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 mengunakan sevomotor. Projek ini didirikan dengan menggunakan PIC yang telah diprogramkan. PIC yang diprogramkan akan mengawal pergerakkan 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.

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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

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.

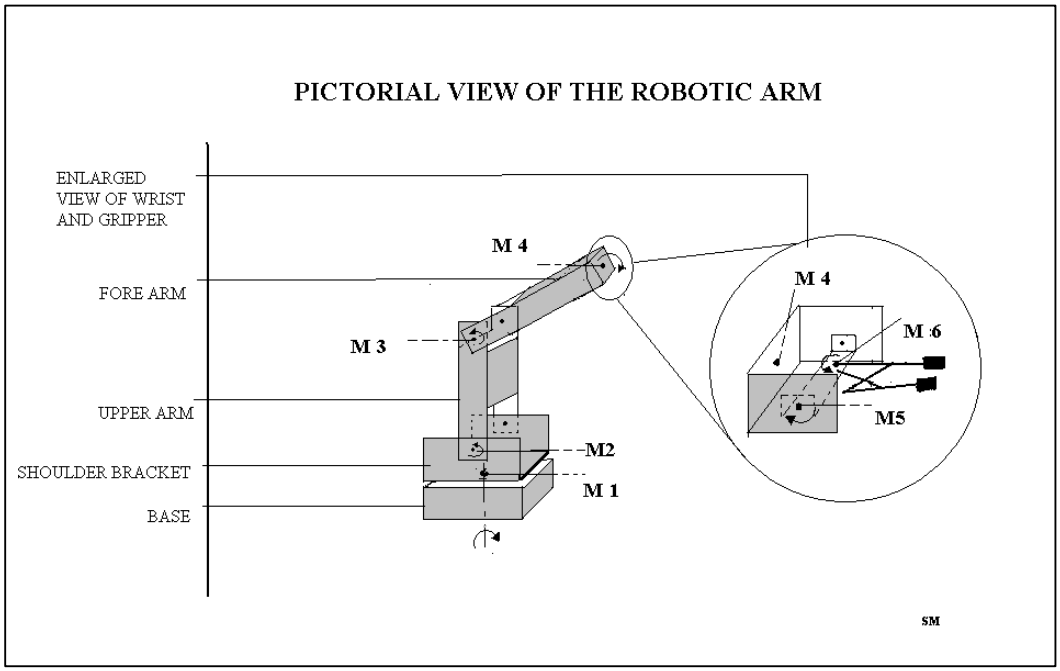
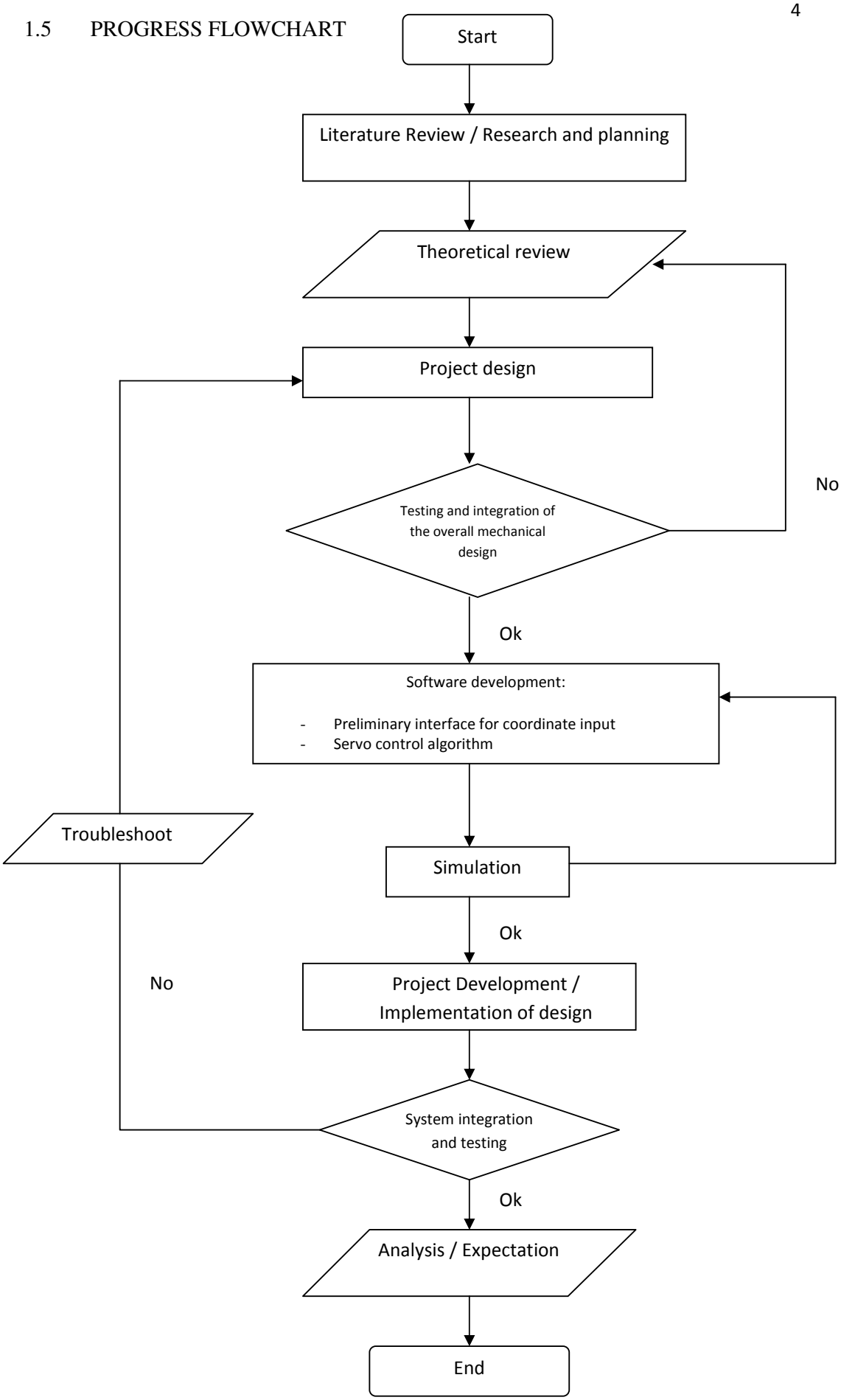


Figure 1: Pictorial View of the Robotic Arm

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.

1.5 PROGRESS FLOWCHART



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.

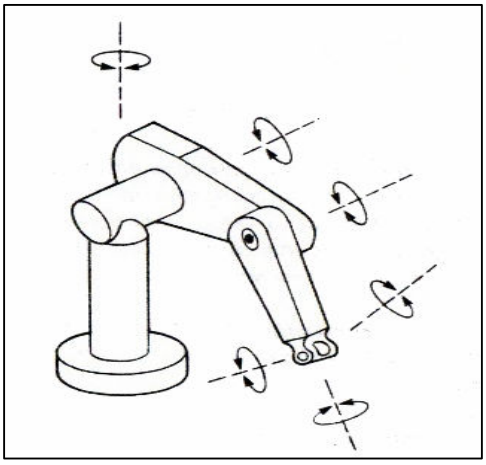


Figure 2: *Anthropomorphic Type of Robot Design* (Selig, 1992, p.29)

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