UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Control of Robotic Arm Using Visual Basic and PIC Microcontroller

Thesis submitted in accordance with the requirements of the
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Bachelor of Engineering Manufacturing (Robotic and automation)

By

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DECLARATION

I hereby, declare this thesis entitled "Control of Robotic Arm using Visual Basic and PIC microcontroller" is the results of my own research except as cited in the reference.

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ABSTRAK

Projek Sarjana Muda ini adalah mengenai "Control of the robot arm using visual basic and PIC microcontroller". Hasil kajian daripada orang-orang terdahulu mengenai lengan robot telah dijadikan rujukan khususnya pada bahagian badan robot itu sendiri, sistem kawalannya dan pemacu yang digunakan pada robot. Selain itu juga, projek ini mengetengahkan tentang cara lengan robot dikawal melalui penggunaan perisian Visual Basic 6.0 dan implementasinya dengan PIC microcontroller. Bagi melengkapkan bahagian kajian ilmiah bagi projek ini, perisian khas seperti VModelo atau dengan nama "virtual reality modeling language" telah digunakan. Ia bertujuan untuk mendapatkan orientasi robot yang tepat berdasarkan maklumat asas yang telah didapati dari DH parameter. Dalam menjalankan projek ini, langkah kendalian projek telah disusun mengikut aturan yang sistematik bermula daripada membuat kajian, membuat analisa terhadap fungsi robot, kajian terhadap sistem kawalan robot, rekabentuk litar elektronik dan membuat ujkaji terhadap hasil kajian. Bagi pembangunan dan kerja-kerja lanjutan, beberapa cadangan telah dibuat terutamanya peningkatan penambahbaikan pada bahagian litar kawalan motor dan juga sistem pacuan robot bagi memastikan objektif yang dilaksanakan untuk projek ini tercapai.

ABSTRACT

This project is about "Control of the robot arm using visual basic and PIC microcontroller. Past researchers have been implemented in this project especially the robot mechanism, the control system of the robot and the actuator of the robot. Visual Basic 6.0 is the type of software that is used in control the robot arm and was implemented with the Visual Basic software as the control system of the robot. To completed the literature review of this project, special software has been use in adapted the robot orientation using VModelo or known as "virtual reality modeling language". The purpose is to implement the DH algorithm in reason to get the right orientation of the robot through virtual reality. To make sure that the objectives of this project achieved, a systematic method have been applied in order to obtain the future development of the robot especially for the robot motor control circuit and actuator mechanical system.

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CHAPTER 1
INTRODUCTION

1.0 Project Overview

This project is about to design a robot arm manipulator and control system of the robotic arm that using visual basic and microcontroller as the controller based system. The project is focusing on designing a serial interface system that is use to control the serial DC motor controller circuit board to run the robotic arm. The graphic user interface has been design using the Microsoft Visual Basic 6.0. The ability to design the serial interface application that runs on any personal computer (PC) has never been easier using Visual Basic 6.0.Using a microcontroller in conjunction with a PC provides enormous power and flexibility to any project. All of the concepts in this project can be adapted and applied to any number of projects that require serial communications software development.

The project will consists of three disciplines; programming, electrical and electronic and fabricating. Additionally, experimental setup will be done in getting the best result especially for the electronic parts. Research and journal study of robot system and control helps most in adding ideas and to create the robotic arm control system. Perhaps, the conclusion of the project report will briefly describe the whole of the project activity.

1.1 Problem Statement

The robots of the movies, such as C-3PO and the Terminator are portrayed as fantastic, intelligent, even dangerous forms of artificial life (Robot, 1999). However, robots of today are not exactly the walking, talking intelligent machines of movies, stories and our dreams. Today, we find most robots working for people in factories, warehouses, and laboratories. In the future, robots may show up in other places: our schools, our homes, even our bodies.

Robots have the potential to change our economy, our health, our standard of living, our knowledge and the world in which we live. As the technology progresses, we are finding new ways to use robots. Each new use brings new hope and possibilities, but also potential dangers and risks (Robot, 1999).

Most robots are designed to be a helping hand. They help people with tasks that would be difficult, unsafe, or boring for a real person to do alone. At its simplest, a robot is machine that can be programmed to perform a variety of jobs, which usually involve moving or handling objects. Robots can range from simple machines to highly complex, computer-controlled devices. Many of today's robots are robotic arms. In this project, the focus topic is on one very "flexible" kind of robot, which looks similar to a certain part of human body. It is called a jointed-arm robot.

The problem statement that is discussed in this chapter consists of 4 parts of the robot arm; controller, arm, actuator, end effector and sensor.

1.1.1 Controller

Every robot is connected to a computer, which keeps the pieces of the arm working together. This computer is known as the controller. The controller functions as the "brain" of the robot. The controller also allows the robot to be networked to other systems, so that it may work together with other machines, processes, or robots. The controller of the robot arm also can be in teaching pendent type where user operates the robot arm manually according to the task.

Robots today have controllers that are run by programs - sets of instructions written in code. Almost all robots of today are entirely pre-programmed by people; they can do only what they are programmed to do at the time, and nothing else. In the future, controllers with artificial intelligence, or AI could allow robots to think on their own, even program themselves. This could make robots more self-reliant and independent.

1.1.2 Arm

Robot arms come in all shapes and sizes. The arm is the part of the robot that positions the end-effector and sensors to do their pre-programmed business. Many (but not all) resemble human arms, and have shoulders, elbows, wrists, even fingers. This gives the robot a lot of ways to position itself in its environment. Each joint is said to give the robot 1 degree of freedom. So, a simple robot arm with 3 degrees of freedom could move in 3 ways: up and down, left and right, forward and backward. Most working robots today have 6 degrees of freedom.

1.1.3 Actuator

Actuator of the robot arm is the "engine" that drives the links (the sections between the joints into their desired position. Without a drive, a robot would just sit there, which is

not often helpful. Most drives are powered by air, water pressure, or electricity. In this project, the preferred actuator that is chose is electrical drive.

1.1.4 End – Effector

The end-effector is the "hand" connected to the robot's arm. It is often different from a human hand and it could be a tool such as a gripper, a vacuum pump, tweezers, scalpel, and blowtorch or just about anything that helps it do its job. Some robots can change end-effectors, and be reprogrammed for a different set of tasks. If the robot has more than one arm, there can be more than one end-effector on the same robot, each suited for a specific task

1.1.5 Sensor

Most robots of today are nearly deaf and blind. Sensors can provide some limited feedback to the robot so it can do its job. Compared to the senses and abilities of even the simplest living things, robots have a very long way to go. The sensor sends information, in the form of electronic signals back to the controller. It also gives the robot controller information about its surroundings and lets it know the exact position of the arm, or the state of the world around it. Sight, sound, touch, taste, and smell are the kinds of information we get from our world. Robots can be designed and programmed to get specific information that is beyond what our 5 senses can tell us. For instance, a robot sensor might "see" in the dark, detect tiny amounts of invisible radiation or measure movement that is too small or fast for the human eye to see. In the project of control of robotic arm using visual basic and PIC microcontroller, sensor for the robot is used such as the limit switch. This type of sensor famously used currently in robotic system as the positioned limit of robot movement. To reduce the high costing on using encoders, this type of sensor is the good solution for the robot positioning sensor.

1.2 Objectives

The objectives of this project are to:

- Design and fabricate a robotic arm
- Design the hardware and software of the robotic arm control system.
- Encourage the application of the microcontroller and Visual Basic 6.0
- Test the robot movement using programmable microcontroller PIC16f877a joystick and serial interface programming.

1.3 Scope of Project

Scope of the project will make sure that the objectives of the project accomplished. This includes of hardware and software parts. These aspects will remain the robotic arm control system which will be added as soon as the mechanical part of the robot is build. The robot arm model will be simulating using the RModelo software to get the trajectory model of the robot arm.

Another part in this project that has been establish is to design the control the DC motor which have high current and high voltage using serial communication via PC. Additional knowledge in PIC microcontroller has been very useful and as advantages to taking furthers the project using both different programming.

Software for the robot arm will be build using the Visual Basic 6.0 where a graphical user window interface will be design using this software. Typically, the method for the arm robot control is in serial communications where the RS 232 PC port will be use as the conjunction with the robot.

Experimental setup for the project consist of circuit analysis especially the DC motor driver and the interface circuit. The results will then discuss and the best results will be chosen. This will ensure that the control system of the robot will remain in stable condition even it is not design by high technology precision machine. A special chart has been built to make sure that the research and project activities are systematic (table. 1.0).

CHAPTER 2
LITERATURE REVIEW

2.0 Robotics Overview

Robotics developed as an offspring of the industrial revolution and the more recent information revolution. According to the *Rachid Manseur*, robots are machines controlled by computers (Manseur, 2006). Although the terms of *robot* has come to represent almost any machines, in this text, a robot is defined as a computer-controlled machine that can be programmed to accomplish different task autonomously. Robotics is multidisciplinary sciences that realize on contribution and advance in many areas of science technology (Manseur, 2006). Figure 2.0 illustrates the multidisciplinary nature of robotics and shows some of contributing disciplines to robotics as well as a few of its fields of application. The field of robotic will contribute directly with multidisciplinary field such as mathematics, physics, electrical and computer engineering and engineering field. The application of robotic is widely spread out and as a result, robotics is a subject of study and research in a wide variety of department within universities and scholarly centers, usually at the graduate level.

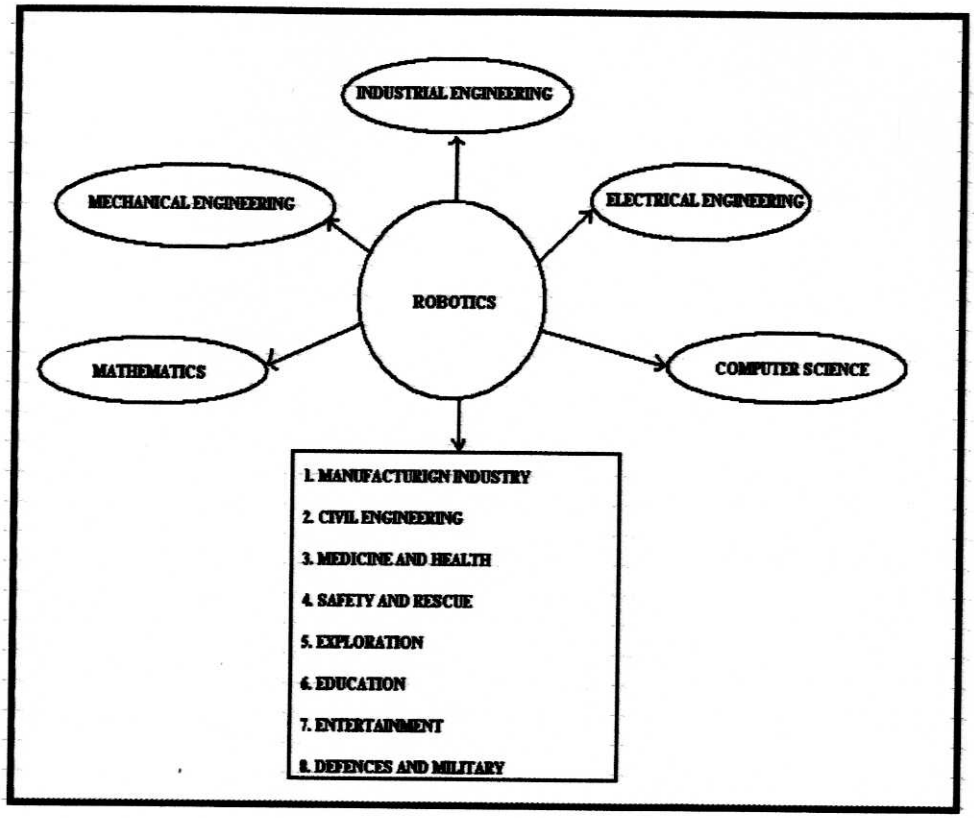

Figure 2.0: Robotics as a multidisciplinary field (Manseur, 2006)

2.1 Robotic Arm

From previous study of robotics, the main attraction that makes robot became popular and useful is the beneficial to human especially in help human to do job that requires long concentration and precision. According to *Rachid Manseur*, what is means by attraction of robotics is the mechanical labor that similar to human arm. Labor is exactly performed by human arms powered by muscles and augmented by the use of tools (Manseur, 2006). Therefore, industrial robotics today's were robotics arm which is call as manipulator.

2.1.1 Robot Manipulator

Manipulator system for robot consists of links, joints, actuators, sensors and controllers. Links for robotic is consider as the joints that connected to perform an open kinematics chain. Links for the robot arm can be more than one. *Man Zhihong* has stated that the end of the chain is attached to the robot base, and the other end is equipped with a tool (gripper, hand, end-effectors) to perform assembly operations or tasks (Man Zhihong, 2004). Joints is use to connect the neighboring links and may be rotary or prismatic. The rotation of rotary joints and the sliding of prismatic joints aloe the links to move the robot in the workspace. Figure 2.1 show the symbol of rotary joint and prismatic joint respectively. Z is the motion axes of the rotary joint or a prismatic joint; l_1 and l_2 are two neighboring links. The angle θ of the rotary joint and the sliding distance d of the prismatic joint is called joint variables. In a robot system, the number of degree-of-freedom is determined by the number of independent joint variables.

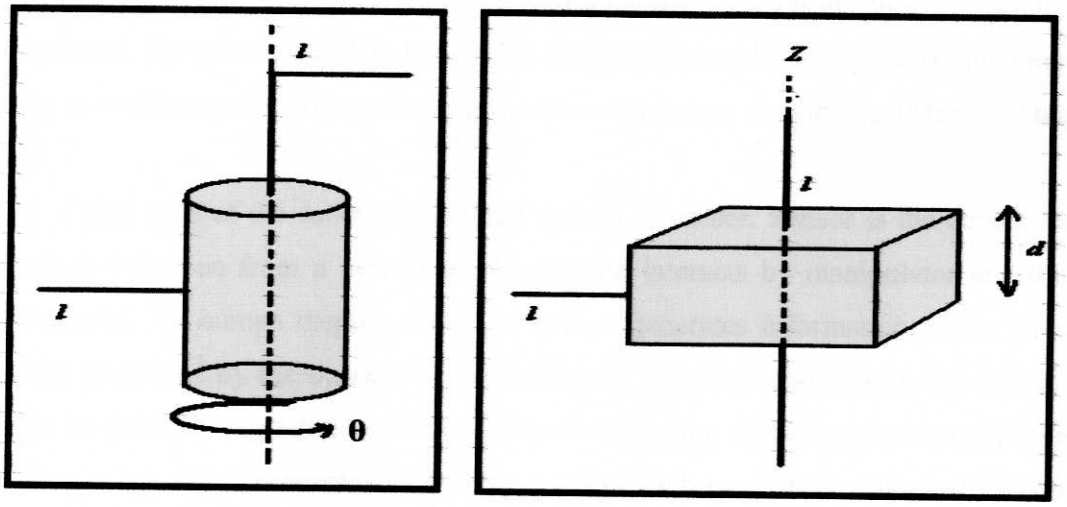

Figure 2.1: (a) symbol of rotary joint (b) symbol of prismatic joint

Actuators are devices that cause rotary joints to rotate about their motion axes. In general there are three types of actuating systems that has been use in robotic systems; hydraulic actuating systems, pneumatic actuating systems and electrical actuating systems. Hydraulic actuating systems provide more powerful forces and torque to handle heavy loads compared to pneumatic actuating systems. The different between these two kind of actuating systems is the types of fluid. Hydraulic use the oil as the fluid but pneumatic use air compress to operate. The accuracy level of working condition for both types of actuating also different. Pneumatic actuating system is less accuracy than hydraulic because the elastically nature of the compress air, but pneumatic actuating system is cheap, clean and reliable with high power compare to hydraulic (Man Zhihong, 2004).

Electrical actuating systems also part of actuators and currently use for robotic arm. DC motor, stepper motor and AC motor are commonly use as the electrical actuating system for the robotic arm. The quick response from electric motor makes the robot easily to control by operators and automated. However, the electric motors are often heavy and gear system provides high torques and as a result, backlash problem encountered. Electric motor often heavy, but the precision and the degrees of movement can be controlled easily without having trouble with nature responding (Man Zhihong, 2004).

Other type of the robot manipulator system is sensor. Sensor is the device that collects information from a system or objects that interacts by manipulator and their environments. In human display design, a system generates information, some which must be processed by the operator to perform task. Same to robotic arm, the task that need to be done is interpreted by the sensor and information of the environment will then translate in the robot processor or computer (Man Zhihong, 2004). Figure 2.2 shows how human interact with system and figure 2.3 shows the robot sensory interaction. Both figures describe the same idea of the ways of classifying displays. Human sensory systems are not same as robot sensor because, human sensory principles senses the display information that provided by the systems. Robot sensory systems have more that one sensor to detect information and one of the examples is vision systems.

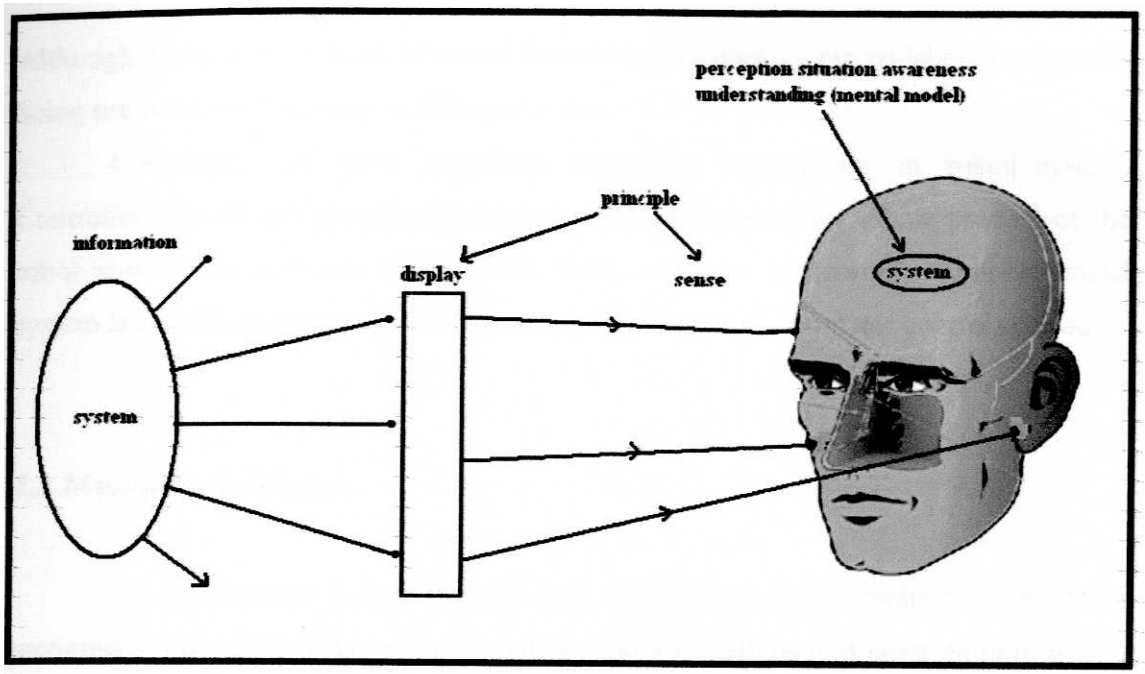

Figure 2.2: Human sensory system

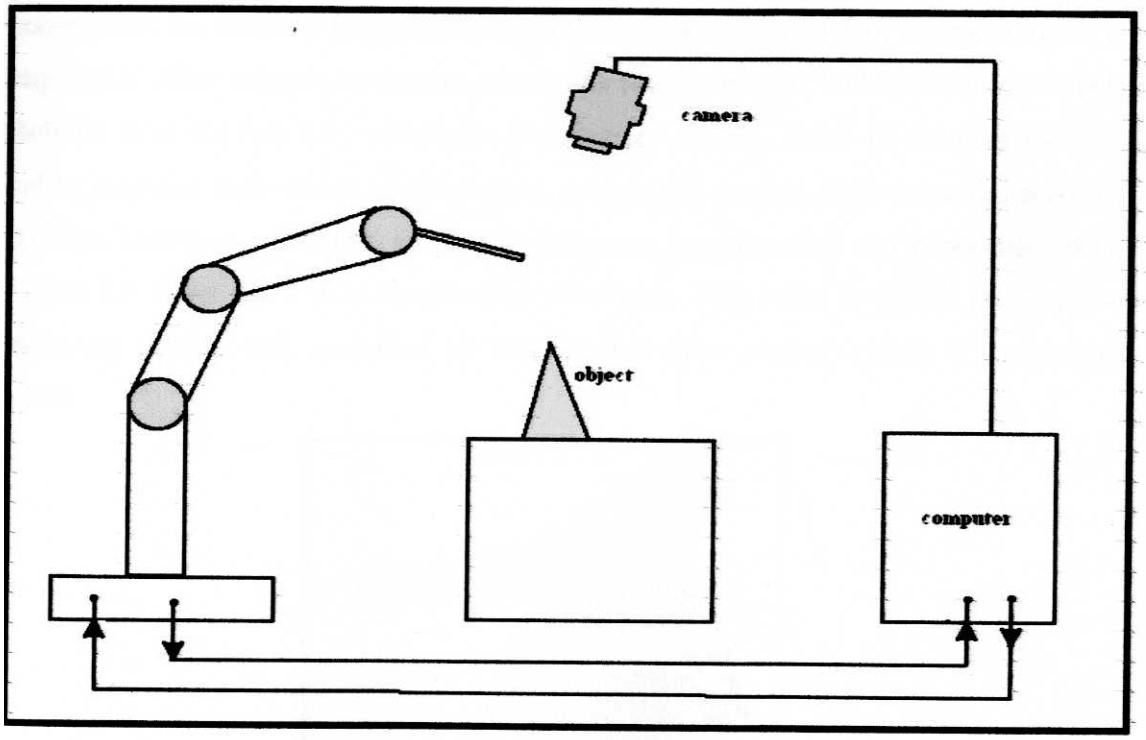

Figure 2.3: Robot sensory system with camera.