Ain Shams University

Faculty of Engineering

# MICROCOMPUTER APPLICATIONS IN SCENE MATCHING

By Ahmed

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A Thesis

Submitted in partial fulfillment for the requirements of the Degree of M.Sc. in Electrical Engineering



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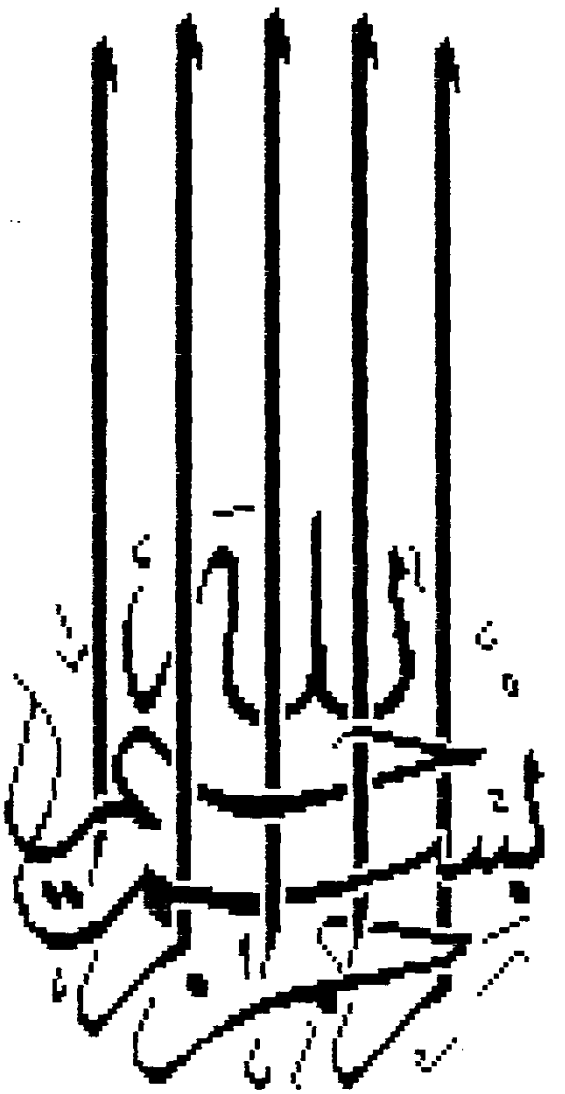
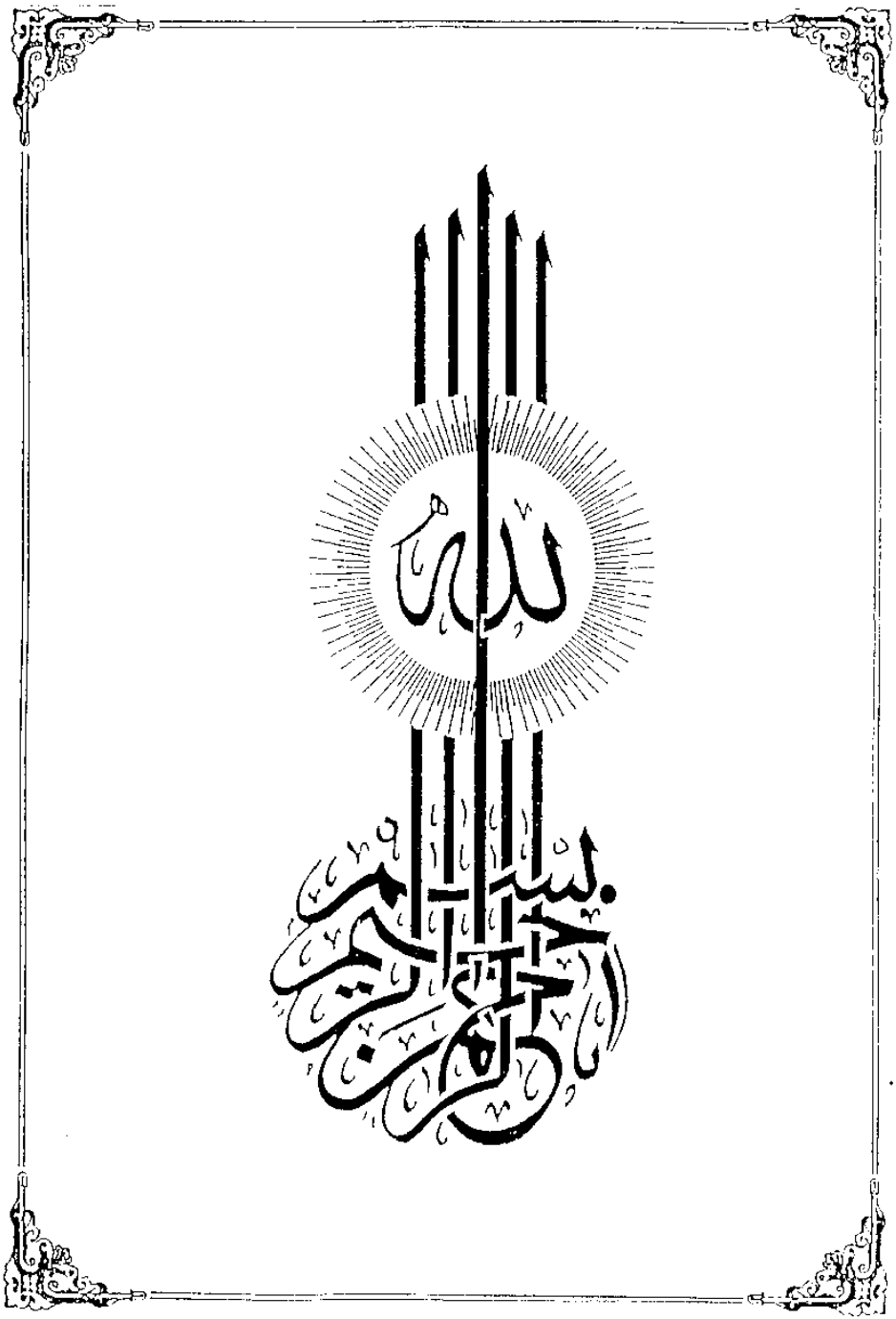
Cairo - 1988





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Date : 29/12/1988

## Statement

This dissertation is submitted to Ain Shams University for the degree of M.Sc. in Electrical Engineering.

The work included in this thesis was carried out by the author in the department of Electronics and Computer Engineering, Ain Shams University, from October 1985 to December 1988.

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

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## ACKNOWLEDGEMENT

I wish to express my sincere gratitude, deep thanks and appreciation to Prof. Dr. Safwat Mahrous for his kind supervision, guidance, and advice.

Also, I have the great honour to express my deepest gratitude and sincerest thanks to Prof. Dr. Attia Shahin for his close supervision, guidance, unlimited help, and continuous encouragement.

My special thanks to Prof. Dr. Mohammed Marzouk Ibraheem of Ain Shams University ,who contributed in the supervision of this thesis from 1/10/1985 to 14/11/1988, for his guidance, continuous encouragement, and great help.

Finally, thanks to my family for their understanding, supporting, and patience.

## ABSTRACT

This thesis deals with the problem of scene matching. Given a pictorial description of a region of a scene, it is desired to determine which region in another image is similar. The simplest method to solve this problem, which is called template matching, is described as it is the backbone of all other methods.

A review of other image matching techniques using image processing based algorithms such as ordered search techniques in template matching, two-stage template matching, coarse-fine template matching, and sequential similarity detection algorithms are discussed.

The most effecient algorithms for scene matching are analyzed and discussed. Those are the sequential hierarchical scene matching algorithms. The main target of this thesis is to investigate those approaches. The first approach is the basic sequential hierarchical scene matching dealing with gray-scale images. The sequential decision rules are discussed as well as the derivation of threshold sequence. The " pairing functions " concept applied to the second approach, namely, the sequential scene matching using edge features, is described as well as edge extractions and similarity measure.

Experimental results are presented for matching sattelite images of Al-Minea (Egypt) and Montana (USA) using those sequential hierarchical scene matching algorithms as well as the two-stage template matching algorithm. The experimental work is done using the Remote Image Processing System (RIPS). The results prove efficency and success in reaching the best match location with minimum required computations. A comment on the results is presented.

## LIST OF SYMBOLS

### Chapter 1 :

| | |
|---|---|
| $N$ | Number of features to be measured for each input pattern |
| $\Lambda_x$ | Feature space |
| $x_K$ | Kth feature measurements |
| $w_j$ | Pattern class j |
| $D_i(x)$ | Discriminant function |
| $\sim$ | Related to |
| $r(w_i, d)$ | Conditional loss for $X \sim w_i$ |
| $R(P,d)$ | Average loss |
| $r_x(P,d)$ | The a posteriori conditional average loss of decision d for a given feature measurement X |
| $d^*$ | Optimal decision |
| $L(w_i, d)$ | Loss function |
| $\lambda$ | Liklihood ratio |
| $e_{ij}$ | The probability of deciding $X \sim w_i$ when $X \sim w_j$ is true |
| $U_n(X/w_i)$ | The generalized sequential probability ratio test for the ith pattern class |

### Chapter 2 :

| | |
|---|---|
| $R(u,v)$ | Normalized correlation measure at the reference location (u,v) |
| $E(u,v)$ | Accumulated error at the reference location (u,v) |
| $m, \bar{n}$ | Subtemplate size |
| $t_i$ | The level value of the ith point of the template |
| $p_i$ | The level value of the ith point of the picture of the same size |

| | |
|---|---|
| $U$ | The set of template points which are 1 |
| $Z$ | The set of template points which are 0 |
| $N_U(0)$ | The number of picture points in U which are 0 |
| $N_Z(1)$ | The number of picture points in Z which are 1 |
| $n$ | Number of template points |
| $N[\mu, \delta]$ | Normal distribution of mean $\mu$ and standard deviation $\delta$ |
| $\Phi(u)$ | Normal distribution function |
| $\varphi(u)$ | Normal density function |
| $r_i$ | The frequency of occurrence of the gray level value of the ith point in the template |
| $t$ | Threshold for mismatch measure |
| $E(p,q,t,m,n)$ | Expected computational cost |
| $I(i,j)$ | Sequential Similarity Detection Algorithm surface |
| $W$ | Window |
| $S$ | Search area |
| $S_M^{i,j}$ | Subimage of the search area of size MxM |

Chapter 3:

| | |
|---|---|
| $L$ | Number of levels |
| $K$ | Resolution level K |
| $E_R$ | Spectral energy |
| $\epsilon_A$ | Aliasing error |
| $f_K(x,y)$ | Gray scale image at resolution level K |
| $F_K(w_x, w_y)$ | Fourier spectrum of the sampled image field $f_K(x,y)$ |
| $s(x,y)$ | sampling signal |
| $\bar{s}$ | mean intensity of the image elements |

| | |
|---|---|
| $\bar{w}$ | mean intensity of the window elements |
| $G_K(i,j)$ | Location matrix formed at resolution level K to deal with the image at resolution level K-1 |
| E | Cumulative error |
| $\bar{E}$ | Expected error |
| $T_n^K$ | Threshold value for resolution level K |
| SR | Search region |
| R(u,v) | Similarity measure (correlation) |
| $R_b$ | Correlation with a background level |
| $R_T$ | Threshold for similarity measures |
| $p_K$ | Probability of match |
| $P_d$ | Overall Probability of match |
| $\eta$ | Amount of computational saving |

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# INTRODUCTION