FACE RECOGNITION USING EIGENFACES TECHNIQUE

HAZIRAH BINTI ZAKARIA

This Report Is Submitted In Partial Fulfilment Of Requirements For The Bachelor Degree Of Electronic Engineering (Computer)

Faculty of Electronics and Computer Engineering

Universiti Teknikal Malaysia Melaka

June 2014

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : ..... FACE RECOGNITION USING EIGENFACES .....

Sesi Pengajian : | 1 | 3 | / | 1 | 4 |

Saya .....HAZIRAH BINTI ZAKARIA.....

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐ **SULIT*** *(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **TERHAD**** **(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☒ **TIDAK TERHAD**

(HAZIRAH BINTI ZAKARIA)

Tarikh: 4/6/2014

Disahkan oleh:

(ROSMAN BIN ABD RAHIM)

Tarikh: 4/6/2014

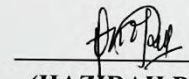
ROSMAN ABD RAHIM
Lecturer
Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya,
76100 Durian Tunggal, Melaka

iii

DECLARATION

This declaration is to clarify that all of the submitted contents of this project are original in its figure excluding those, which have been admitted specifically in the references. All the work process involves is from my own idea and creativity. All contents of this project have been submitted as a part of partial fulfilment of Bachelor of Electronic Engineering in Computer Engineering.

"I hereby declare that this project is the work of my own excluded for the references document and summaries that have been acknowledge."



(HAZIRAH BINTI ZAKARIA)

B021110073

Date: 4/6/2014

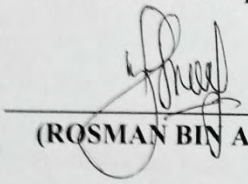
BACHELOR of ELECTRONIC ENGINEERING (COMPUTER ENGINEERING)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

June 2014

"I hereby declare that I have read this report and in my opinion this report "Face Recognition Using Eigenfaces Technique" is sufficient in terms of the scope and quality for the bachelor of Electronic Engineering (COMPUTER)."

Checked and Approved by



(ROSMAN BIN ABD RAHIM)

Project Supervisor

Date: 4/6/2014

Faculty of Electronic Engineering and Computer (FKEKK)

Universiti Teknikal Malaysia Melaka

June 2014

Special Dedicated

To my beloved family members for their true love, prayers and encouragement. Then to my supervisor that guide and give moral support to me and to all my friends for your support throughout my educational journey.

ACKNOWLEDGEMENT

Bissmillahirrahmanirrahim,

Assalamualaikum and greetings.Alhamdulillah and thanks to Allah the Almighty for by His permission me completing this Final Year Project with title “Face Recognition Using Eigenfaces Technique”. This final year project was prepared for Faculty of Electronic Engineering and Computer(FKEKK), Universiti Teknikal Malaysia Melaka (UTeM), basically for students in final year to complete the undergraduate program that leads to the degree of Bachelor of Electronic Engineering (Computer).

Firstly, I would like to express my deepest thanks to, En Rosman bin Abd Rahim, a lecturer at Faculty of Electronic Engineering and Computer and also assign as my supervisor who had guided be a lot of task during two (2) semesters session 2013/2014. I also want to thank the lecturer for their ideas as project enhancement and suggestions in the compilation and preparation this final year project report.

Deepest thanks and appreciation to my parents, family and friends for their cooperation and contributed by supporting my work, constructive suggestion and full support for the report completion, from the beginning till the end.

Last but not least, my thanks to Faculty of Electronic Engineering and Computer staffs for the great Inotek competition and my PA, Dr Soo Yew Guan

Abstract

This project used Viola-Jones algorithm as face detection of person face showing high-success rate and enable to operate together with face recognition as real-time detection. There are some limitation to consider as well as the environment, the size of image and the pose of the person itself. Face recognition concept s is one of the successful and become substantial applications of image analysis and computer vision. Eigenface approach is one of the earliest methods for face recognition, which was developed by M.Turk and A.pentland in 1991[1].It has built based on computerized face-matching process and can be applied for a wide variety of problems such as Biometrics, Information Society, Criminal Identification, Smart Cards, Access Control, etc. The system is to implement a model for a particular face and distinguish it from a large number of stored faces with some real-time variations as well. An algorithm called Principle Component Analysis (PCA) is used for Eigenfaces as a method for face recognition. The process for face recognition involves the given image which formed to the eigenfaces, and the Euclidean distances between the eigenfaces, then, the previously stored eigenfaces are calculated. The smallest Euclidean distance of the eigenfaces resulting the one the person resemble the most. The simulation has done by generating a matlab code using image acquisition tool box. The success rate for the large database has reach up to 94.74%.

Abstrak

Menggunakan algoritma Viola-Jones sebagai pengesan wajah seseorang telah menunjukkan prestasi yang baik dan berkesan serta berupaya dalam beroperasi dalam satu aplikasi yang sama dengan fungsi pengecam wajah. Gabungan ini telah menghasilkan sebuah aplikasi pengesan wajah secara masa nyata. Namun begitu, terdapat juga beberapa halangan atau had seperti latar belakang gambar, saiz gambar dan gaya seseorang dalam gambar tersebut. Konsep pengecam wajah telah berjaya digunakan dalam bidang analisa imej dan penglihatan menerusi komputer dimana aplikasi ini digunakan secara meluas dalam sektor biometrik, siasatan jenayah, kad pintar, kawalan masukan dan lain-lain.sistem ini juga berupaya menganalisa lebih dari satu wajah dalam satu masa. Eigenface ialah salah satu teknik terawal yang digunakan dalam sistem pengecam wajah dimana telah direkacipta oleh M.Turk dan A.Pentland pada tahun 1991 [1].Seterusnya ialah algoritma Principle Component Analysis (PCA) yang menggunakan teknik Eigenfaces dalam proses mengecam wajah. Satu imej akan dimasukkan sebagai imej masukan seterusnya dengan menggunakan algoritma tersebut, Euclidean Distance dikenalpasti. Semakin kecil jarak tersebut, maka wajah masukan itu semakin hampir atau sama dengan wajah-wajah yang terdapat dalam pangkalan data. Perisian yang digunakan ialah Matlab 2013 bagi menjalankan aktiviti pengkodan dan alat yang digunakan ialah Webcam untuk menangkap gamabr pengguna. Hasil dari analisis mendapati kadar keberkesanan mencapai 94.74 % bergantung kepada jumlah imej wajah yang dianalisa.

CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Introduction

Human‟s brain is very good in memories and recognizing faces and complex patterns. Even there is obstacle around doesn‟t affect the capability and therefore it would help if computer become intelligent as humans in face recognition. A face recognition system is an application which automatically identifying and verifying a person from images that capture either by digital camera or by webcam. Face recognition and face detection also a first step in Human Computer Interaction (HCI) systems [31].

Computational models of face recognition in particular are interesting because they can contribute to practical applications as well instead of theoretical insights. Computer that recognizes faces is a high level visual problem which has numerous practical applications such as criminal identification, biometrics, security monitoring, image and film processing, pattern recognition and human-computer interaction.

Those are the fundamental behavior that is essential for effective communications and interactions among people. Large number of stored face images would be able to be distinguished and recognized thus improves the efficiency of

criminal identification. The recognition will be performed only with "one layer" images contained black and white color but in the same outcome.

An approach named Eigenfaces uses Principle Component Analysis (PCA) algorithm for the recognition of the images. It considers only subspace of image with lower dimensionality to represent faces. The recognition is performing into static images. The system can also be modified by using dynamic images. In this case the images first need to be converted into static one and then continue with the same procedure as static image.

1.2 Objectives

i. To apply real-time image capturing.
ii. To detect human faces in digital images.
iii. To determine the threshold for Euclidean distance classification.
iv. To give output whether face is known or unknown person.
v. To implement the operation in Graphical User Interface.

1.3 Problem Statement

The existing systems are using recognition by considering WHOLE FACE FEATURES with HIGH DIMENSIONALITY. It may increase the number of error rate and lot of computation work. The process requires extended time to make comparison for entire training images with image input. The extracted image which contained noise is affected to recognition result.

1.4 Scope of Project

i. Hardware

- Web Camera for live image capturing

ii. Software

- MATLAB 2013
  - used for coding and simulation, testing and analysis of results

  - Face Detection: Taking benefit from Image Processing Toolbox as it built in with Viola-Jones algorithm.

  - Face Recognition: Applying Digital Image Processing which provides technology for feature extraction and Principle Component Analysis algorithm.

iii. Database

- ORL Database: Getting from internet.
- Personal Collection: Selecting classmates as the samples.

1.5 Brief Explanation for Methodology

The research can be divided into two (2) categories:

i. Face detection

- Applying Viola Jones algorithm for face detection.
- To capture image via web camera and save as dataset.
- To detect the face of the static image.
- Save only the „face in box" and remove unnecessary part of the image.
- Set the saved image with grayscale format.

ii. Face Recognition

- Applying Principle Component Analysis(PCA) algorithm
- Do testing between training image and test image.
- Analyze the performance of the system in term of accuracy rate, false positive and false negative of recognition.
- Matlab will be used for coding and simulation, testing and analysis of results
- Face databases will be used – ORL database which available for public used from internet and also personal collection
- Serves the crime deterrent purpose due to recorded image is provided.
- Visual perception of familiar faces.

1.6 Project Significance

i. This project is essential for computational models applications such as:

Table 1-1 Typical application over their research area

Typical Application	**Research Area**
Immigration Management	Public Security
Monitoring sensitive characters (spies, terrorists, etc.)	
Automated Login System	Human Computer Interaction (HCI)
Realistic Virtual Games	
E-commerce authentication	Financial Security

ii. Goals:

- Fast and effective system
- Reasonable simple
- Accurate in constrained environment

1.7 Thesis Organization

This thesis comprises five (5) chapters: Introduction, literature review, project methodology, result and discussion and conclusion and future work. The introduction of the project has been given in this chapter where it specifically explains the background of the project for further understanding of the thesis. Chapter 2, the literature reviews, reviews the theory on algorithm for face detection and recognition, percentage of accuracy detection and recognition among the algorithms and existing work, also several other topics related to the project. Chapter 3 discusses the methodology of the overall project which is divided into two categories; detection design and recognition activity flow. In chapter 4, the explanations for the outputs on both categories include the performance of recognition rate over number of eigenfaces. Finally, the thesis ends with Chapter 5 which concludes the overall project followed by a number of recommendations for future work and research.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter categorize into two (2) sections: face detection and face recognition. It provides an overview of literature as well as the basic concept of how face recognition is been done by using various methods. The chapter begins with existing face recognition system that been commercial by airports. Then, there are also explanation for some method that can be compared their performance, characteristics with eigenfaces method. As summarization, it shows that the capability of eigenfaces method to produce greatest success rate of recognition.

2.2 Existing Face Detection Methods

There were a few face detection have been used such as the Schneiderman and kanade Statistical Detection Approach and the Neural Network-based Face Detection. Among these methods, the Viola-Jones only the methods that gives high efficiency rate in detecting faces and has proven fast enough for real-time detections.

Schneiderman and kanade presenting the faces which determined from the histogram of image subsections. This method able to detect multiple faces at one time. However, the processing is slow and hard to implement in real-time applications.

The Neural Network based detector focus on image training. For every pixel of the image need to train first and learn which part are a face and not a face. So it consume low speed and not high enough for real-time applications.

By using viola-Jones detector, it has advantage to determine what can be a face and best method for real-time applications. Detail explanation chapter 2 and the implementation are explained in chapter 3.

Figure 2-1 The security camera with face detection into the lens [30]

2.3 Existing Face Recognition Methods

Face recognition [4] is one of biometrics system build for computational application which automatically identifying and recognizing person‟s face directly from static images or converted digital images.

Figure 2-2 Surveillance cameras with human detection[4]

The algorithms will identify facial features by extracting landmarks or features from an image of the subject‟s face. The features include its position, size, shape of the eyes, nose, cheekbones and jaw. Once they are recognize, then it will start searching with other images for the same features through their similarity. There are also gallery for images which also known as “training images database”. It is the place where all the face images have been save and compress. The face recognition is only valid for the data that place inside the gallery. A probe images then will be compared to face data. There is earliest system which successful in building a system based on matching / comparison techniques.

The algorithms for recognition can be divided into two (2) main approaches; geometric which determined by observe at distinguishing features among faces. It is also yields with statistical approach called photometric. An image is distils into values and compare them with templates to eliminate variances. One of the algorithms is Principle Component Analysis (PCAs) by using Eigenfaces.

Eigenfaces [3] technique is capable in reducing error rate from 25.5% to 20.4%, based on experienced record that can be achieved using surface shape alone, despite variations in head orientation and expression. This technique is considering whole face features that classified into **two-dimensional recognition**. There are a few more techniques including direct correlation and Fisherface. All three methods discussed in this chapter are considered to be „appearance-based‟, in that all image pixel data is used as whole to perform recognition, rather than detecting and analyzing relationship between facial features.

The direct correlation is differ compare to eigenface and Fisherface methods based on its simplicity in direct comparison between two images thus producing similarity score. The direct correlation investigation may allowed in providing an initial baseline comparison by which portion it will contribute in selection of any improvement of the image pre-processing techniques towards the three methods. A standard image for two-dimensional face recognition is captured either by using camera, web-cam or scanned photograph and it can be either in color image or gray scale.

The existing system that been used for years; for example: biometric system of facial recognition system in airports that been developed by Human Recognition Systems (HRS) as a world leader in the deployment of premium biometric identification solutions and has been used for over 10 years. It is implementing to verify, monitor, report and alert on staff and passenger movements for entire airport environment. This system provides benefit in increasing security and operational efficiency improvement [5].

Figure 2-3 Facial recognition system used at airport [5]

2.4 Related Theoretical Review

This section provides study and research regarding the most recent techniques used and the description and limitations of face detection and recognition. It is also reviewing on existing techniques used to detect faces from a single intensity or also known as gray scale image.

2.4.1 Viola-Jones Algorithm for Object Detection.

[19]Face detection is a computerized system that identifies or determines the location and size of human faces in digital images. In contrast, comparison between Viola-Jones algorithm and Schneiderman and kanade is their [29] speed of frontal face detection.

Table 2-1 Comparison between methods of face detection in term of their speed

Method of face detection	Speed of frontal face detection
Schneiderman and kanade	5 seconds of detection
Viola-Jones	15 frames per second of detection