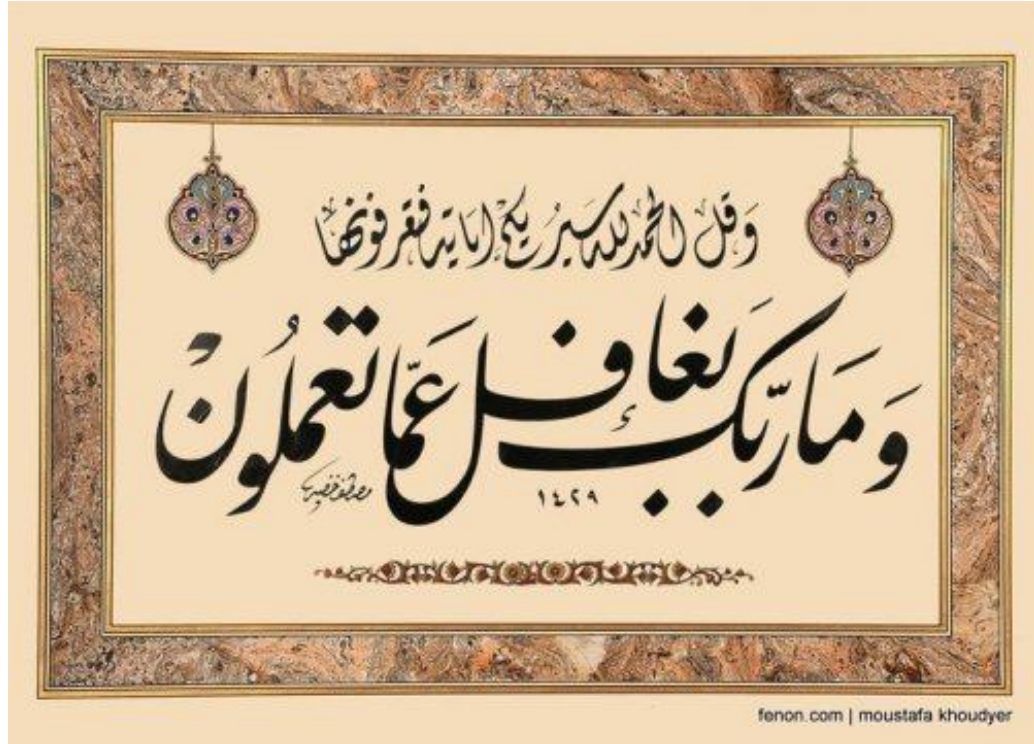2. Arwa Mohamed Abass.
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إستهلال

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النمل(93)

DEDICATION

We dedicate this thesis to our parents, without
their patience, understanding, support, and
most of all love the completion of this work
would not have been possible.

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In the name of Allah The Most Gracious and The Most Merciful. Alhamdulillah, praise to Allah and may His blessing be upon Prophet Muhammad peace be upon him. The Final Year Project program that we have gone through the year had given us an experience that we might remember forever especially as a student of Sudan University of Science and Technology.

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Last but not least, thanks to individuals that has contributed either directly or indirectly to make this thesis. Without all these people encouragement, support, and advices this thesis might not be successfully carried out.

ABSTRACT

The objective of this thesis is to allow the manufacturer to keep pace with modern technology using programmable platform such as Field Programmable Gate Array (FPGA) with minimum cost. Robots have many uses in industrial field such as production line, handling, medical fields …etc, to minimize time, cost and labors. And increase efficiency, performance, flexibility and reliability.

Implementation of robotic arm using programmable platform is done in this thesis with ST112A, ST112C kits. Software is designed and developed on Very high speed Hardware Description Language (VHDL) to manipulate the model in various directions; ST112C kit contains three servo motors; which provide the movement of the arm.

المستخلص

الهدف من هذه الأطروحة هو السماح للمُصنِّع لمواكبة التكنولوجيا الحديثة باستخدام منصة برمجة مثل (FPGA) مع الحد الأدنى من التكلفة. الروبوتات لها العديد من الاستخدامات في المجال الصناعي مثل خط الانتاج، المناولة، والمجالات الطبية ... الخ، لتقليل الوقت والتكلفة والعمالة. وزيادة الكفاءة والأداء والمرونة والموثوقية .

ويتم تطوير الذراع الروبوتية باستخدام منصة للبرمجة في هذه الأطروحة مع العُده ST112A، ST112C. تم تصميم البرمجيات وتطويرها على (VHDL) للتلاعب بالذراع في اتجاهات مختلفة؛ ST112C يحتوي على ثلاثة محركات. والتي توفر حركة الذراع.

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LIST OF ABBREVIATIONS

.BIT	BIT Generation.
ASIC	Application Specific Integrated Circuit.
CPLD	Complex Programmable Logic Device.
DOF	Degree Of Freedom.
FPGA	Field Programmable Gate Array.
FRC	Flat Ribbon Cable.
GUI	Graphical User Interface.
ISE	Integrated Software Environment.
J-TAG	Joint Test Action Group.
LPT	Line printer port.
ms	Millisecond.
NRE	Non-Recurring Engineering Cost.
PC	Personal Computer.
PLD	Programmable Logic Device.
PWM	Pulse Width Modulation.
TTL	Transistor Transistor Logic.
UCF	User Constraint File.
VB	Visual Basic.
VHDL	Very High Speed Hardware Description Language.

CHAPTER ONE

INTRODUCTION

1. Introduction

1.1. Preface

Nowadays, Field-Programmable Gate Array (FPGAs) are the best solution for designers who want to verify their prototype of the device [1]. Recently, revolution of industry field head to reduce dependence on human labors to save energy, cost, and time; by autonomous instruments such as robots. And there are various applications such as robotic arm.

Robotics is an interdisciplinary field involving diverse disciplines such as physics, mechanical design, statics and dynamics, electronics, control theory, artificial intelligence (AI), and manufacturing. Various specialists study various limited aspects of robotics, but few engineers are able to confront all these areas simultaneously. This further contributes to the nature of robotics, for the control theorist, for instance, has a quixotic and fanciful notion of AI [2]. On the other hand, techniques from other research fields can be embedded into AI applications, in which is shown how hardware/software co-design techniques can be exploited, so as to map AI application on a single FPGA board. Since most AI applications need to conform to very strict real-time margins, one of the key requirements for the efficiency of such systems is that of performance. As a result, designing fast algorithms for logic derivations is a key requirement for the efficiency of the implementation of an intelligent embedded system [3].

In this Thesis, a handling arm robot will be implemented using software design approach, Xilinx editor will be used on ST112 kit which is used to prototype the design and for evaluation of the overall performance.

Finally, it seems that FPGAs are going to rule in the future because of their flexibility, increasingly better power efficiency and decreasing prices.

1.2. Problem Statement

Rapid change of technologies are forcing firms to frequently upgrade their production lines, this will make firms resist the changes due to economic matters. Besides, time to market will also take longer time to deliver the products due to the change in the production lines. This appears specially when using robots.

1.3. Proposed Solutions

It is highly recommended to design systems that can easily be changed either by software development or/and hardware upgrade. That will allow the manufacturer to adopt states of the art with minimum cost. Thus, Programmable platform is proposed in this area.

In this thesis an implementation of handling arm robot using programmable platform has been implemented using FPGA.

1.4. Objectives

The main objectives of this thesis are:

- To implement the robot arm that controls eight movements which carry the payload.
- To prepare a manual sheet for educational purposes.
- Contribute to implement binary bit (.BIT) file.

1.5. Methodology

Evolutionary prototyping method is adopted in this thesis; the main concept is to build a functional model and continuously improve it, in order to deliver a proper system to the end user.

Specifically, FPGA Spartan II is used to implement this thesis as a proposed solution; it needs software environment Xilinx ISE 8.1i editor to write commands using windows XP 2002 operating system, Xilinx ST112 kit contains three parts: receiver ST11A, transmitter ST11B and the robot arm ST112C. Interfacing between personal computer (PC) and ST11A, B by Joint Access Group (J-Tag), and between ST11A and arm by Flat Ribbon Cable (FRC). In this thesis just ST112A, C were used to attain handling scenario to grapping an objects.

1.6. Thesis Outlines

Chapter Two, and Chapter Three highlights previous work. The former shows timeline through the programmable devices, to FPGA. The later gives a brief history about robots, the main structure, and also the algorithm that is used in it. A discussion of the design approach and implementations of robot arm, general scenario explain how it works, and block diagrams is discussed in Chapter Four. Finally, Chapter Five also draw the conclusion and outlook for future work.