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Design and implementation of an automated workpiece
pattern recognition system using sensors and PLC /
Memoria Anak Jangoh.

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WORKPIECE PATTERN RECOGNITION SYSTEM USING
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MAY 2006

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PATTERN RECOGNITION SYSTEM USING SENSORS AND PLC**


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**This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of
Bachelor In Electrical Engineering
(Industry Power)**


**Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia**

May 2006

“I / We admit that I/we have read this literature work through my/our observation which has fulfilled the scope and quality in order to be qualified for the conferment of Bachelor Degree in Electrical Engineering (Industry Power).”

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**“I admit that this is done by myself except the conclusion and extracts taken from
other sources that I explained each in detail.”**

Signature : 

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Date : **MAY 2006**

This thesis specially dedicated to:
My most beloved parents and siblings for their continuous supports, patience, confidence, affection, trusts and hopes in guiding me to achieve my dreams, Somebody that I love very much, thank you for everything.

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Glory be to God Almighty for Your blessed name, in Thy name full of Loving and Mercy, we come to Thee for peace, wisdom and power. For You alone are the Holy one, You alone are the most High and it is right to give thanks and praise.

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ABSTRACT

This project is to design and implementation of pattern recognition system using PLC (Programmable Logic Controller) and the application of sensors. This project combined the knowledge of mechanical, electrical and electronic. The objectives of this project is to design and implementation of an automated work piece pattern recognition system where this intelligent machine can recognize the color of toy car as the pattern to be detected and will sort it into different station according to the color. Sensors as the input devices will send signal to PLC where PLC as the controller will give command to the actuators to do action. This action involves turning ON or OFF an output devices such as conveyer motor, valves and switches. The main system to be use in this project is PLC with the combination of Pneumatic and Electro-Pneumatic system. In this project, proximity sensors; capacitive and photoelectric sensor, is used as it is a pilot devices that detect the presence of an object without physical contact.

ABSTRAK

Projek ini adalah mengenai rekacipta dan pelaksanaan rekacipta suatu system pengenalpastian corak atau bentuk sesuatu objek dengan menggunakan PLC (Programmable Logic Controller) dan juga aplikasi sensor. Projek ini adalah gabungan pengetahuan mekanikal, elektrik dan elektronik. Objektif projek ini adalah untuk merekacipta dan melaksanakan hasil kerja automasi system pengenalpastian corak di mana mesin pintar ini boleh mengenalpasti warna pada kereta mainan sebagai corak yang akan dikesan, dan mengasingkannya mengikut warna ke stesen-stesen yang telah ditetapkan. Sensor sebagai alatan masukan akan menghantar isyarat ke PLC di mana PLC bertindak sebagai pengawal dan akan memberi arahan kepada penggerak untuk melakukan tugas. Tugas yang dilakukan adalah melibatkan 'ON' dan 'OFF' beberapa alatan keluaran seperti motor alat pengangkut, injap dan suis yang berkaitan. Sistem utama yang digunakan ialah PLC dengan gabungan sistem Pneumatik dan Elektro-Pneumatik. Dalam projek ini penggunaan proximity sensor seperti sensor kapasitif dan fotoelektrik adalah kerana sensor ini merupakan alat petunjuk yang dapat mengesan kehadiran objek tanpa perlu sentuhan fizikal.

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CHAPTER 1

PROJECT BACKGROUND

1.1 INTRODUCTION

Nowadays, in the present state of intense competition, production efficiency is generally regarded as the key of success. Production efficiency includes the speed at which production equipment and production line can be, lowering material and labor cost of the product, improving quality and lowering rejects, minimizing downtime of production equipment and low cost production equipment. The program that meets all above needs is PLC (Programmable Logic Controller). PLC also is the factor that contributes to furthering production efficiency in the industries. In today industries, it is important to automate production of multiple varieties of goods, in moderate quantity, as well as achieving higher overall productivity and requiring minimum investment plant and equipment. In an industrial context, we can define automation as a technology that is concerned with the use of mechanical, electrical, electronic, and computer-based systems in the operation and control of production.

In this project, the task to be done is to design and implementation of an automated work piece pattern recognition system using sensors and PLC. The main keyword of this design is PLC and sensors. In this project we will see the application of PLC and the principle of control processes. Before that we should clear with the term of pattern recognition. Pattern recognition techniques are used to automatically classify a variety of physical objects or abstract multidimensional patterns. A number of commercial pattern recognition systems exist which can automatically classify printed

text, blood cells, fingerprints, speech, face, and cursive hand writing. Most machine vision systems employ pattern recognition techniques to identify objects for sorting, inspection, and assembly. The design of a pattern recognition system requires development of following modules:

- a) Sensing,
- b) Feature extraction and selection,
- c) Decision making, and
- d) System performance evaluation.

At the end, the students should be able to get some hands-on experience in the design, implementation and evaluation of pattern recognition algorithms.

1.2 PROBLEM STATEMENT

In today industrial world, many company want maximum profits by increasing the production efficiency. To achieve that goal, human energy had to be replaced but not all, with a new energy which is more productive and efficient. In the manufacturing and/or production industry the use of adaptive robotic position control systems are limited due to various factors including manual controls and inaccurate vision-based system. In systems that require manual control, human interaction is needed to teach the robot to identify and manipulate an object. Vision-based systems in industry are limited due to poor image-processing algorithms and video equipment, resulting in precision loss. Ideally, the process of object identification on a production line would be completely automated, eliminating the need to teach the robot how to pick up an object. The objective is to fully automate the object recognition and manipulation process, and improve the precision of systems to a better one.

The main purpose of this project is to design and implementation of an automated work piece pattern recognition system using sensors and PLC. In this project the selection of PLC software and the selection of appropriate sensors are emphasize or strongly considered in order to satisfy the need of this project design. Beside that the

basic concept of control process, concept of automated system, PLC program, input and output device of PLC also have to be studied.

1.3 OBJECTIVES OF THE PROJECT

The main objective of this project is to design and implementation of an intelligent machine that can carry out certain task as human being do. The ability to recognize a pattern is an essential requirement for sensory intelligent machine. Secondly is to do research on the principle of pattern recognition where the scope of pattern recognition also compassed tasks human are not good at for example reading bar codes. The goal of this research is to devise ways means of automating certain decision, making processes that lead to classification and recognition. Other objective is to gain knowledge in control process, expose to the PLC and other software that will be used in this project and also to study different types of sensors in automation system. Lastly, this project hopes to enable student to experience the hands-on in designing, implementation and evaluation of pattern recognition algorithms.

1.4 SCOPE OF THE PROJECT

This project is about designing and development of an intelligent machine which can recognize different pattern of targeted object and can sort it to different station. The pattern to be recognized might be color, shape, material, etc. the object recognition techniques may be classified into two categories which are template matching techniques and structural techniques. Template matching techniques are a subset of the more general statistical pattern recognition techniques that serve to classify objects in an image into predetermined categories. Structural techniques of pattern recognition consider relationship between features or edges of an object.

The main application here is by using sensors which are proximity sensors such as inductive, capacitive and photo-electric sensors as it is a pilot devices that detect the

presence of an object without physical contact. These sensors are the input device for PLC and its signals are interfaced to the PLC through various types of PLC input module. The main system to be use in this project is PLC with the combination of Pneumatic and Electro-Pneumatic system. In automated system, the PLC is commonly regarded as the heart of control system.

1.5 QUESTIONS RAISING FROM THE PROJECT

The important aspect in this design is the used of PLC system and the application of sensors. Hence, the research made is to find information regarding above aspect in order to achieve the effectiveness of the design prototype operation and task doing by each sensors used in this design. Hereby, several questions arise due to the research finding:

- a. Are the concept and principle of PLC and sensors really understood by student?
- b. Are student sure that the development of this project base on theory and specification given by supervisor?
- c. Are the student understand the different factors that have to be considered in selecting suitable materials in order to implement the hardware for this project?

1.6 PROJECT CONTRIBUTION

For this project, it is hope that this project can contribute to the improvement of others previous design prototype that used the same concept and principle. It is hope that this mini project able to be applied in real industry world. The research in this project where a lots of information collected and documented in log book is hope to give knowledge to future students and certain parties who is interested in this study.

1.7 LIMITATION OF PROJECT

The duration given by the faculty to complete this project is two semester from 13th July 2005 to 4th May 2006. The pattern to be detected by the system is color only to smaller the scope of the project. The using of toy cars as the model to be detected is due to its size and availability in market. The main purpose of this project is only to give knowledge and experience to the final year student and on the other hand hope to improve the automation design in real industry world. A budget of RM200 has been provided by Kolej Universiti Teknikal Kebangsaan Malaysia. A desktop computer, PLC panel, base to fabricate the hardware, arm robot, conveyer belt, proximity sensor, DC motor, solenoid valves and cylinders also been supplied (not included in the budget).

1.8 PROJECT METHODOLOGY

For implementation of this project, many design concept and methodologies have to be understood thoroughly. This subchapter views the overall theory of designing the pattern recognition system by using sensors and PLC.

1.8.1 CONTROL SYSTEM AND APPLICATION

All automated system have two parts that is the Application (Operative Unit) and the Control System, which coordinates actions of the “Application”. The diagram below illustrates the organization of the Control System and the Application.

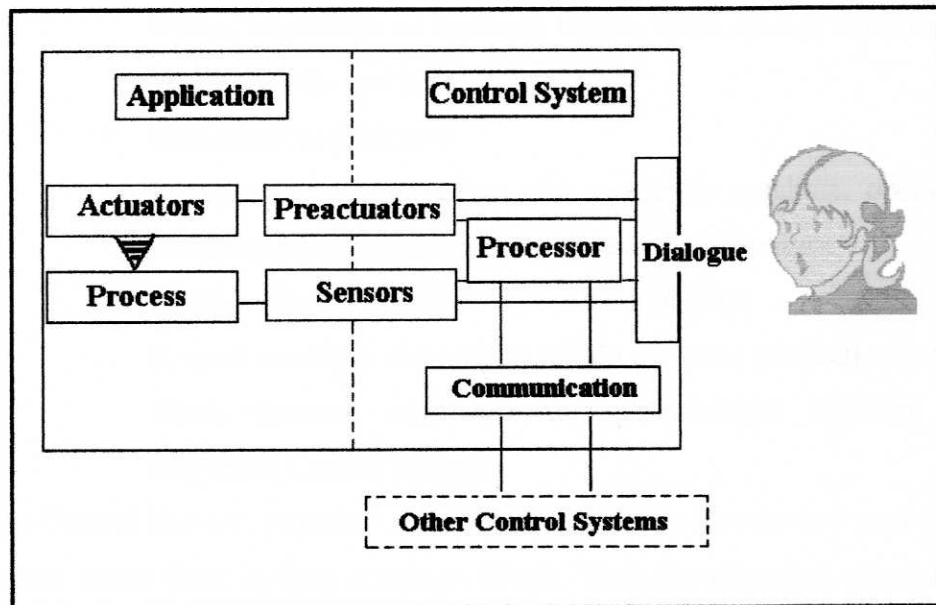


Figure 1.1: Organization of The Control System and The Application

- Application- operates on the worked material and the product. Its generally consists of
 - Tooling and various facilities performing the production process, for example: punches, cutting tools, welding heads, and marking head.
 - Actuators intended to drive or operate these facilities, each as:
 - I. Electric motors to activate pumps
 - II. Hydraulic cylinders to close moulds
 - III. Pneumatic cylinders to drive marking heads
- Control System
 - Send orders to the Application which then feeds signals back to the Control System. In this way, actions are coordinated

- Based on programmable controller or hard-wire technology depending on the system complexity
- Coordinates three types of dialogue:
 - Dialogue with the machine
Control of the actuators such as, motors and cylinders via pre-actuators such as contactors, control valves and variable speeds drives, acquisition of feedback signals from sensors reporting the progress of the machine
 - Man-machine Dialogue
In order to operate, adjust and repair the machine, operations personnel enter instructions and receive data in return
 - Communication machines with other machines
Several machines can operate within the same production system. These machine coordinate through dialogue between their respective Control Systems.

In the Control System, processor received data from the sensors and send orders to the actuators where there is three actuators device. They are electrical, pneumatics, and hydraulics. The pre-actuators associated with the actuators energy either electrical comprise on contactors and variables speed controller, pneumatic or hydraulic directional control valves. The processor unit can be programmable controller, micro or mini computer, standard electronic board and special purpose board.

1.8.2 BASIC CONCEPT OF PATTERN RECOGNITION SYSTEM

Before the model or prototype for this project can be designed and implemented, it is important to understand the basic concept of pattern recognition system. The purpose of this methodology is to ensure that the project to be developed not out of the scope. Below diagram shows four basic principles in pattern recognition system.

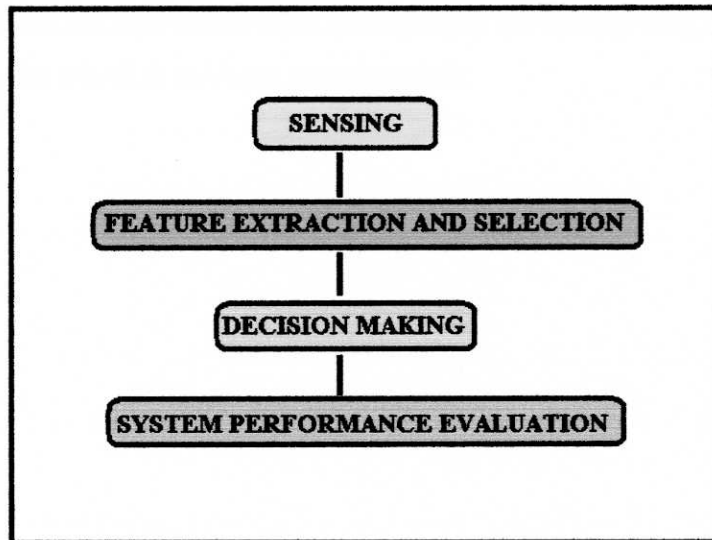


Figure 1.2: Basic concept of Pattern Recognition System

Based on the above diagram, this project should have four basic principles which are:

- Sensing,
- Feature Extraction and Selection,
- Decision Making, and
- System Performance Evaluation.

The system to be designed must have sensing so that it can detect object and send the signal to PLC so that the next step could be done. This system also should have feature extraction and selection. As for example, this system should know how to differentiate between two different colors of two different toy cars. Then for decision making, the system should know how to make decision. As for example the robot arm.

The robot arm should be program to do decision making on what it have to do when the targeted object reach the end of the conveyer and need to be sorted into another station. When the robot arm already pickup the object, it must be able to make decision where to put the object. PLC program will help robot arm to make decision by giving command to the robot arm. Lastly, for system performance evaluation, the overall system should be able to evaluate the command given by the operator. As for example, after the operator enter sequence of instruction such as program into the memory of the PLC, the controller will monitors the input and output according to the entered program and caries out the control rules for which it has been programmed.