FACE RECOGNITION USING EIGEN-FACE IMPLEMENTED ON DSP PROCESSOR

by

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LIST OF SYMBOLS

d	Distance
S_W	With-in class scatter matrix
S_B	Between class scatter matrix
D_E	Euclidean distance
D_C	City block distance
D_M	Mahalanobis distance
M	Total number of images
I	Image
h	Height
w	Weight
av	Average
IA	Zero mean image
$Covar$	Covariance matrix
$Evec$	Eigenvector
$Eval$	Eigenvalue
W	Weight space
$norm$	Normalization
P	Projected features of training samples

Tr	Train image
Ts	Test image

LIST OF ABBREVIATIONS

PCA	Principle Component Analysis
ORL	Olivetti Research Laboratories
ED	Euclidean Distance
LDA	Linear Discriminant Analysis
ICA	Independent Component Analysis
KPCA	Kernel Principal Component Analysis
KLDA	Kernel Linear Discriminant Analysis
MPCA	Multilinear Principal Component Analysis
SVM	Support Vector Machines
HMM	Hidden Markov Model
EBGM	Elastic Bunch Graph Matching
HD	Hausdorff distance
HE	Histogram Equalization
EDM	Euclidean Distance Matrix
MRTD	Machine Readable Travel Documents
RBF	Radial Basis Function
DCT	Discrete cosine transform
CG	Coarse grained

FERET	Face Recognition Technology
DARPA	Defense Advanced Research Projects Agency
NIST	National Institute of Standards and Technology
AR	Aleix Martinez and Robert Benavente
RGB	Red, Green, Blue
JPEG	Joint Photographic Experts Group
CVC	Computer Vision Center
1-D	One Dimensional
2-D	Two Dimensional
3-D	Three Dimensional
MUCT	Milborrow / University of Cape Town
UMIST	University of Manchester Institute of Science and Technology
HCI	Human-Computer Interaction
ATM	Automated Teller Machine
ANN	Artificial Neural Networks
ID	Identification Card
PIN	Personal Identification Number
SSS	Small Sample Space

PC	Principal Components
BSS	Blind Source Separation
DSP	Digital Signal Processing
TI	Texas Instruments

Pengecaman Wajah Menggunakan Eigen-Face Dilaksanakan oleh Pemproses DSP

ABSTRAK

Sistem pengecaman wajah adalah bidang penyelidikan yang semakin berkembang di dalam sistem pengecaman biometrik dan telah digunakan secara meluas dalam sistem keselamatan. Sistem pengecaman wajah adalah suatu pemprosesan fisiologi maklumat biometrik berdasarkan imej dua dimensi muka. Fokus tesis ini adalah untuk membangunkan pengecaman muka automatik menggunakan ciri-ciri holistik yang diambil daripada imej muka. Ciri holistik diekstrak menggunakan kaedah *eigenface* dimana teknik unjuran linear seperti PCA digunakan untuk mendapatkan data penting yang terdapat dalam imej tersebut. Imej muka mempunyai maklumat frekuensi rendah seperti bentuk mulut, mata, dan hidung yang mempunyai kuasa diskriminasi yang tinggi. Dengan menggunakan kaedah PCA, hanya beberapa vektor eigen yang mempunyai nilai eigen yang tinggi dipilih untuk digunakan. Ruang rendah dimensi yang dihasilkan oleh PCA dikelaskan dengan menggunakan pengelasan jarak. Klasifikasi jenis ini digunakan untuk mengira persamaan di antara dua titik data dalam ruang PCA berdasarkan kepada jarak dua vektor. Kaedah yang digunakan diuji menggunakan dataset ORL yang mempunyai 400 imej daripada 40 individu. Kadar pengecaman terbaik adalah 97.5% apabila diuji menggunakan 9 imej latihan yang diwakili oleh 35 pekali PCA. Menggunakan pekali PCA yang sedikit membolehkan pengelasan jarak dilaksanakan menggunakan perkakasan seperti pemproses DSP. Pengelasan jarak diuji dengan menggunakan pemproses DSP TMS320C6713. Masa pengiraan dapat dikurangkan berbanding simulasi menggunakan komputer.

Face Recognition Using Eigen-Face Implemented on DSP Processor

ABSTRACT

Face recognition is the established research area in 2D biometric recognition system and broadly used in a security system. Face recognition system is a physiological biometric information processing based on the two dimensional face image. This thesis focus to develop an automatic face recognition using holistic features extracted that use the global features represented by low frequency data from face image. Holistic features are extracted using eigenface method where a linear projection technique such as PCA is used to capture the important information in the image. Face image has low frequency information such as shape of mouth, eye, and nose which has high discrimination power. By using PCA, only several number of eigenvector is preserved which belong to these features. A low dimensional feature space is classified using distance classifier. Distance classifier is used to calculate the similarity between two data points in the feature space based on the distance of two vectors. Euclidean distance is used for matching process. The propose method is tested using a benchmark ORL dataset that has 400 images of 40 persons. The best recognition rate is 97.5% when tested using 9 training images and 1 testing image represented with 35 PCA coefficients. Using less number of PCA coefficients is able for the classifier module to be implemented using hardware such as DSP processor. Euclidean distance classifier is tested using the TMS320C6713 digital signal processor (DSP). The computational time is less compared with the offline simulation using PC based.

CHAPTER 1

INTRODUCTION

1.1 Background

Face recognition, one of the most relevant applications of image analysis and computer vision, has become an increasingly important and active research topic in recent years because of its numerous applications in different domains (Sharma & Dubey, 2014). Using the face for biometric applications seems logical because it is the body part with the most obvious and important role in human communication and identification (Delac et al., 2008). Facial biometrics is among the fastest growing biometric areas, but building an automated system for human face recognition is a challenge because humans are not well skilled in recognizing numerous unknown faces (Li & Jain, 2004; Parmar & Mehta, 2013). In recent years, much work has been carried out in face recognition, which has become successful in actual applications. Face recognition can be divided into two main methods: two dimensional (2D) and three dimensional (3D). 2D and 3D refer to the actual dimensions in a computer workspace. 2D is "flat", using the horizontal and vertical (X and Y) dimensions, the image has only two dimensions. While 3D adds the depth (Z) dimension. This third dimension allows for rotation and visualization from multiple perspectives.

Many face recognition methods, including their modifications, have been developed. Face recognition has gained considerable attention recently. Identifying whether a face is known or unknown can be accomplished by comparing a person's face from a database of faces. Research interest in face recognition is rapidly increasing given the many laws and commercial applications of face recognition (Christy et al., 2014).

Face recognition has special advantages over other system characteristics because it is a non-contact process that can identify a person from a distance. The identification process does not require interacting with the person. People are not required to place their hands on a reader or their eyes in front of a scanner in a specific position, processes that can sometimes be sources of disease transfer and may not be acceptable in some cultures. Face recognition also aids in crime prevention because face images that are recorded and archived can later help identify a person (Parmar & Mehta, 2013). Different biometric indicators are appropriate for various kinds of identification applications because of the varying cost, intrusiveness, ease of sensing, and accuracy of these applications.

Biometric-based methods became the most promising face recognition option. Biometrics is a user-friendly authentication method that utilizes biological data to identify a person. Instead of certifying people and allowing them access to physical and virtual domains based on smart cards, passwords, PINs, plastic cards, keys, and tokens, these methods examine the physiological and/or behavioral characteristics of a person to verify identity. Biometric-based methods identify based on physiological characteristics (e.g., face recognition, finger geometry, fingerprints, palm prints, hand veins, hand geometry, ears, voice pattern, iris, and retina) and behavioral traits (e.g., keystroke dynamics, gait, and signature).

Passwords and PINs can be guessed or stolen and are difficult to remember; cards, keys, and tokens can be misplaced, forgotten, or duplicated; and magnetic cards can be damaged and corrupted. However, biological traits cannot be forged, misplaced, forgotten, or stolen (Shah et al., 2014; Parmar & Mehta, 2013). Figure 1.1 shows the most important biometrics types.

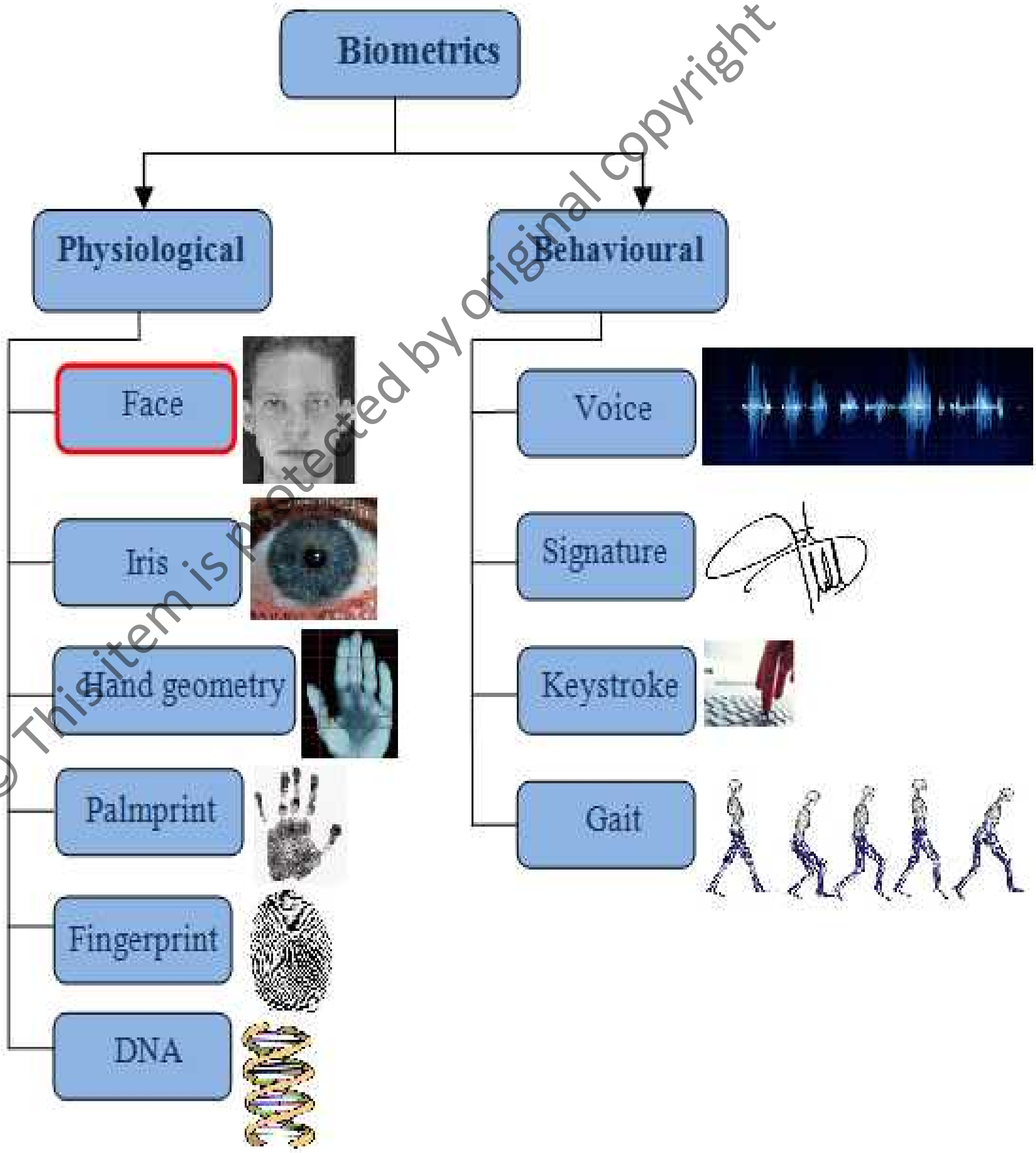

Figure 1.1: Types of Biometrics.

Face biometric systems have the highest possible collectability and acceptability. These systems use images that are acquired quite easily. In addition, using face images for identifications in daily activities, such as in passports and national identification cards, is readily accepted by people. Figure 1.2 shows that facial features is nearly 97% and have the highest possible compatibility than biometric indicators because it is a non-contact process that can identify a person from a distance (Li & Jain, 2004).

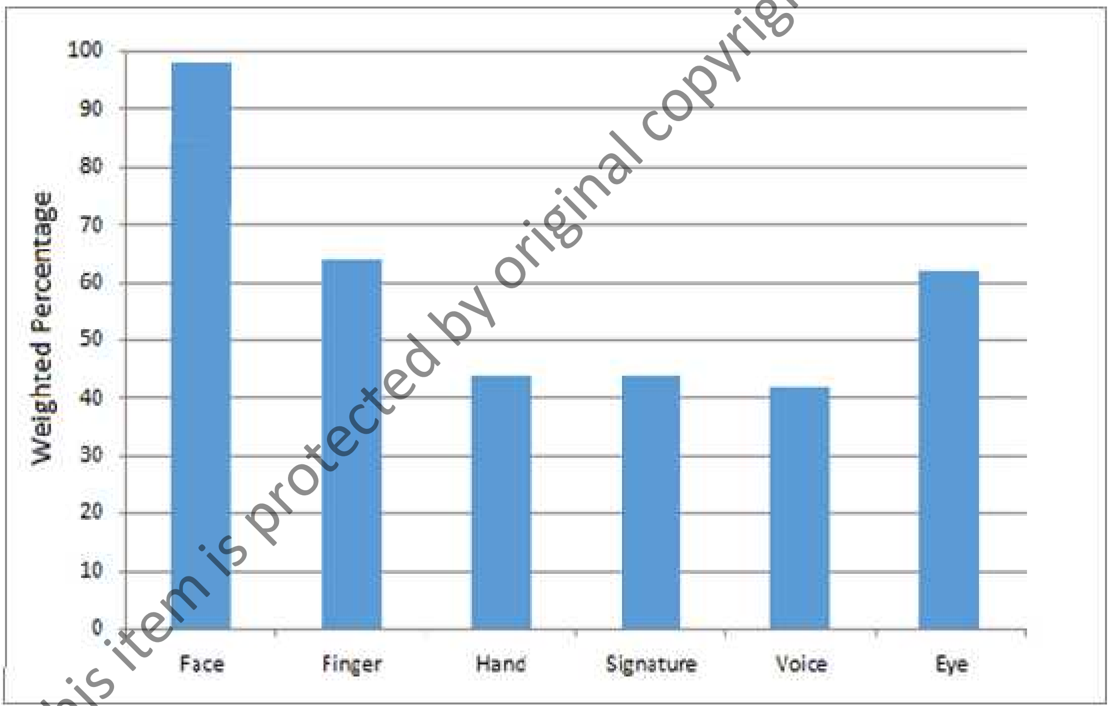

Figure 1.2: Facial Features Scored the Highest Compatibility.

Face detection is the strategy of determining whether a face in a given image (usually in gray scale) exists or not, and returning the image location and content of each existing face detected. This strategy is the starting point of any fully automatic system that analyzes facial information (e.g., identity, gender, expression, age, race, and pose).

1.2 Face Recognition Classifications and Methods

A face recognition system falls under two classifications: verification and identification (Jafri & Arabnia, 2009).

1. Face Verification (one-to-one matching) that compares the face images against a template face images whose identity is being claimed.
2. Face Identification (one-to-many matching) that compares a query face image against all image templates in a face database. Figure 1.3 shows the process of face identification.

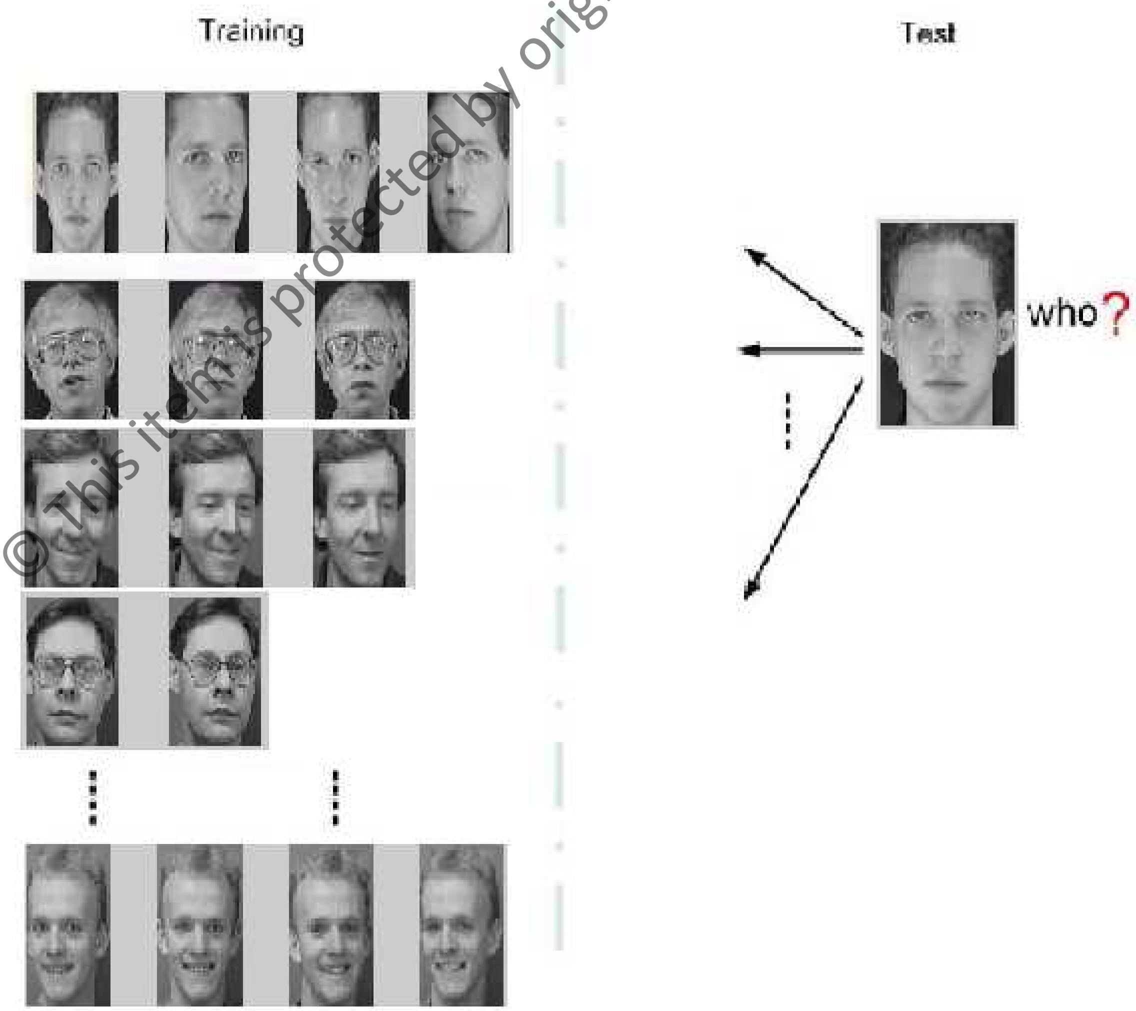

Figure 1.3: Face Identification.