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A STUDY ON INDUSTRIAL COMMUNICATION NETWORKING: ETHERNET BASED IMPLEMENTATION

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A STUDY ON INDUSTRIAL COMMUNICATION NETWORKING:
ETHERNET BASED IMPLEMENTATION

SESI PENGAJIAN : 2006/2007

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A STUDY ON INDUSTRIAL COMMUNICATION NETWORKING: ETHERNET BASED IMPLEMENTATION

HAIRULAZWAN BIN HASHIM

A project report is submitted as partial fulfillment of the requirements for the award of the degree of

Master of Electrical Engineering

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NOVEMBER, 2006

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

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Date : 30 NOVEMBER 2006

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ASSOC. PROF. DR. ZAINAL ALAM BIN HARON

For my beloved wife,
Norasiah binti Md Aspan

My father and mother,
Hashim bin Mohd Said and Uminah binti Kaseran@Hj. Yusof

My family,
Zainita, Mohd Rizal, Mohd Nazree, Norzela, Mohd Haizam, Md Syfulnizam,
Noorzalila, Siti Norida, Mohd Salehudin, Siti Nordianah and Mohd Syafiq

for their encouragement, support, caring and blessing...

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ABSTRACT

Recent enhancement of an industrial communication and networking technology has made it possible to apply Ethernet networks at all levels of industrial automation, especially at controller level where the data exchange in real-time communication is mandatory. This thesis presents a study on the development of industrial communication network based on the Ethernet and its implementation on a Computer Integrated Manufacturing (CIM-70A) system which located at Robotic Laboratory in KUiTTHO. The Ethernet module was installed on supervisory OMRON PLC to integrate the various stations in the CIM-70A system. The workability of this communication technique was analyzed and compared with the conventional serial communication which is widely used in automation networking systems. Through this approach, the communication and integration of CIM systems can be accessed easily and hence available to be upgraded to the management and enterprise levels of automation.

ABSTRAK

Penambahan penggunaan komunikasi dan rangkaian industri sejak akhir-akhir ini telah menjadikan rangkaian Ethernet boleh diaplikasikan di semua peringkat automasi perindustrian, terutamanya di tahap pengawal di mana penukaran data dalam masa nyata adalah mandatori. Tesis ini membentangkan satu kajian pembangunan perindustrian rangkaian komunikasi berdasarkan Ethernet dan seterusnya akan diaplikasikan kepada sistem pembuatan komputer bersepadu (CIM-70A) yang terletak di Makmal Robotik, KUiTTHO. Modul Ethernet telah dipasangkan kepada pengawal logik boleh aturcara (PLC) jenama OMRON (siri CJ1M) untuk menyepadukan pelbagai stesen pengeluaran di dalam sistem CIM-70A. Kebolehkerjaan teknik komunikasi ini telah dianalisis dan dibandingan dengan sistem konvensional yang begitu meluas digunakan di dalam rangkaian sistem automasi iaitu komunikasi bersiri. Menerusi pendekatan ini, komunikasi dan integrasi sistem CIM lebih mudah dicapai dan seterusnya boleh dipertingkatkan ke peringkat pengurusan dan perusahaan di dalam sistem automasi.

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LIST OF ABBREVIATIONS

ACK	-	acknowledgement
ARP	-	address resolution protocol
ASRS	-	automatic storage and retrieval system
AUI	-	attachment unit interface
BACNet	-	building automation and control network
CAN	-	controller area network
CD	-	compact disc
CIM	-	computer integrated manufacturing
CiN	-	CAN in automation
CIO	-	common input/output
COM	-	component object model
CPU	-	central processing unit
CSMA/CD	-	carrier sense multiple access with collision detection
DCOM	-	distributed component object model
DEC	-	Digital Electronic Corporation
DIX	-	DEC, Intel, and Xerox
DM	-	digital memory
DNS	-	domain name system
EHS	-	European Home System
ERP	-	entrepreneurs resources planning
FA	-	field assembly
FF	-	Foundation Fieldbus
FINS	-	factory interface network service
FINS/TCP	-	factory interface network service/transmission control protocol
FINS/UDP	-	factory interface network service/user datagram protocol

FIP	-	factory instrumentation protocol
FKEE	-	Faculty of Electrical and Electronic Engineering
FTP	-	file transfer protocol
HART	-	Highway Addressable Remote Transducer
HMI	-	human machine interface
ICMP	-	internet control message protocol
ID	-	identity device
IDA	-	interface for distributed automation
IEEE	-	Institute of Electrical and Electronic Engineer
IEC	-	International Electrotechnical Commission
IP	-	internet protocol
ISA	-	Instrument Society of America
ISP	-	interoperable system project
KUiTTHO	-	Kolej Universiti Teknologi Tun Hussein Onn
LAN	-	local area network
LLC	-	logical link control
LonWorks	-	local operating networks
MAC	-	medium access control
MAU	-	multi-station access unit or medium attachment unit
MES	-	manufacturing execution system
MRP	-	material requirement planning
MRP-II	-	manufacturing resources planning
NIC	-	network interface card
OSI	-	open system interconnection
PC	-	personal computer
PID	-	proportional, integral and derivative
PING	-	packet internet groper
PLC	-	programmable logic controllers
POP3	-	post office protocol version 3.0
Profibus	-	Process Fieldbus
P-Net	-	Process Network
SCADA	-	supervisory control and data acquisition
ScTP	-	screened twisted-pair cable
SDS	-	smart distributed system

SMTP	-	simple mail transfer protocol
SNTP	-	simple network time protocol
STP	-	shielded twisted-pair cable
TCP	-	transmission control protocol
TCP/IP	-	transmission control protocol/internet protocol
UDP	-	user datagram protocol
UTP	-	unshielded twisted-pair cable

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CHAPTER I

INTRODUCTION

1.1 Project Overview

Data communication and networking may be the fastest growing technology in our culture today (Forouzan, 2001). It is extensively used in an industrial network to integrate both office and manufacturing equipment. During the last two decades, the industrial communication system have evolved at a rapid pace and passed from the traditional serial communication to the fieldbuses. The term fieldbus applies to a large family of two-way digital communication protocols that were specially developed to overcome the physical and performance limitations of low level digital and analogue standard (Sterling and Wissler, 2003). A full fieldbus protocol can handle byte size data for complex transmitters and valves as well as diagnostics or control information. Any control device requiring extensive communication for configuration requires a full fieldbus.

Ethernet, the well-known Local Area Network (LAN) standardized by IEEE has been largely utilized in industrial communication. The Ethernet network have gained the capability of communicating in real-time thus opening an attractive scenario, implementation of Ethernet at all level of an industrial automation system (Figure 1.1).

1.2 Problem Statement

Real-time communication has become some major issue in automated manufacturing system. Some problems such as data and status monitoring, transmission data size and speed, online program editing, and accessibility of controller are encountered in conventional serial communication networking such as in Computer Integrated Manufacturing (CIM) system. Furthermore, the integration into higher level of automation system; Manufacturing Resources Planning (MRP-II), Manufacturing Execution System (MES) and Entrepreneurs Resources Planning (ERP) has difficulty to implement (Figure 1.1).

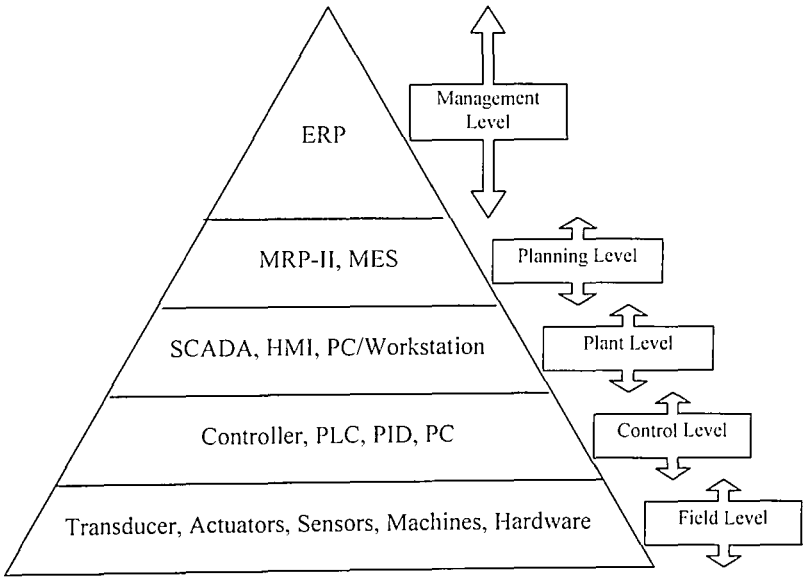

Figure 1.1: Pyramid of industrial automation system

1.3 Objective

The objectives of this project are:

i) To develop a hardware infrastructure of CIM system communication network based on Ethernet protocol.

ii) To familiarize and thus overcome real-time monitoring issues so that allows easier integration between the different units of the CIM systems via Ethernet module on OMRON PLC CJ-series.

iii) To verify and validate the functionality, feasibility and workability of the project.

1.4 Scope of Work

This project is concentrating to develop a CIM system communication network based on the Ethernet protocol. The work will involve using OMRON PLC controller (CJ Series) attached with Ethernet module to integrate the various production units in the CIM system including supervisory workstation. The environment of this implementation is established CIM-70A systems developed in the Robotics Laboratory, Faculty of Electrical and Electronic Engineering (FKEE), Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO).