Ain Shams University
Faculty of Engineering
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Design and Implementation of a Real-Time Multiprocessor-Based Distributed Control System

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By

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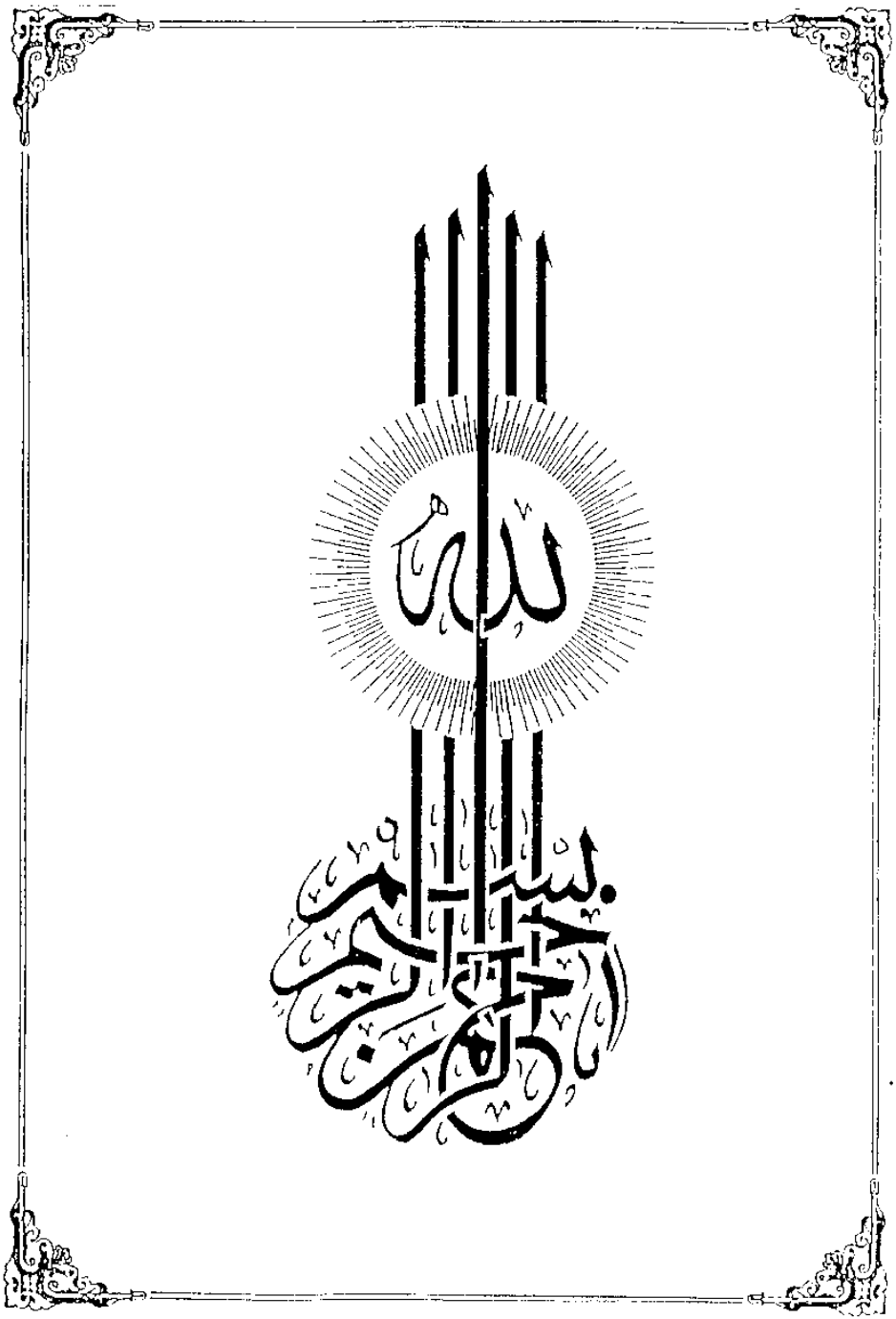

Statement

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering (Computer and Systems Engineering).

The work included in this thesis was carried out by the author at the Computer and Systems Engineering Department, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at other university or institution.

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To my parents

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Abstract

A comprehensive survey is carried outon the different existing methods of implementing distributed control systems and the undelying theory is studied

A microcomputer based control system is designed incorporating the following features:

1- The system is highly reconfigurable. The particular control algorithm of each individual controller can be changed by connecting the controller to a portable PC, downloading the new algorithm, then disconnecting the PC.

2- The control system can be easily connected, if so desired, to a larger system or host computer that may be used for supervisory control or DDC purposes.

3- The controllers can be tuned locally or remotely, by a human operator or a self-tuning algorithm.

4- The controllers are designed in such a way as to facilitate system maintenance.

5- The hardware involved is available at the local market at economic prices.

6- The system performance does not degrade abruptly should any individual connection be broken.

A case study is advanced in which an industrial process (complex enough to warrant the use of a distributed control system) is controlled by the above described scheme.

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Chapter 1
Introduction

During the last several decades automatic control applications have spread to affect virtually every detail of modern life. Microprocessors have been largely used in such applications. As the applications grew more complex, so did the systems which control them. Today, distributed microprocessor-based control systems have become very common. Such systems are used to control diverse environments. Examples range from process control and factory automation on one side to space shuttle control and complicated military defense systems on the other. As diverse as such systems may be they share one important attribute, time criticalness. The system is typically embedded in an environment which it must monitor, control, or interact with in some other form. The nature of the environment imposes time constraints on the behavior of the system thus making it a real-time one. Distributed Control Systems, DCS, are often organized in a hierarchical manner.

The first and lowest level in the hierarchy is directly connected to the controlled system (environment). It is composed of a set of data acquisition and output modules, each of which is concerned with a single point in the environment.

Each group of data acquisition and output modules belongs to a single processor module, a collection of which comprises the second level of the system hierarchy. Processor modules have computational power and are responsible for data logging as well as different control functions.

A collection of processor modules may be interfaced to a local host computer thus making a single DCS node. The system may be composed of several such nodes together forming the third level of its hierarchy. Each host may have a local user interface as well as mass storage facility. Nodes are typically connected to a central computing facility by data hiways.

For commercial DCS products, the internal design of hardware and software is classified and is a vendor confidential information. Therefore the mere implementation of such a system is a contribution, not to mention an implementation which uses components that are both economical and available at the local market. This consideration has been the motivation for the work presented in this thesis.