الآيـة

قال تعالى :

(هُوَ الذي جَعَلَ الشمْسَ ضيَاءً والقَمَرَ نُورا وَقَدرَهُ مَنَازلَ لتَعْلَمُوا عَدَدَ السنينَ وَالحسَابَ مَا خَلَقَ اللهُ ذَلكَ الا بالحَق يُفَصلُ الايَات لقَوم يَعْلَمُونَ)

سورة يونس

آية (5)

DEDICATION

Thankful appreciation for support, encouragement and understandings to our beloved mothers, fathers, brothers and sisters.

ACKNOWLEDGEMENT

First and foremost, we would like to express our gratitude to the most Gracious and Most Merciful **ALLAH** for helping us to complete this research.

It has been an honor and pleasure to have Ust. Gaffar babiker Osman as our supervisor. We are grateful to him for the time given to us to make this requirement and for his valued suggestion. In addition to his huge knowledge and experience. We enjoyed his support and patience during the very tough moment of the research work and writing of the research.

Lastly but certainly not least, we would like to deeply acknowledge our beloved parents for their untiring efforts in providing moral and financial assistance that inspired to finish this work and also to all our friends that's been really helpful in providing us some help along with their kind opinion.

ABSTRACT

The human deal with many problem and risks in any fields like industrial fields , chemical laboratories and nuclear industries …. Etc. These risks which mentioned above happen because the human doing it manually , because of that hand simulator control system has been built , to avoid that risks by doing dangerous jobs instead of the human. Hand simulator control system has been implemented to do work with high efficiency in fields mentioned above.

المستخلص

يتعرض الإنسان للعديد من المشاكل و الأخطار في شتى المجالات, مثل المجالات الصناعية والمعامل الكيميائية والصناعات النووية....الخ . تلك الأخطار السابق ذكرها تكون بسبب أن الإنسان يقوم بالعمل فيها يدويا" ؛ لذلك يتم تصميم نموذج لمحاكاة حركة ذراع الإنسان لتفادي تلك المخاطر بان تقوم الذراع الآلية بما كان يقوم به الإنسان. وقد تم تصميم نموذج للذراع بما يحقق العمل بكفاءة في المجالات السابق ذكرها .

TABLE OF CONTENTS

	Page no
الآية	I
Dedication	ii
Acknowledgement	iii
Abstract	iv
المستخلص	V
Table of Contents	vi
List of Figures	X
List of Tables	xii
List of Abbreviations	xiv
CHAPTER ONE **INTRODUCTION**	
1.1 Background	1
1.2 Problem Statement	1
1.3 Objectives	3
1.4 Methodology	3
1.5 Project Outlines	3

CHAPTER TWO HAND SIMULATOR	
2.1 Introduction	5
2.2 Hand Simulator Control System Applications	7
2.2.1 IED (Improvised Explosive Device)	8
2.2.2 Bomb	8
2.2.3 Bombing	8
2.2.4 Bomb threat	8
2.2.5 Hoax device	9
2.2.1.6 Current bomb disposal practices	10
2.2.1.7 Attempted bombing	13
2.2.1.8 Suspect item	13
2.2.1.9 System statement of scope	13
2.2.2 Risk assessment of chemical hazards	14
2.2.2.1 risk assessment	14
2.2.2.2 Assess the risks	16
2.2.2.3 specifying the Control Measures	17
2.2.2.4 Implementing the outcome of the risk assessment	18

CHAPTER THREE CONTROL SYSTEM	
3.1 Introduction	23
3.2 Closed-Loop Control Versus Open-Loop Control	23
3.3 PLC	21
3.4 Microprocessor, Microcomputer and Microcontroller	26
3.5 Arduino	28
CHAPTER FOUR APPLICATION	
4.1 Introduction	30
4.2 System Components	31
4.2.1 Gloves	31
4.2.2 Arduino mega 2560	32
4.2.3 Slide linear potentiometer	34
4.2.4 Accelerometer , Gyroscope (MPU 6050) sensor	35
4.2.5 Servo motor	38
4.3 Design Of The Robotic Arm	54
4.4 System Main Block Diagram	57
4.5 System Operation	57

CHAPTER FIVE CONCLUSION AND RECOMONDATIONS	
5.1 Conclusion	**64**
5.2 Recommendations	**64**
REFRENCESE	**66**
APPENDICES	**67**

LIST OF FIGURES

Figure	Title	Page
3.1	PLC conceptual application diagram	26
3.2	The difference between microprocessor and microcontroller	28
4.1	Glove construction	32
4.2	Arduino mega 2560 connection	32
4.3	Arduino mega 2560	34
4.4	Slide linear potentiometer	34
4.5	Connection of IMU sensor with arduino	35
4.6	MPU sensor	36
4.7	Accelerometer operation	37
4.8	GY-521 sensor	38
4.9	Servo motor electrical circuit	39
4.10	Servo motor block diagram	40
4.11	Continuous rotation servo motor SM-S4315R	42
4.12	Servo power connection with the arduino	45

4.13	Servo connection with the arduino and power supply	47
4.14	Standard servo motor construction	48
4.15	Servo speed representation	50
4.16	Servo power connection	52
4.17	Servo power connection	53
4.18	R/C servo connection	54
4.19	Robotic arm design	55
4.20	Block diagram of the hand simulator control system	57
4.21	Hand at normal case	58
4.22	Hand at case one	59
4.23	Hand at case two	59
4.24	Hand at case three	60
4.25	Hand at case four	60
4.26	Hand at case five	61
4.27	Hand at case six	61
4.28	Hand at case seven	62
4.29	Hand at case eight	62
4.30	Hand at case nine	63
4.32	Hand picking the first object	63
4.33	Hand picking the second object	63

LIST OF TABLES

Table	Title	Page
4.1	Arduino mega 2560 technical specifications	33
4.2	Slide linear potentiometer electrical characteristics	35
4.3	Servo power details	53
4.4	Torque calculations	57

T	Torque
F	Force acting on the motor
L	Length of the shaft
g	Gravitational constant = 9.8 m/s
m	Mass to be lifted by the motor

LIST OF SYMBOLS

LIST OF ABBREVIATIONS

AC	Alternating Current
CPU	Central Processing Unit
DC	Direct Current
DOF	Degrees of Freedom
EP	Emergency Procedure
IDE	Integrated Development Environment
IED	Improvised Explosive Device
IMU	Internal Measurement Unit
LED	Light Emitting Diode
LEV	Local Exhaust Ventilation
MEMS	Micro Electro Mechanical Systems
OP	Operating Procedure
PLC	Programmable Logic Controller
PWM	Pulse Width Modulation
PPE	Personal Protective Equipment
RAM	Random Access Memory
ROM	Read Only Memory
RPE	Respiratory Protective Equipment
SDS	Safety Data Sheet
USB	Universal Serial Bus