ROBOT INTERFACING STUDIES FOR AUTOMATED MANUFACTURING SYSTEM DESIGN

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PENGESAHAN STATUS LAPORAN PROJEK SARJANA

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SESI PENGAJIAN : 2006/2007

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MOHD YUSRI BIN MOHD YUSOP

A project report submitted in partial fulfillment of the requirements for
the award of the Degree of
Master of Electrical Engineering

Faculty of Electrical and Electronics Engineering
Kolej Universiti Teknologi Tun Hussein Onn

7 NOVEMBER, 2006

"I hereby declare that the work in this report in my own except for quotations and summaries which have been duly acknowledged"

Student : ....

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Date : 30/11/06

Supervised by

Supervisor : ....

ASSOC. PROF. DR. ZAINAL ALAM BIN HARON

DEDICATION

Dedicated to my parents, my beloved wife and children
for their support, love and understanding during
the completion of my Master study

ACKNOWLEDGEMENT

Bismillaahirrahmaanirahim...

Praise be all to Allah SWT, the Most Gracious, the Most Merciful. Shalawat and salam be to Rasulullah Muhammad saw. By the grace of Allah SWT, this research is finally completed to full fill the requirements for Degree of Master of Electrical Engineering.

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ABSTRAK

Projek ini menerangkan pengajian tentang perhubungan robot dengan sistem pembuatan automatik. Integrasi kepelbagaian komponen seperti robot, CIM dan PLC dianalisakan bagi memberikan kefahaman tentang hubungan dan batasan berkaitan dengan integrasi. Pengajian ini terbahagi kepada dua bahagian, iaitu hubungan di antara robot dan PLC dan juga hubungan di antara keduanya dengan CIM. YAMAHA SCARA robot dan OMRON PLC digunakan di dalam ujikaji untuk projek ini. Ujikaji ini mengunakan sambungan 'point-to-point' dan pergerakan robot dikawal oleh PLC. Untuk integrasi pada sistem CIM memerlukan penyambungan talian dan juga perisian SCADA.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In modern manufacturing operation, most of the production systems are using automated system. Manufacturing system in the factory can be referred as equipment arrangement and the workers who operate them. Manufacturing systems can be individual work cells, consisting of a single production machine and worker assigned to that machine or as groups of machines and workers, for example production line. The future of the factory will be a fully automated factory that manufactures a wide variety of products without human intervention. Although some "peopleless" factories do exist and others will be built, the major advances being made today occur in manufacturing operations where computers are being integrated into the process to help workers create high-quality products. Computer-integrated manufacturing (CIM) is an umbrella term for the total integration of product design and engineering, process planning, and manufacturing by means of complex computer systems. Less comprehensive computerized systems for production planning, inventory control or scheduling are often considered as part of CIM. By using the powerful computer system to integrate all phases of the manufacturing process, starting from the customer order to final shipment, firms hope to increase productivity, improve quality, meet customer needs, and offer more flexibility.

Computer Integrated Manufacturing (CIM) describes a new approach to manufacturing, management and corporate operation. The Computer and Automation System Association (CASA) of the Society of Manufacturing Engineers (SME) defines CIM as, the integration of the total manufacturing enterprise through the use of integrated systems and data communications coupled with new managerial philosophies that improve organization and personnel efficiency. Although CIM systems can include many advanced manufacturing technologies such as robotics, computer numerical control (CNC), computer aided manufacturing (CAM) and just in time production (JIT), it goes beyond these technologies. In addition to the above definition, CIM might be viewed as an integration tool, which uses information and automation hardware and software for production control and management. In this context, CIM is considered as an integrative tool for an organization, which is able to increase productivity, quality and competitive advantage. [1]

Many single purpose machines, often called hard automation, have some features that make them look like robots. The International Standard Organization (ISO) defines an industrial robot in standard ISO/TR/8373-2.3 as; a robot is an automatically controlled, reprogrammable, multipurpose, manipulative machine with several reprogrammable axes, which may be either fixed in place or mobile for use in industrial automation applications. The key words are reprogrammable and multipurpose, because most single purpose machines do not meet these two requirements. Reprogrammable implies two elements:

1. The robot's motion is controlled by a written program.
2. The program can be modified to change significantly the motion of the robot arm.

The purposed of this project is to apply the knowledge in robotics research to a CIM environment and to integrate different subsystems into a concerted manufacturing system with computer workstations. The robot-based CIM system, in which hardware and software are integrated to perform manufacturing tasks, is implemented and presented. A study of robot work cell and the integration of robots into CIM systems will be the major focus in this project.

The existing stand-alone YAMAHA robot is being proposed for this project, to be interfaced with the CIM system. This project will use OMRON CQM1H PLC to control the YAMAHA YK 350X SCARA robotic arm and then interface with other OMRON CQM1H PLC attached to CIM system, where the robotic arm will be programmed and setup to perform some task.

1.2 The importance of CIM/Robotics

There is no doubt that many of the activities and functions currently being performed by human will gradually taking over by the automation system. The primary requirement for automating any function are the availability of a model of the activity necessary for that function, the ability to quantify the model and a clear understanding of the associated information and control requirements. There are several reasons for some functions should be performed by CIM or robotics, which are:

1. Design accuracy and tolerance requirement.
2. The nature of the activity being such that it cannot be performed by human.
3. Speed and high production volume requirement.
4. Size, force, weight, and volume requirement.
5. Hazardous nature of the work.
6. Special requirement.

1.3 Problems Identification in the Integration

Computer-Integrated Manufacturing (CIM) was the best solution for successful flexible automation of the world factories. CIM aims at the comprehensive integration, by means of computers, of all stages of the manufacturing cycle. A flexible manufacturing system (FMS) is only part of the CIM concept. Flexibility of manufacturing system is the key issue in modern industry. As far as flexibility is concerned, transport forms one of the most notorious bottlenecks in typical FMS. The flexibility problem in transport function can be solving by the development of industrial robots. Difficult interface problems, insurmountable so far, have prevented the smooth introduction of robotics into CIM. The most problem lies in the interface of the robot with the parts to be handled. The uncertainty in the robot environment (inaccurately positioned parts) is another cause of problems, reducing the overall system flexibility. External sensors, such as vision, force and tactile sensors are used to resolve the problem, but still have a lot of space to be improved.

Beside mechanical interface problem, information interface are more even important, and often the only alternative, for increasing the flexibility of CIM. To execute a manufacturing task, the different components of an FMS must be able to exchange information smoothly and swiftly. This requires interoperable data interfaces and communication protocols. In the context, bandwidth and real-time response issues must be addressed almost on an equal level with data exchange.

One of the key issues regarding CIM is equipment incompatibility and difficulty of integration of protocols. Integrating different brand equipment controllers with robots, conveyors and supervisory controllers is a time-consuming task with a lot of pitfalls. Quite often, the large investment and time required for software, hardware, communications, and integration cannot be financially justified easily. Another key issue is data integrity. Machines react clumsily to bad data and the costs of data upkeep as well as general information systems departmental costs are higher than in a non-CIM facility. Another issue is the attempt to program extensive logic to produce schedules and optimize part sequence. There is no substitute for the human mind in reacting to a dynamic day-to-day manufacturing schedule and changing priorities. It is an operational tool that, if implemented properly, will provide a new dimension to competing: quickly introducing new customerized high quality products and delivering them with unprecedented lead times, swift decisions, and manufacturing products with high velocity.

1.4 Project Objectives

1. To integrate robotic work cell into CIM system.

1.5 Scope of the Project

There are three steps in running the projects, which are:

1. Understanding and familiarization of robotic work cell and how to control the YAMAHA robot using OMRON PLC.
2. Understanding and familiarization of the CIM system and connection.
3. Analyze and identify the task (process) needed to be programmed and integration requirement.
4. Control robot using the OMRON PLC and integrate to the CIM system

CHAPTER II

AUTOMATED MANUFACTURING SYSTEMS

2.1 Introduction

Some elements of the production system are likely to be automated, whereas others will be operated manually. As per discussion here, automation can be defined as a technology concerned with the application of mechanical, electronic and computer-based systems to operate and control production. The automated element of the production system can be separated into two categories: (1) automation of the manufacturing systems in the factory and (2) computerization of the manufacturing support system. The term computer-integrated manufacturing is used to indicate this extensive use of computers in production system. The two categories of automation are shown in Figure 2.1 below.

Automated manufacturing systems perform operations such as processing, assembly, inspection or material handling. They are called cases automated because they perform their operations with a reduced level of human participation compared with the corresponding manual process. In some highly automated systems, there is virtually no human participation.

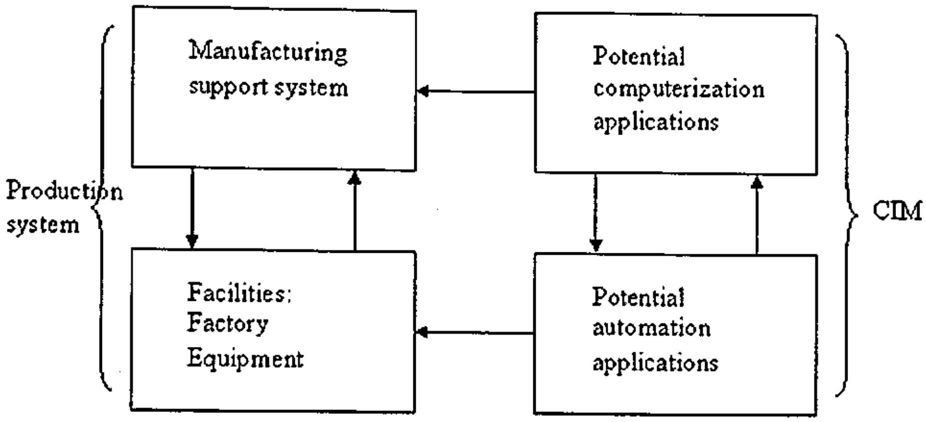

Figure 2.1: Automation categories

Automated manufacturing systems can be classified into three basic types:

1. Fixed automation
   It is a system in which the sequence of processing operation is fixed by equipment configuration. Each of the operations in the sequence is usually simple, involving perhaps a plain linear or rotational motion or an uncomplicated combination of the two. It is the integration and coordination of many such operations into one piece of equipment that makes the system complex. Example of fixed automation includes machining transfer lines and automated assembly machines.

2. Programmable automation
   In the programmable automation, the production equipment is designed with capability to change the sequence of operations to accommodate different product configurations. The operation sequence is controlled by a program, which is a set of instructions coded so that they can be read and interpreted by the system. New programs can be prepared and entered into the equipment to produce new products. Examples of programmable

automation include numerically controlled (NC) machine tools, industrial robots and programmable logic controllers.

3. Flexible automation

   It is an extension of programmable automation. A flexible automated system is capable of producing a variety of parts with virtually no time lost for changeovers from one part style to the next. Also no lost production time while reprogramming the system and altering the physical setup. Consequently, the system can produce various combinations and schedules of parts (products) instead requiring that they be made in batches. What makes it possible is that the differences between parts processed by the system are not significant. Examples of flexible automation are the flexible manufacturing systems for performing machining operations that date back to the late 1960s.

The relative positions of the three types of automation for different production volumes and product varieties are shown in Figure 2.2 and Figure 2.3. For low production quantities and new product introductions, manual production is competitive with programmable automation.

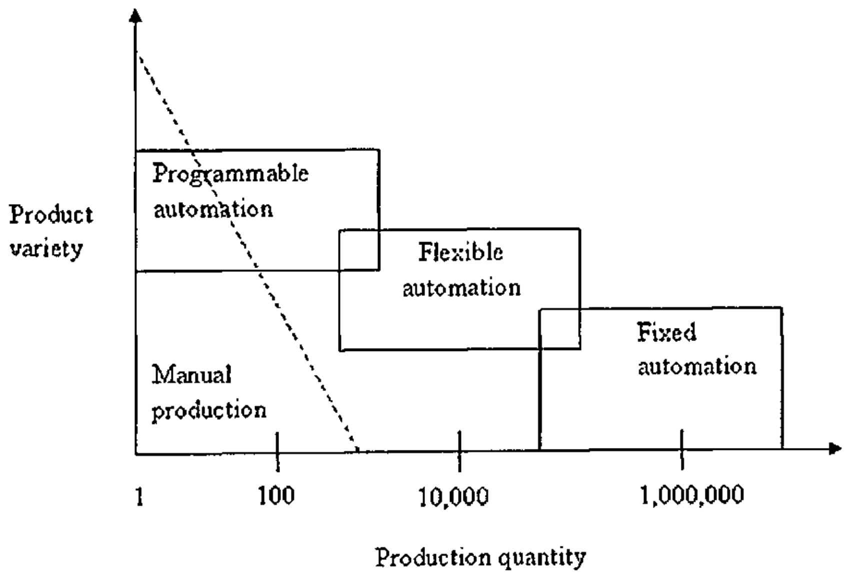

Figure 2.2: Production quantity versus Product variety