Ain Shams University
Faculty of Engineering

EXPERT SYSTEMS FOR IMAGE PROCESSING

By

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A Thesis

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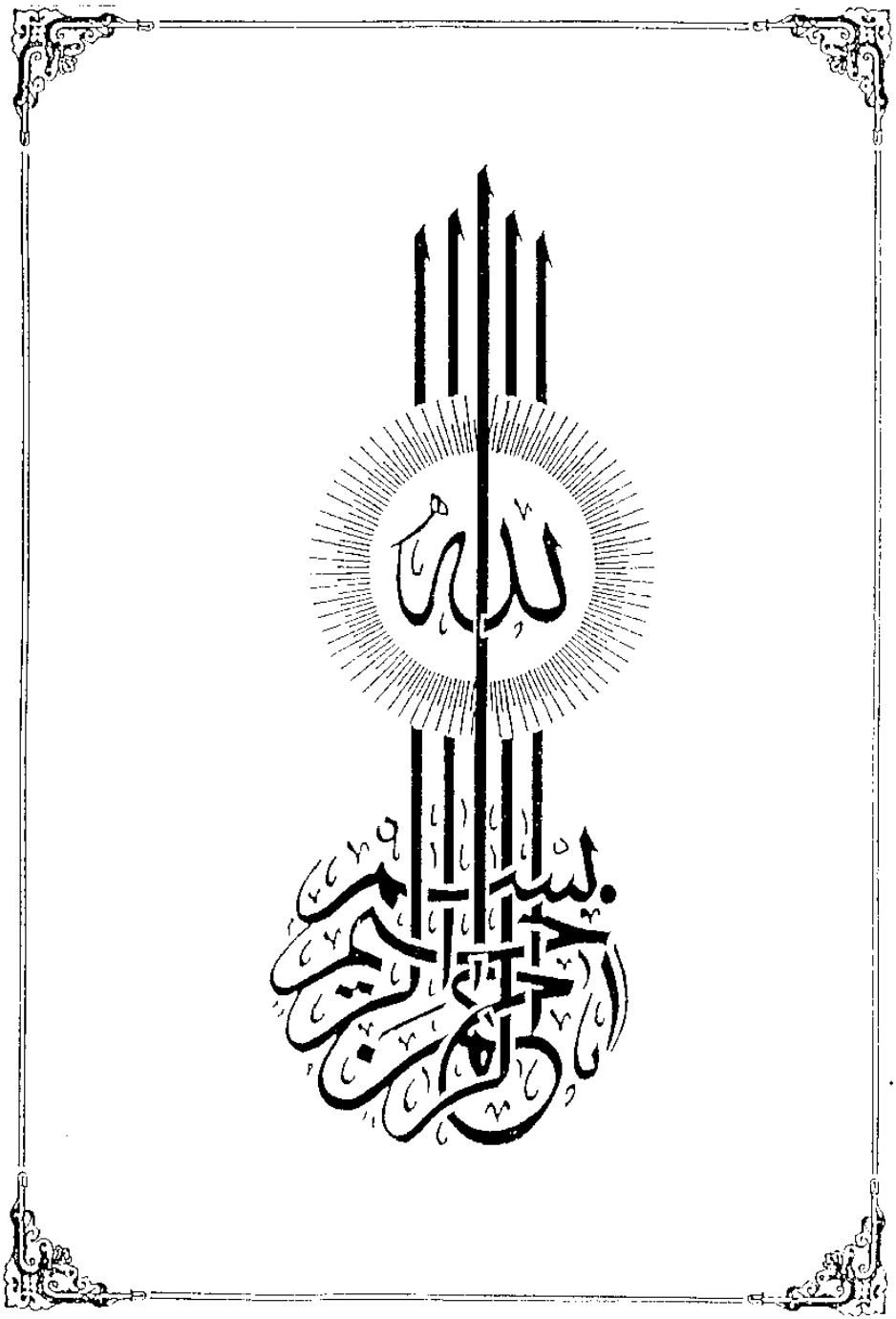

STATEMENT

This dissertation is submitted to Ain shams University for degree of PH.D. in Electrical Engineering.

The work included in this thesis was carried out by the author in the Department of Computer and Systems Engineering, Ain Shams University, from October 1987 to August 1992.

No part of this thesis has been submitted for a degree or qualification at any other University or Institution.

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ABSTRACT

This thesis describes the building of an image capture station, the development of the image processing package, and the building of the expert system. The present system is capable of capturing, manipulating in a digital store, large amounts of high speed data then classifing the case according to the knowledge of the domain.

The particular domain used in this research is the classification of fractures in the shaft of femur. This domain provides a suitable data stream which may be stored in the knowledge-base of the expert system for diagnosis and subsequently deduces the decisions.

The modular approach is used for the design of the system. Commercially available subsystems are used as faras possible, in addition to an expert system shell. This modular approach allows most recent developments in the technology to be incorporated as they become available.

To accommodate versatility in use, a set of software subroutines feature as an integrated part of the system. This set allows the user to attach new knowledge-base or develop the expert system structure easily and so customizes his system software.

To provide for the transfer of captured image data into the system a fast link software subroutine is provided which may be used to access either a local image capture station or one which is part of a main comprehensive computer network.

CONTENTS

DETAILED CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 EXPERT VISION AND COMPUTER VISION

The need for understanding human organs stems not only from purely medical reasons but also, very often, from the necessity to help in the design of useful devices, which do functions similar to those generally associated with our organs. This approach is very noticeable in the field of image acquisition and processing.

A deep insight into the mechanism of the human visual system [1] provides useful information. It almost becomes a prerequisite for the design and implementation of man-made image capture and interpreting systems as mentioned by Rosenfeld and Kak [2].

Also, it allows the determination of specific criteria for image evaluation relating to the physiological characteristics of the eye. To be more specific, it can be said that the basic components in any electronic imaging system, i.e., camera, processor, memory, and interfaces are in essence, equivalent to their corresponding human organs namely the eye, brain and nerve paths. This similarity cannot yet, unrealistically extend beyond certain limits due to some fundamental differences between the two systems,

both in their very conception and general performance.

In this respect the compactness, sophistication and complexity of the various organs that form the human visual system make for a better perception of the surrounding world. The eye, for instance, can perceive a very wide range of brightness; containing deep shadows as reported by Fink [3]. The conventional cameras can only cope with a comparatively limited range usually hundreds of times smaller.

Other features such as auto-focusing and automatic aperture setting, usually not provided by conventional cameras, considerably enhance the performance of the human eye as an image sensing device. Another fundamental difference between the human visual system and a corresponding electronic system is the way the acquired data is transmitted from the sensing device to the processor to be stored or processed.

The huge number of nerve fibers; about 101 to 103 million contained in the optic nerve bundle, allows for a fast and efficient parallel transfer. In an electronic system, by contrast, this operation is performed by using a comparatively very limited number of wires that results in a slower information transfer.

A further point worth mentioning is that in the human visual system, the acquired information are not transferred

in the same form as in any other equivalent electronic system. In the latter, the binary system is adopted for circuits compatibility. This is quite different in a human visual system where the information reach the brain in a form not yet fully understood but clearly more amenable to fast processing.

At the processing stage, the staggering capabilities of the human brain are beyond even the most powerful electronic processor no matter how efficient and sophisticated the software used for that purpose is. An expert system, which is an intelligent program represents the expertise of a human expert, can be used to process the image in this stage.

Fortunately, in most practical situations, a sensor and its associated conditioning and processing software are required to extract only that bit of information about the specific process under investigation. In such cases, the information of interest are localized, i.e., magnitude or frequency band limited. Therefore, certain features inherent in electronic devices, which are usually regarded as disadvantages, may be turned to advantage by selectively optimizing the performance of the devices used within the specific range of interest.

Under the above circumstances, electronic devices may then equal, or sometimes even excel human organs in many different aspects. For instance the human expert has the