"I hereby verify that I have read this report and I find it sufficient in terms of quality and scope to be awarded with the Bachelor's Degree in Electrical Engineering (Industrial Power)."

Signature	:...
Supervisor's Name	: PROF. DR. MARIZAN BIN SULAIMAN
Date	: 18 NOVEMBER 2005

SENSORY SYSTEM FOR INDUSTRIAL ROBOT AUTOMATION

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor's Degree In Electrical Engineering (Industrial Power)

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"I admit this report is written by me except the summary and extraction for each I have been clearly presented."

Signature :..

Name : TIOH BOON PENG

Date : 18 NOVEMBER 2005

Specially dedicated to my family and friends ...

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ABSTRAK

Projek ini adalah untuk mengkaji sistem pengesanan berasaskan penglihatan bagi pengautomatic robot industri. Sasaran utama projek ini adalah untuk membina algoritma bagi robot untuk membuat keputusan semasa mengambil objek dari suatu tempat dan meletakkannya di tempat yang diarahkan dengan menggunakan sistem pengesanan penglihatan. Robot akan mengesan lengan dan menggerakkan pemegang untuk menggerakkan objek ke sasaran yang ditetapkan. Misi projek ini adalah untuk menulis algoritma bagi mengarahkan robot tersebut beroperasi secara automatik melalui sistem pengesanan penglihatan. Algoritma ini akan menggerakkan tangan robot yang diprogramkan bagi membolehkan tangan robot untuk bergerak secara terperinci ke objek dan memegangnya. Selain itu, robot itu juga boleh membezakan objek yang mempunyai struktur yang berbeza-beza dalam kawasan kerjanya.

ABSTRACT

This project is to study the vision sensory system for industrial robot automation. The main aim of this project is to develop an algorithm for the robot to make decision by picking up an object from one spot and putting it down as commanded, within the work envelop depending on the task based through vision sensory system. Given an object and its destination, the robot will figure out the actual arm and gripper motion to move object to the goal. The task is to write programs to command the automation process based on the vision sensory system. It would then generate large-scale motion of the robot arm, within the work envelop to another. It will enable the robot arm to work out how to move the last few inches toward an object and grasp the object. In addition, the robot is able to distinguish or recognize objects that have different structures within the work envelop.

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INTRODUCTION

1.1 Introduction

This project with title "sensory system for industrial robot automation" is meant for those who intend to design and learn more about the technology of applied sensory system for industrial robot automation that required the programming intelligence (software). It is also appropriate as a reference tool for those who need to understand more about vision sensor concepts and terminology.

1.2 Project Objective And Aims

This project has the main objective as to establish whether the project is technically and financially feasible, which means whether it fulfils the criteria of being cost effective and are practical enough in all terms. This project will also be important as to state the awareness in terms of money or commercial value in its development. As a whole, the project aims to expose the students to the processes of Engineering design management and practice through the appropriate use of skills and knowledge learned throughout the program. This project will include details such as a time plan; work undertaken for developing the project, risk assessment as well as resources checklist. This project has the objectives in the view of the whole course as follows:

1. To apply a range of techniques for generating, evaluating and selecting design concepts to meet specified requirements in term of vision sensory system technology.
2. To investigate about the operation in vision sensory system by makes decision of pattern recognition as part of applied-industrial automation.
3. To learn the Fanuc Robot's programming on certain tasks. E.g. searching for object, pick and place operation.
4. To acquire a range of interpersonal skills throughout meetings, interviews, questionnaires, group meetings, conferences and lecturer's supervision during projects development.
5. To be critical in term of evaluating time concepts and material resources throughout the development of the project.

1.3 Scope Of Project

The scope of this project is to develop vision sensory system that enables the robot to perform the following tasks:

1. The robot is expected to be able to make decision by moving forward, reverse, left, right and stop depending on the task on automation from vision sensory system.
2. The robot is expected to be able to distinguish objects that have different structure.
3. Edge-based matching of an object may not always be adequate, the robot must be able to distinguish objects based on surface shape.
4. The system should process each image of scene within a few seconds, except in exceptional circumstances, such as recognizing the object for the first time.

1.4 Project Basic Requirement

Multiple tools as below are needed to complete the sensory system for industrial robot automation:

1. Software design and development
   - FANUC ROBOT LR MATE 200iB – two types of programming, teach type and language type are used. By applying language programming. It might be very similar to a Pascal or C language program with some special functions for moves, loops and palletizing routines. The other type of robot programming uses a teach type. Robot is programmed by moving the robot to the desired position. The programmer then inputs the information for that particular step and the desired speed.
   - F160-2 VISION SENSOR (OMRON) – it utilize window graphical interface to make programming easy. The easiest is to acquire an existing program that can perform many of the needed image operations. The user writes an application program, which calls the library routines to perform the required operations on the user's image data.
2. Parallel port implementation and interfacing
   - It is very important for me to understand the port number of the parallel port in order to let the Digital I/O interfacing that to switch for an expected result and output.
3. F160 – 2 Vision sensor and Fanuc robot characteristic
   - By understand the Fanuc robot structure, we can program the robot by moving the robot to the desired point.
   - By understand the F160 – 2 Vision sensor structure, we can implement the build-in program by setting inspection measurement to the desired conditions.

1.5 Overview Of Sensory System For Industrial Robot Automation

This section introduces the concepts of the automated system and the integration of various devices. It presents an overall perspective on what a system is, what components are involved and how devices are integrated to provide a foundation.

1.5.1 Industrial Automation

An automatic apparatus or device that performs function ordinarily ascribe to being or operates with what appears to be human intelligence which an automated system is a collection of devices working together to accomplish tasks or produce a product or family of product. An automobile, for example, is an automated system. The automobile has a brain box to receive inputs from various sensors and to control various outputs that regulate the engine's operation and other functions such as antilock braking.

Industrial automated system can be one machine or group of machine called a cell. Device includes those that actually produce the product and that provide support, control and feedback to the system. The four basic types of devices in a cell are production, support, control and feedback.

1.5.2 Production Device

Production device may include robots, vision system and so on. Production devices add value to the product. They perform manufacturing processes such as machining, assembly, welding, painting and other value-adding processes to form a completed part. The Figure 1.1 shows a simple automated work envelop with several devices. The cell has a work envelop for bringing material into and out of the work envelop, a robot to move the material between devices in the work envelop, a vision system for inspecting the parts and controller for integrating and controlling all of the other devices.

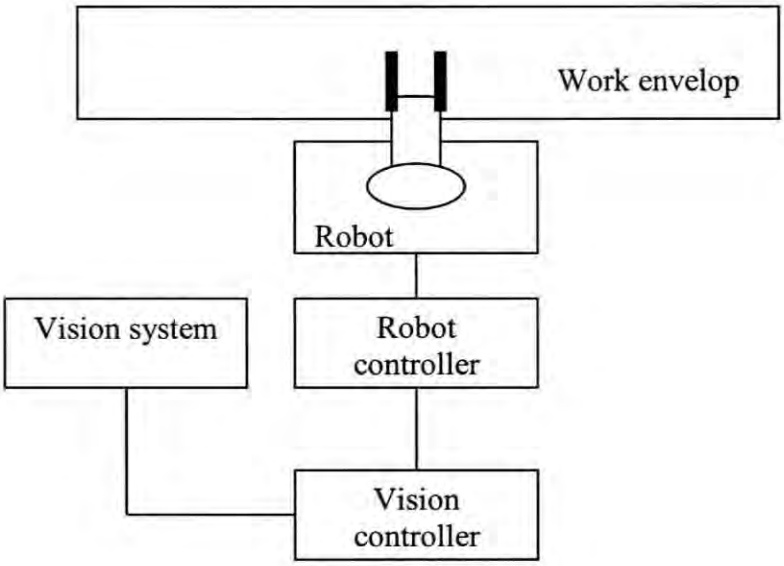

Figure 1.1: Simple automated work envelop with several devices

1.5.2.1 Robot

Fanuc Robot is used for many functions in a work envelop including repetitive ones such as moving and positioning parts between devices and production tasks. Fanuc Robot is very good for repetitive tasks. They are fast and accurate. Fanuc robot is a Pneumatic type of robot that is inexpensive, fast and accurate but they are very limited in some ways. They are not good for complex tasks and very limited in the number of positions to which they can move.

1.5.2.2 Robot Integration

Fanuc Robot is relatively easy to program and integrate into robot controller and is simply moved to each position and a key is used to teach each position. Fanuc robot is programmed using specialized robot language and have digital (on/off) inputs and outputs (I/O) available. Most robot controller wait for an input to tell the robot what to do. It then performs a task and sends an output to a robot controller to tell the control device it has finished the task and is waiting for another. This exchange of inputs and outputs between devices is called handshaking.

1.5.2.3 Vision System

Vision systems are used to inspect product quality. The inspection might be used to check to ensure that all components are on a printed circuit board, to measure the size of product or to read labels and ensure they are complete and accurate. Vision systems are increasing in use and importance in industry. They are much more accurate than humans for performing repetitive inspection tasks.

1.5.2.4 Vision System Operation

Vision systems look at contrast to make decisions. A picture taken with a camera is analyzed by the computer. Lighting of the object is very important because most vision systems can see only contrast. The vision processing board looks at each pixel to determine its brightness level, called a gray level. Typical systems have 256 levels of gray (brightness). The computer must look at all areas of the object and assign brightness levels, which represent contrast to each. The Figure 1.2 shows a pictorial example of a vision system. On the left is the lighting and vision (1). The image acquisition hardware receives image information from the camera (2). Next the image must be processed (3). Based on the processing, outputs are turned on or off (4). The results from inspections can then be analyzed and used to adjust and improve the process (5).

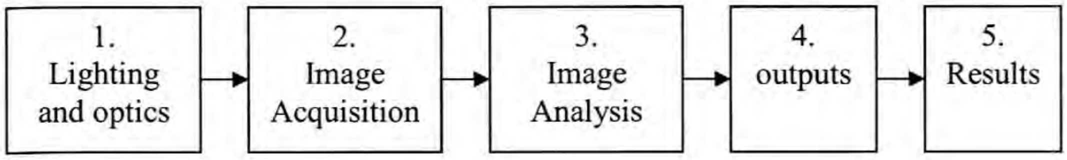

Figure 1.2: Vision system

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Robots have been a subject of philosophical and a source of literary inspiration for hundreds of years. It is only since this century that robots have emerged out of fiction and philosophy into the real world. Today robots are commonplace, for instance, fixed-location robotics arms now tirelessly perform precise repetitive tasks for industry. However, robots still have significant limitations. Specifically, most industrial robots require the parts they operate on to be precisely aligned and mobile robots that move around in an environment are still largely confined to academic research laboratories. Clearly, there is a need for a more advanced generation of robots that can react to unexpected events and can complete complex tasks under less controlled conditions. To facilitate the advancement, systems must be developed that enable robots to perceive and understand their environment.

Perhaps the greatest potential benefit to humanity that robots can provide is to alleviate the need for humans to regularly perform tasks in dangerous environments, such as underground mines, underwater, in space and in hazardous industrial environments. In such applications, robots can perform not only the tasks that humans currently undertake, but also handle operations that are too dangerous for individuals. As well, anti-personnel mines kill and maim civilians but removing them is dangerous, hence robots could play an invaluable role in demining [1].

In order to facilitate more advanced applications, robots need to be capable of more flexible autonomy than is currently possible. Robots need to be able to seek out and removing dangerous objects (e.g. mines and nuclear material) returning to base stations and docking and performing operations on objects that are dangerous for humans to access. As a basis for such operations, robots require means for identifying and operating on specific objects. My project aims to take an initial step along the path, by constructing a framework to enable the robot to identify particular objects, when other similar objects may present and then navigate around the required objects. Importantly, the robot must have knowledge of its approximate position with respect to the object.

2.2 Background

Autonomous mobile robots are machines that are able to move around freely in a manner appropriate for their environment, with respect to some general goals. Control of the robot's movement in an environment is generally referred to as navigation. The earliest autonomous mobile robot was built by Dr. Grey Walter in the 1940's[12]. However, research in developing mobile robots as an end in itself began in earnest in the late 1960's with the development of vision-based robots such as 'Shakey' [8].

2.2.1 A Vision-Guided Approach

Researchers have used many types sensors as a basis for mobile robot perception. This project focuses almost exclusively on vision-based sensors that produce an image of light intensity values and directed at autonomous robot navigation applications that require high-level perception, for tasks such as uniquely identifying and object when other similar objects are also visible. For such tasks, vision offers advantages in the type and amount of information in recovers in good lighting conditions. Sensors such as sonar are insensitive at a fine resolution; laser-