



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**PRODUCT IDENTIFICATION AND ROBOTIC ARM
CONTROLLER SYSTEM USING ARTIFICIAL NEURAL
NETWORKS AND MICROCONTROLLER**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology
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by

MOHD ZULFADHLI BIN SALEHAN

B071210007

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) (Hons.). The member of the supervisory is as follow:

.....
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ABSTRAK

Projek ini berkaitan dengan sistem pengenalan produk menggunakan rangkaian neural buatan di mana sistem ini mampu mengenal pasti jenis produk dan mengelaskannya berdasarkan klasifikasi produk. Melalui projek ini, ia digunakan pemprosesan imej yang memerlukan imej produk dan menggunakan Fungsi Asas Rangkaian Neural Jejarian (RBFNN) bagi mengenalpasti kategori produk. Kelebihan Rangkaian Neural ini adalah ia merupakan struktur yang mudah, proses latihan pesat di mana ia adalah sesuai untuk digunakan dalam pelbagai bidang terutamanya dalam aspek klasifikasi pola dan pendekatan fungsi. Output rangkaian boleh dioptimumkan dengan menetapkan nilai-nilai yang sesuai dan pusat penyebaran RBF. Dalam kertas kerja ini, nilai penyebaran tetap akan digunakan untuk setiap kelompok. Projek ini juga menggunakan pengawal lengan robot untuk tujuan pengasingan produk. Pengawal ini direka untuk mengawal lengan robot dan penghantar pergerakan sama ada ke kiri atau kanan atau lari atau berhenti dan ia juga boleh digunakan untuk mengawal proses mengangkat objek menggunakan lengan robot dengan bantuan perisian MATLAB. Projek ini juga menggunakan PIC litar mikropengawal sebagai litar asas. 6 motor servo akan digunakan untuk membuat pergerakan dan mengangkat objek atau sebagai sendi robot. Dalam projek ini, mikropengawal PIC akan diprogramkan untuk mengawal motor servo. Pada akhir projek, sistem ini mampu untuk memaparkan kategori produk melalui paparan LCD seperti produk A, produk B, produk C dan produk D. Projek ini juga boleh digunakan dalam industri elektronik dan industri pembuatan.

ABSTRACT

This project present a product identification system using artificial neural networks where this system capable of identifying and categorize the product based on classification range of the product. Through this project, it applied the image processing that required the product image and used Radial Basis Function Neural Network (RBFNN) to recognize the product category. Advantage of this RBF Neural Networks is it is a simple structure, rapid training process and good extend ability where RBF Neural Network is appropriate to used in various fields especially in the aspects of pattern classification and function approach. The output of the network can be optimized by setting suitable values of the center and spread of the RBF. In this paper, fixed spread value will be used for every cluster. This project also using a Robotic Arm Controller for pick and place the product according to their type. The controller is designed to control the process of lifting object using a robot arm using MATLAB. This project also uses a PIC microcontroller circuit as the basic circuit. 6 servo motors will be used as an application extension to make movements and lifting an object or as robot joint. In this project, the PIC microcontroller will be programmed to control the servo motor. At the end of the project, this system capable to display the product category through LCD display such as product A, product B, product C and product D. The project is also can be used in the electronics industry and the manufacturing industry

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AVI	-	Automated Visual Inspection
VDU	-	Visual Display Unit
GUI	-	Graphical User Interface
PIC	-	Programmable Integrated Circuit
SCARA	-	Self Compliant Automatic Robot Assembly
DC	-	Direct Current
PCB	-	Printed Circuit Board
LCD	-	Liquid Crystal Display
RAM	-	Random Access Memory
ROM	-	Read-Only Memory
PROM	-	Programmable Read-Only Memory
I/O	-	Input / Output
IC	-	Integrated Circuit
CPU	-	Central Processing Unit
USART	-	Universal Synchronous Asynchronous Receiver Transmitter
RGB	-	Red Green Blue

CHAPTER 1

INTRODUCTION

1.1 Background

This project is about product identification and robotic arm controller system using artificial neural network and microcontroller where the purpose of this project is to identify the category of the products in real time situation based on the range classification. This project applied the concept of automated visual inspection (AVI) in terms of automation for the quality control in manufactured products where through this system it using the camera that connected to a computer. The AVI is a branch to the industrial machine vision where the machine vision system used to check out a large number of products rapidly.

The AVI system operates by employing a camera to get the image of products and image processing method will find the interest areas in the image and the appropriate action will be taken by handling system which is the robotic arm. If the image that taken is similar with the original products and display the correct categorize, the output will be display on a monitor that called visual display unit (VDU) and the robotic arm will be act proportionally. Through this system, the computer will control the camera, lighting and handling system that show in Figure 1.0. The robot will move, grab the product and place it onto the right place according to the product type. The project focuses on MATLAB software that will be used to control the robotic arm. To control the movement of the robotic arm, 6 servo motor will be used as a joint. For this

particular case, the PIC microcontroller that is used to control the servo motor will be programmed. This project used MATLAB software as a base to control the robotic arm.

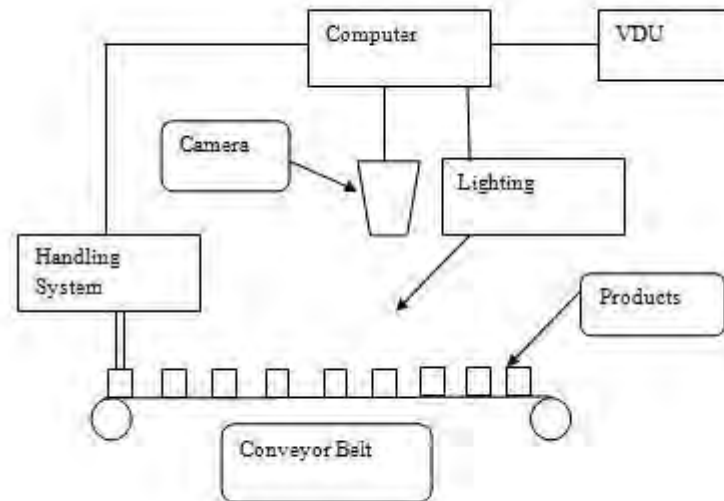


Figure 1.1: The AVI system.

The purpose of this inspection is to monitor low quality defective products do not passed to the customer where if the product unsatisfied by the consumer and there would not repeat the purchase. This is happened because human that handle the inspection production line feel tired and boredom that's why the performance of the products quality not satisfactory. Thus, this automated inspection not only necessary in the production line but it can be applied in handling dangerous materials such as inflammable, explosive and radioactive substances. So, in this project the concept of the AVI system are applied through this project where in this project it applied the morphological based approach and neural network method for image analysis and product classification.

Besides that, MATLAB are used in this project because neural network method implement MATLAB software where the neural network consists of three main parts which is input layer, hidden layer and output layer. The input layer represent as all entire products, the hidden layer represent as neural network system while the output

layer represent as the range classification. The reason why is MATLAB used in this project because it is easy to use because the language that easy to understand, easily to written and modified and also there are many useful toolboxes such as for image processing, statistics, optimization and neural network. Besides that, using MATLAB software a programmer can build graphical user interface (GUI) by own self. In this project, the system can identify and sort the product using this system in real time situation. For example, if the production line runs two products, the system can distinguish the products then separate them by its category. The application for this project will involve webcam as image detector and MATLAB software as the system that use to separate the product based on range classification.

The operation of this project is that webcam will capture the models and send the data into the MATLAB software. Image preprocessing will run in the system (MATLAB) which is the image will be converted to grayscale image from a RGB image before filtering process (thresholding and edge detection) had been done. Then, the neural network was applied in recognition process by defining the models based on classification.

The simplest robotic arm is the Cartesian robot or pick and place type. In this case the parts are moved from one location to a conveyor without caring how the part is going to be handled. However, these days robot is much more advance. It can be design and program to handle such fragile and sensitive object without any damage. It can be used to assemble little part in the electronic board or fit them into clamps and fixture. This is possible because of the high accuracy of the robotic arm.

1.2 Project Objective

The objectives of this project is to develop a system that is able to identify the products in real time situation by capturing the image using webcam. The webcam will be connected to computer for image acquisition while process such as image processing and product identification will be done by using MATLAB. Artificial

Neural Network such as Radial Basis Function Neural Network and Probabilistic Neural Network will be used to make the identification process. Neural network from the MATLAB software will classify the images based on the shape and allocate the objects based on their criteria. The system can send output to a PIC based circuit for control purpose. The objective of this project as follows:

- (a) To develop a system which is able to detect the product and classify it.
- (b) To ensure that the product recognition system integrate with the PIC microcontroller to trigger the Robotic Arm Controller.

1.3 Scope of Project

All projects have their own scope or limitation as a guideline throughout the completion of the project. The project scope for implementation this project is study and research which is get as many information about this project from books, internet, journal, and also from the supervisor so that more knowledge can be obtained. Besides that, the images from the products can be detect in grayscale or binary image. Furthermore, this project limits the products only one type of products with four different categorize based on its range classification and every products testing 50 times. This project used webcam to capture the products image while MATLAB program used to develop a system that can identify, sort and separate the products. Then, construct the program to make sure that the program has error or not. Other aspects such as the marketing of the system will not be covered in this project.

The scope of this project also includes conducting a microcontroller using PIC microcontroller to control the servo motor located in robotic arm. This project started with designing a PIC Microcontroller Circuit to control the servo motor. The circuit will be run and tested to make sure that it is running smoothly. The next stage is designing the robotic arm that will be used for this system. 6 servo motor are being use in this robotic arm. The last stage is implementing the design by connecting the PIC microcontroller to the MATLAB GUI. The implementation is basically connecting and

program both PIC and MATLAB so that it can work together.

1.4 Problem Statement

In the industrial sector, some company faced with problem regarding on the classification of the shape or the size of the product that the company produces for example bottles, plastic or glass in sorting operation. This situation gives big impacts to the company because the company will take long time to produce the products. These situations happened because the company are still using manpower to verify the classification process and prone to error will be happened. This new system needs to be applied in the industry so that the company can reproduce human behavior in object classification tasks and produce proper time consuming for sorting process. This system gives much benefit to the production lines because this system capable to analyze and classify the products based on its category accurately.

Nowadays robotic controller is lack of function. Sometimes the robot needed to do extra function that pick and place item. With the help of this MATLAB, this is possible. The MATLAB software is a dependable software that can do many functions such as image processing. The common robotic controller is using console. The MATLAB GUI offers a better control because the GUI can be design to make the interface user friendly. It also can be very flexible because it can be used in any device that can support MATLAB GUI.

1.5 Report Structure

This report consists of 5 chapters that describe the flow of this project in detail. The first chapter explains about the introduction of the project where the content inside

this chapter are project introduction, project objectives, project scope, and problem statement.

For the second chapter, it will explain the literature review of the sorting system information, image preprocessing, Neural Network and MATLAB where this part describe the source or article that related to this project.

Hence, for the third chapter is project methodology where through this part it will explain about the method that used into the project to ensure the project successful.

For the fourth chapter, it will show the result along the project held and discuss the project finding and find the analysis throughout the research while for the last chapter is conclusion where in this part it will conclude the overall system from beginning until the end of the project.

Chapter five is about the conclusion and future work. In this section, we will conclude what we have done and followed by some recommendation on how to improve the performance of the system based on the desired results.

CHAPTER 2

LITERATURE REVIEW

This chapter presents literature review on the info and process that involve in this project. It consists of all the process for the development of this project such as Neural Network, image processing and hardware involvement. The advantages and disadvantages of Neural Network are also presented and compared.

2.1 Introduction

This chapter will explain the concepts used in this project based on the sources or information that gets from the books, website or journal. The content into this part are information about the machine vision and computer vision, the benefit of using the MATLAB software, image processing, neural network and parameters that applied on the project. Besides that, in this part it will describe the pros and cons of the neural network and sorting system that applied on this project. The main idea of literature review is to obtain enough relevant information and knowledge on similar projects done by others. A few projects done previously by students and researchers will be discussed here.

2.2 Previous Project Development

For the past years, many have attempted to design, create and construct robotic arms using different approaches. Many also have tried to create a robotic arm controller using other software and its GUI. Many types of robotic arm design can be seen. The projects have its own pros and cons. Stated below is some of the projects which are closely related to the concept of a robotic arm and its controller.

2.2.1 Robotic Arm

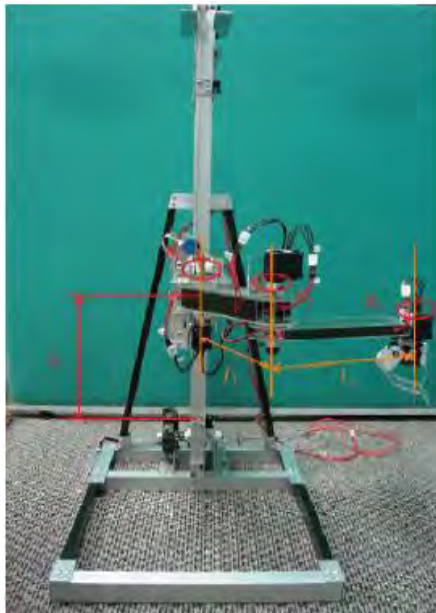


Figure 2.1: Robotic arm

This project was created in 2010 by an undergraduate student from UTM. The objective of the project is to build four degrees of freedom (4DOF) robot arm with Self Compliant Automatic Robot Assembly (SCARA) geometry to perform the motion of pick-and-place for the purposes of education and research. A graphical User Interface (GUI) is also included in this project in order to provide the interaction between the robotic arm and the user (Yong Shen Goh, 2010, 1-2).

This robot arm has a horizontal reach of 37cm and vertical reach of 40cm with horizontal displacement of 0° to 180°. The joint sensor is provided for each robotic arm joint in order to monitor the position and displacement of each joint and gain angular displacement feedback from each joint. To allow the user to control the movement of the robotic arm for picking and placing motion of the robot is the main objective of this GUI in this project. As a simple explanation, the GUI allow the user to put the object in the desired location within its range and the robot arm will then move to the corresponding location after the execution instruction has been send. This robot arm can also perform the motion of picking and placing through the GUI manually. (Yong Shen Goh, 2010, 1-2).

Although this project look smart, but there are some improvements that can be done to the project in order to make it looked smarter. Firstly, it is suggested that the mechanical hardware need to provide a precise dimension of the mechanical hardware. This mechanical part is lack of accuracy because of the dimension and the structure is a handmade mechanical hardware. The use of handmade may reduce the cost, but this result in the lack of the accuracy. Second part to improve is the actuator of the robot. DC motor can be used as an actuator for this robot instead of servomotor since there are many academic researches on it. So, DC motor can replace the servomotors but for my project, the DC motor will be used to control the conveyor instead of the robotic arm.

Last but not least are the sensors. The accelerometer can be placed on the robot to provide additional information for each joint at the robotic arm. The camera or ultrasonic sensor can be placed to be an extra function to the robot as to detect and identified object. This will be the future development of my project. To be integrated with other function other than pick and place item that is robotic arm basic function.

2.2.2 Robotic Arm With Image Processing



Figure 2.2: Robotic Arm with image Processing

Figure 2.2 shows that the Self Compliant Automatic Robot Assembly (SCARA) robotic arm that was conducted in 2009. The objective for this project is to build six degree of freedom (6DOF) of robot arm that can sufficiently emulate human arm movement. To aid the robotic arm when doing work to help humans do chores, an image processing function is added. Learn the object criteria is the main purpose of this robotic arm. The robotic arm will be using image processing function system and the data will be stored for future reference. (Men Wee Sam, 2009, 1-2).

The image processing system that gain image from the camera is used to extract data from the image of an object and its feature. This helps the robot to recognize the object. The robotic arm will also learn in real time, where it will recognize more and more objects and do classification based on object features. This aspect of function will be using artificial intelligence specifically neural network. The GUI that include several control panel is used to monitor the robotic arm status. The control panel will give and receive information from robotic arm and from there, the information will be analyze for improvement. (Men Wee Sam, 2009, 2-4).

However, there is some disadvantage on the hardware design. The use of string push pull mechanism proves to be clumsy and time consuming in construction. By using gear drive system or using commercially available advanced motor (digital servo, stepper) will be much of the improvement. But, this will potentially increases the cost of the project dramatically. Then, for further improvement is about the PCB board for the embedded microcontroller. The better PCB will actually improve the circuit stability and look more professional if the circuit is soldered using machine. Lastly, for the image processing technique, it must be more advanced. Current blob tracking implementation is still classified as simple task. The host application can be improved to add more functionality such as object recognition. (Men Wee Sam, 2009, 3-5).

The main function that is needed to make the future development of my project is the image processing function. This function will be using neural network as the base. It's like the robotic arm have its own brain to conduct certain task where human is no longer needed like sort the group of item into different conveyor according to its type.

2.3 Robotic Arm

The robotic arm design is quite similar to this project reference. This robotic arm is quite simple. It is basically a robot to lift objects. More specifically, this is a robot arm with base, shoulder, elbow and wrist joints and end effector. This is where the servo motor will be placed.



Figure 2.3: Robotic arm design