

GENERAL ROBOTIC ARM

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## ABSTRACT

Robotic arm has become popular in the world of robotics. This project describes the design and implementation of a 5 axis robotic arm. The arm consists of base, three links and the gripper. The joints are actuated using servomotors. The arm moves the object to its destination autonomously. This part of the project was completed with variable results depending on the size and positioning of the object. The arm executes the required motion. The essential part of the robotic arm is a programmable microcontroller based brick capable of driving basically 5 servomotors design. This project explains the method of interfacing the robotic arm servomotors with the programmable interface controller (PIC) which is used to control the robot operations that used an assembly language. The robot which can grab and release small objects is built for this PSM project, and it can be controlled manually or autonomously. Through the use of techniques learned in lecture and through independent research, the robot should be able to determine the presence of walls and other objects. Thus this project will be improving working conditions.

## ABSTRAK

'Robot arm' atau lengan robot adalah popular di serata dunia terutama dalam industri perkilangan. Projek ini direka dengan mempunyai 5 paksi lengan robot. Lengan ini terdiri daripada tapak, 3 gabungan untuk lengan robot serta pengepit. Semua sambungan robot ini menggunakan sevomotor. Projek ini didirikan dengan menggunakan PIC yang telah diprogramkan. PIC yang diprogramkan akan mengawal pergerakan lengan robot ini dalam mengambil sesuatu barang dan meletakkannya di tempat yang dalam lingkungannya. Robot ini mempunyai 5 suis yang mana ianya boleh dikawal mengikut arah pusingan jam atau sebaliknya. Selain itu ianya juga boleh dikawal menggunakan antaramuka melalui komputer. Oleh hal yang demikian saya akan berusaha untuk menyempunakan projek ini sebaik mungkin dengan mengikut perancangan yang dirancang.

## CONTENTS

CHAPTER	INSIDE	PAGES
	<b>PROJECT TITLE</b>	i
	<b>REPORT APPROVAL FORM</b>	ii
	<b>DECLARATION</b>	iii
	<b>ACKNOWLEDGEMENTS</b>	v
	<b>ABSTRACT</b>	vi
	<b>ABSTRAK</b>	vii
	<b>CONTENTS</b>	viii
	<b>LIST OF TABLE</b>	xii
	<b>LIST OF FIGURE</b>	xiii
	<b>LIST OF ABBREVIATION</b>	xv
	<b>LIST OF APPENDIX</b>	xvi
<b>1</b>	<b>INTRODUCTIONS</b>	
	1.1 Overview	1
	1.2 Objectives	2
	1.3 Scopes	2
	1.4 Methodology	3
	1.5 Progress Flow Chart	4
<b>2</b>	<b>LITERATURE REVIEW</b>	
	2.1 Robot	6
	2.2 Robot Arm	7
	2.3 Types Of Robotic Arms	10



2.3.1	Revolute Coordinate Robot Arm	10
2.3.2	Polar Coordinate Robot Arm	10
2.3.3	Cylindrical Coordinate Robot Arm	11
2.3.4	Cartesian Coordinate Robot Arm	11
2.4	Microcontroller	11
2.5	What Is A Microcontroller	12
2.6	Why Use A Microcontroller	12
2.7	The Compiler	12
<b>3</b>	<b>SOFTWARE</b>	
3.1	Code Explorer	15
3.2	Compiler Results	15
3.3	Real Time Simulation Support	16
3.4	General Review Function Descriptions	16
3.5	Operating The Servomotor	18
<b>4</b>	<b>MECHANICAL PART</b>	
4.1	The Arm	22
4.2	Selection Of Motors	23
4.2.1	Stepper Motors	23
4.2.2	Dc Motors	24
4.2.3	Servomotor	26
4.3	Motors Used In Project	26
4.4	PWM Generation For Servo Motor Control	27
<b>5</b>	<b>ELECTRONICS</b>	
5.1	Equipment	29

5.2	PIC Specification	30
5.2.1	Important Pins	30
5.2.2	Register Control	31
5.2.3	Using A/D Converter	31
5.2.4	Generating PWM Signals	31
5.3	Power Supply	32
5.3.1	Power Supply for the Servo Motors	32
5.3.2	Power Supply for Other Electrical Devices	33

## **6 ROBOT CONSTRUCTIONS**

6.1	Basic Servomotor Bracket Assembly	35
6.2	Robotic Arm Base	35
6.3	Robotic Arm Links	35
6.4	Servo Motor Specifications	40
6.5	Servomotor Information	43
6.6	Servomotor In My Project	44
6.7	Servo Speed	45
6.8	Servo Torque (Power)	46
6.9	Servo Ratings	47
6.9.1	Servo Wire Information	48
6.9.2	Servomotor Safety	48
6.9.3	Servo Centering	49
6.9.4	Inverse Kinematics	51

## **7 ROBOT ARM OPERATIONS**

7.1	Manual Control	53
7.1.1	Speed Position	54
7.1.2	Save Button	54
7.2	PC Control	55
7.2.1	Interactive Mode	57

7.2.2	Speed Slider Control	57
7.2.3	Script Writing	57
7.2.4	Playback	58
7.2.5	Script File Handling	58
7.3	Discussions	59
7.4	Conclusions	62
	<b>REFERENCES</b>	63
	<b>APPENDIX</b>	64

**LIST OF TABLE**

<b>NO</b>	<b>TITLE</b>	<b>PAGE</b>
<b>Table 1</b>	Motor Control Bits	25
<b>Table 2</b>	Servomotor Bracket Compatibility	36
<b>Table 3</b>	Robotic Arm Specifications	58

## LIST OF FIGURE

NO	TITLE	PAGE
<b>Figure 1</b>	Pictorial View of the Robotic Arm	3
<b>Figure 2</b>	<i>Anthropomorphic Type of Robot Design</i> (Selig, 1992, p.29)	8
<b>Figure 3</b>	The six axes Puma robot arm with the TUM multi-fingered hand fixating a wooden “Baufix” toy airplane. The 6D force-torque sensor (FTS) and the end-effectors mounted camera is visible, in contrast to built-in proprioceptive joint encoders.	9
<b>Figure 4</b>	Block Diagram for Microcontroller	12
<b>Figure 5</b>	Robotic arm software flowchart	16
<b>Figure 6</b>	System Block Diagram	20
<b>Figure 7</b>	Sub-System Block Diagram	20
<b>Figure 8</b>	Micro Controller Block Diagram	21
<b>Figure 9</b>	Comparison of servo with stepper having same torque	24
<b>Figure 10</b>	H Bridge using switches	25
<b>Figure 11</b>	H-Bridge circuit using Nmos	25
<b>Figure 12</b>	Servo control signal	27
<b>Figure 13</b>	Timing diagram for PWM generation	28
<b>Figure 14</b>	Servomotor	28

<b>Figure 15</b>	PIC 16F873	30
<b>Figure 16</b>	Servomotor power supply	32
<b>Figure 17</b>	Power supply for other devices	33
<b>Figure 18</b>	Circuit for Robotic Arm	34
<b>Figure 19</b>	Servo Holder	36
<b>Figure 20</b>	U Joint	36
<b>Figure 21</b>	Robot Arm Base	37
<b>Figure 22</b>	Robot Construction Mechanical Drawing	38
<b>Figure 23</b>	Robot Arm Links	39
<b>Figure 24</b>	Servomotor C36S	40
<b>Figure 25</b>	Servomotor C55S	41
<b>Figure 26</b>	Servomotor C40S	42
<b>Figure 27</b>	Servomotor View	43
<b>Figure 28</b>	Servomotor Speed	45
<b>Figure 29</b>	Servomotor Torque	46
<b>Figure 30</b>	Circuit Layout Power Supply	47
<b>Figure 31</b>	Servomotor Wire Information	48
<b>Figure 32</b>	Servomotor Centering	50
<b>Figure 33</b>	Arm Angle Designations	51
<b>Figure 34</b>	Sample plot of arm simulation	52
<b>Figure 35</b>	Servo Motor Controller	55
<b>Figure 36</b>	Servo Motor Controller Descriptions	56

## LIST OF ABBREVIATION

PWM	Pulse Width Modulation
DOF	Degree of Freedom
PIC	Peripheral Interface Controller
FTS	Force Torque Sensor
CPU	Central Processing Unit
RAM	Random Access Memory
ROM	Read Only Memory
SFRs	Special Function Registers
I/O	Input/Output
A/D	Analog To Digital
D/A	Digital To Analog
IDE	Integrated Development Environment
VSM	Virtual System Modelling
AC	Alternating Current
DC	Direct Current
CW	Clockwise
MAN	Manual
COM	Communication

**APPENDIX**

<b>NO</b>	<b>TITLE</b>	<b>PAGE</b>
A.	C Programming	64
B.	Robot Arm Article	70
C.	Datasheet 16f873	74
D.	R/C Servo Function	77
E.	Servo Mechanics	78
F.	Servo Checker	78
G.	PCB Layout	80
H.	3D Layout	81
I.	Types of Robotic	82
J.	Parts List	84



## CHAPTER 1

### INTRODUCTIONS

This report describes the design and implementation of a 5 axis robotic arm designed for the BENU 4973 course. The arm moves in a range to get the exact position and size of an object, and then grips the object and moves it to the selected destination. The arm consists of a base, three links and a gripper. The joints and the gripper are activated using servomotors. This report discusses the system overview followed by the mechanical and programming design description. It will also discuss the implementation issues and provide recommendations as to how the design may be improved.

#### 1.1 OVERVIEW

The project can be broadly divided into three sections which are the mechanical parts, programming parts and electronic part. Mechanical parts are deals with making of a platform and selection of motor. Programming parts is using the C language to program in the PIC to run the robot. The electronic part is to construct the circuit and selection of the devices needs to use in this project.

## 1.2 OBJECTIVES

The purposes of this project are:

1. To develop a robotic arm.
2. To present, analyze, design and troubleshoot the product.
3. To familiarize with the PIC programming and the simulation software.
4. To control the robot arm manually or autonomously.
5. To be able to perform certain tasks we define for it.
6. The tasks must be achieved within some given limitations.

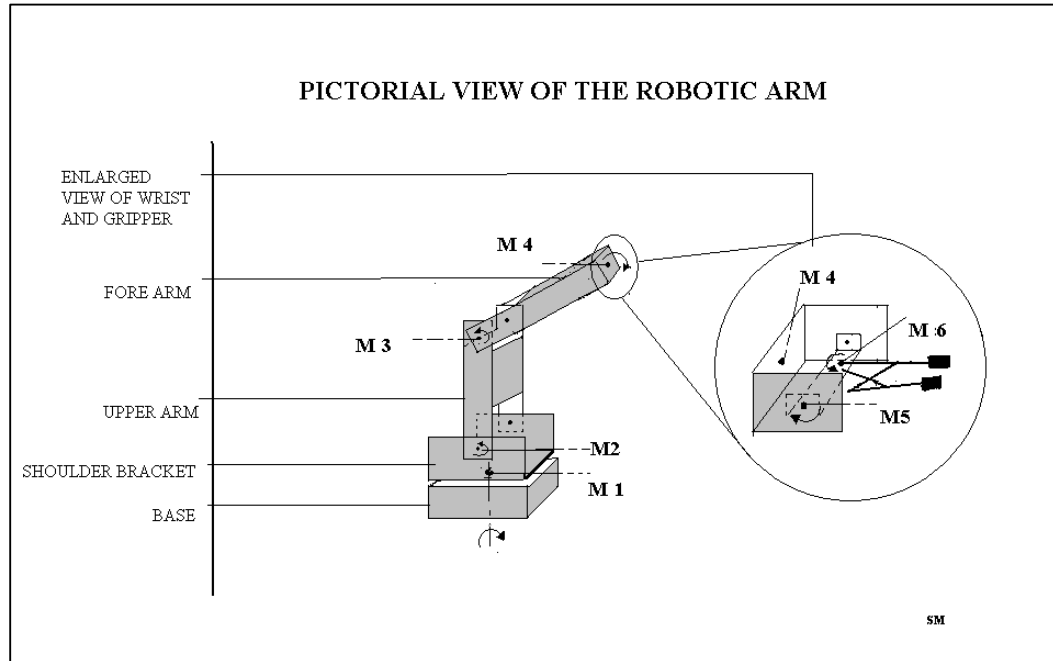
## 1.3 SCOPES

The arm is the main structure consisting of a mechanical structure, servomotors, and power supply.

The arm is a 5 axis robotic manipulator consisting of a stationary base, three links and a gripper. The five axes consist of the following: (*shown in figure 1*)

1. Shoulder, elbow, wrist (vertical movement)
2. An axis at the base (horizontal movement)
3. Finger (gripping movement)

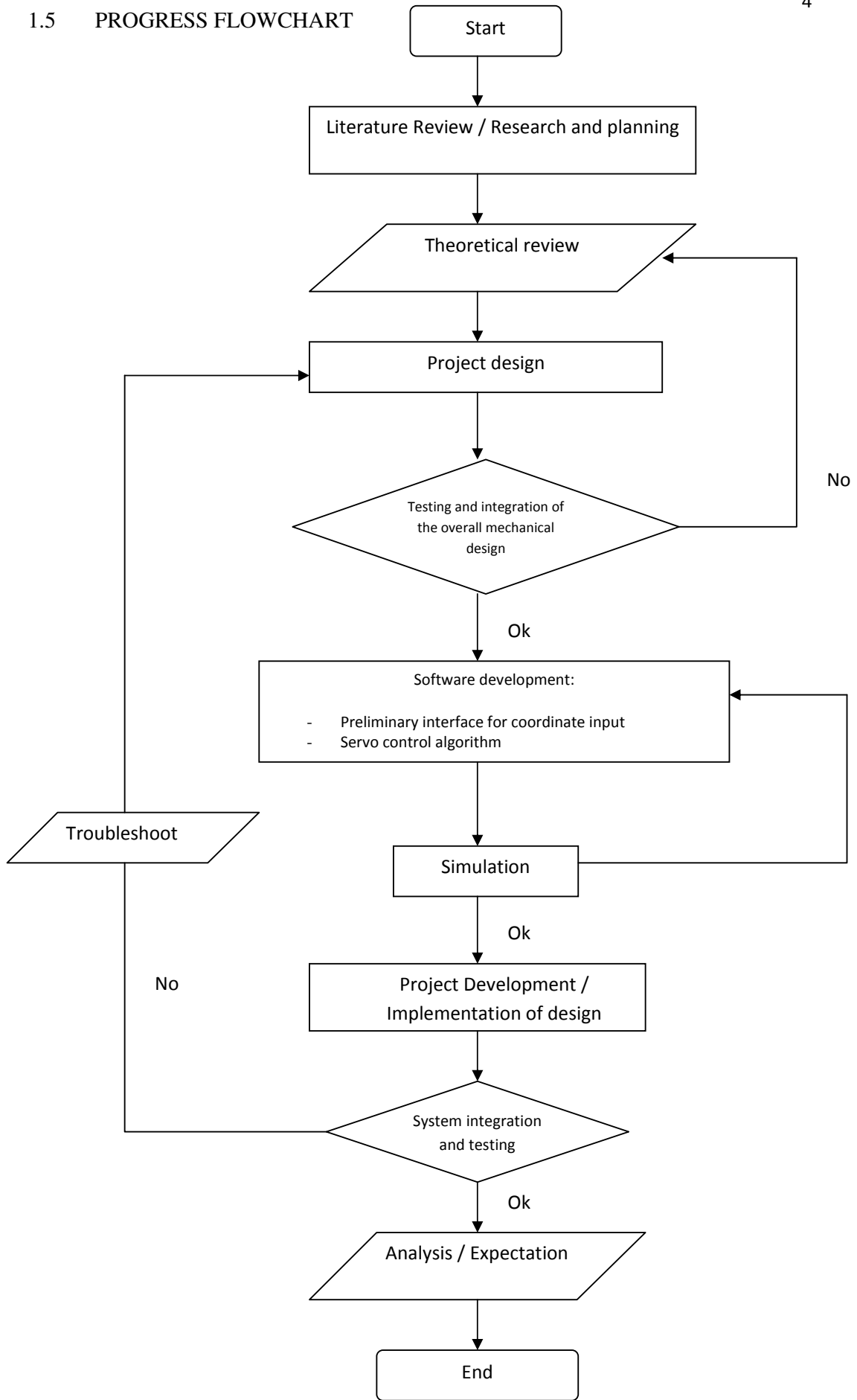
In a neutral state, the arm is extended horizontally and the gripper is open. The arm can rotate around the vertical and horizontal axes 90 degrees each direction from the neutral state. An independent power supply is also incorporated into the arm. The voltage end of it is stationed in separate properly grounded boxes. The power supply powers up the entire arm system. There are five servos in the system, one at each axis. It also is used to close and open the gripper. The servos used at the wrist and at the base.



**Figure 1:** Pictorial View of the Robotic Arm

#### 1.4 METHODOLOGY

1. The method employed in designing and constructing the robotic arm are based on the operational characteristics and features of the microcontrollers, servo motors, the electronic circuit diagram and most importantly the programming of the microcontroller and servo motors.
2. To design a robotic arm that can follow a sequence of precise movements.
3. Constructs the project in a time range.
4. To know the concept of robotic arm this is from the design, programming and troubleshooting.
5. To use an appropriate software for this robotic arm.



The flowchart shown that, my progress project flowed.

In the literature review I was referred to the internet sources and went to the library made a revision how to start this project. Thus, I was prepared a Gantt chart to perform my timeline project. In progress of project design I was try to intend my robot arm. So after finished it, I was tested and integrated the overall of the mechanical design. If this not inappropriate or not suitable I was referred to the theoretical to design it again or to find the weakness of this structure. Software development was very complicated to build. After compile was satisfactory and burned it into the PIC I was started to develop this robot arm. From the system integrations and testing was acceptable, I just to do the analysis and expectation for overall of this project. Otherwise, if this have a problem I was made a troubleshoot which referred to the project design.

## CHAPTER 2

### LITERATURE REVIEW

The robotic projects extensive use of the PIC series of microcontroller from Microchip Technology Inc. In addition to its ability to run programs, the microcontroller has input and output lines (pins) that are used to control motor drive systems, read sensors, and communicate. I demand a lot from my microcontroller, so it's important to have a good idea of what a microcontroller is right from the start.

#### 2.1 ROBOT

1. One of the mechanical men and women in Capek's play; hence, a machine (sometimes resembling a human being in appearance) designed to function in place of a living agent, esp. one which carries out a variety of tasks automatically or with a minimum of external impulse.
2. A person whose work or activities are entirely mechanical; an automaton.

*Oxford English Dictionary, Online Edition.*

Karel Capek used the word Robot in his 1921 play Rossum's Universal Robots, derived from the Czech word *robota*, meaning "forced labor." These Robots were created to replace man and, in their simplified form, as cheap labor. Robots had perfect memory but were incapable of thinking new thoughts. They mirrored the Hebrew legends of the golem, a clay statue that has had life breathed into to by mystical means. And, of course, this all sounds a lot like Dr. Frankenstein's monster, reanimated from the bits and pieces dug up from the local graveyard. One thing these

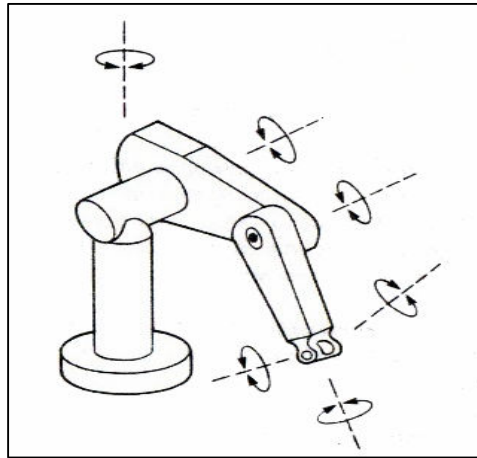
stories have in common is that the creation is ultimately the downfall of their creator robots, golems, and reanimated flesh means trouble. They are an illustration of what happens when we reach too far and are bitten by the unintended consequences.

## 2.2 ROBOT ARM

The word '*robotics*', meaning the study of robots was coined by Isaac Asimov. *Robotics involves elements of mechanical and electrical engineering, as well as control theory, computing and now artificial intelligence (Selig, 1992).* According to the Robot Institute of America, "A robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks"(Robotics Research Group, n.d.)

The fact that a robot can be reprogrammed is important: it is definitely a characteristic of robots. In order to perform any useful task the robot must interface with the environment, which may comprise feeding devices, other robots, and most importantly people.

In constructing the arm, I made use of servomotors. A typical prototype that I employed is as shown in Figure 2. The servomotor at the *base*, which allows for circular movement of the whole structure; another at the *shoulder* which allows for upward and downward movement of the arm; while at the *wrist* allows for the picking of objects by the gripper.



**Figure 2:** *Anthropomorphic Type of Robot Design* (Selig, 1992, p.29)

To control the robot arm I decide to use microcontroller. In this case I saw that, there is a several type can be used to control the robot arm. Taking a look back at the history of robot development, a special kind of human-size *industrial robotic arm* called Programmable Universal Machine for Assembly (*PUMA*) came into existence. This type of robot is often termed *anthropomorphic* because of the similarities between its structure and the human arm. The individual joints are named after their human-arm counterparts. *“It is worth noting that in our work, the hand is magnetic and not a generalized manipulator. In the proper sense of the word, manipulation is the function of the arm. The function of the arm is to position and orient the hand, act as a mechanical connection and power and sensing transmission link between the hand and the main body of the person. The full functional fearing of the arm rests in the hand”* (Bejczy & Jau, 1986). This work provides important elements that are required to build a simple robotic arm of very high quality. As stated earlier it can be making use of the 8051-based microcontroller. *‘The 8051’s instruction set is optimized for one-bit operations that are often desired in real world, real time operations’*. (Pont, 2002).

*The first design was for experimental use on a human-size industrial robot arm called PUMA 560 used to explore issues in versatile object handling and compliance control in grasp actions* (Bejczy & Jau, 1986). This paper explains the