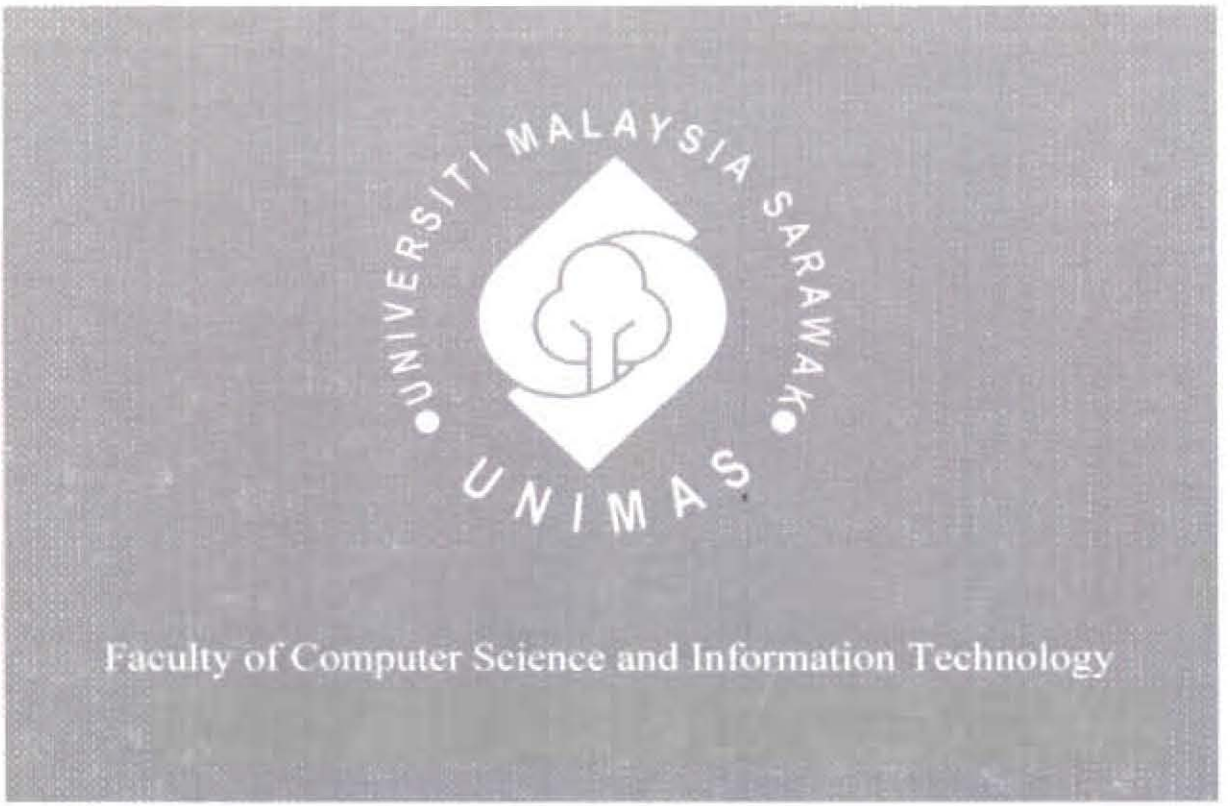

MODULAR APPROACH ON 3D FACE RECOGNITION

Lai Chung Sing

Bachelor of Computer Science with Honours
(Computational Science)
2014

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LAI CHUNG SING

This project is submitted in partial fulfillment of the requirements for the degree of
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PENDEKATAN MODULAR PADA PENGECAMAN MUKA 3D

LAI CHUNG SING

Projek ini merupakan salah satu keperluan untuk
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Dr. Hamimah binti Ujir
Senior Lecturer
Faculty of Computer Science and Information Technology
Universiti Malaysia Sarawak

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LIST OF ABBREVIATIONS

2D	: Two-dimensional Space
3D	: Three-dimensional Space
EBGM	: Elastic Bunch Graph Matching
GUI	: Graphical User Interface
HCI	: Human Computer Interaction
KFDA	: Kernel Fisher Discriminant Analysis
KPCA	: Kernel Principal Component Analysis
LDA	: Linear Discriminant Analysis
MVS	: Majority Voting Scheme
PCA	: Principal Component Analysis
SIFT	: Scale-Invariant Feature Transform
SVM	: Support Vector Machine

ABSTRACT

Face recognition relates to identifying or verifying individuals by their faces. With rapidly developing face recognition technology in various applications such as biometric personal recognition, human-to-machine interaction and access control, face recognition has become one of the most interesting and important research fields in recent years. There are many face recognition approaches suggested by researchers in the past few decades. Most of these approaches can be classified into four main categories, which include holistic-based methods, feature-based methods, template-based methods and part-based methods. The existing methods are mainly used to overcome difference factors such as illumination, expression, scale and pose in order to achieve better recognition rate. Nevertheless, there is still no robust technique against uncontrolled practical cases which may involve kinds of factors simultaneously. In our work, we study the general ideas and structures of recognition, important issues and factors of human faces, existing critical techniques and algorithms. Eventually, we propose a novel modular approach based methodology for human face recognition. In this technique, face model is first decomposed into several sub modules before features are extracted. This proposed method compiles two functions, namely Support Vector Machine (SVM) as classifier and Majority Voting Scheme (MVS) as voter to infer final trained result.

ABSTRAK

Pengecaman muka membawa maksud samaada mengenali atau mengesahkan individu berdasarkan wajah terpampang. Selaras dengan pembangunan teknologi pengecaman muka yang pesat dalam pelbagai aplikasi seperti pengecaman secara peribadi biometric, interaksi antara manusia dengan mesin dan kawalan akses, pengecaman muka telah wujud sebagai salah satu bidang penyelidikan yang sangat menarik mahupun penting kebelakangan ini. Terdapat banyak pendekatan bagi pengecaman muka telah dikemukakan oleh para penyelidik beberapa dekad yang lalu. Pendekatan-pendekatan tersebut boleh diklasifikasikan kepada empat kategori utama, termasuk kaedah berasaskan holistik, kaedah berasaskan ciri-ciri, kaedah berasaskan template dan kaedah berasaskan sebahagian. Kaedah-kaedah yang sedia ada ini kebanyakannya digunakan untuk mengatasi kekangan yang bervariasi seperti pencahayaan, ekspresi wajah, skala mahupun gaya demi mencapai kadar pengecaman yang lebih baik. Walau bagaimanapun, teknik mantap yang mampu mengharungi kes praktikal yang tidak terkawal dan pada masa yang sama, melibatkan pelbagai kekangan dalam pengecaman muka masih belum diterokai. Dalam kerja kami, kami telah membuat kajian tentang idea dan struktur berkaitan pengecaman, faktor-faktor penting yang perlu diambil kira dalam pengecaman muka manusia, teknik kritikal mahupun algoritma yang wujud. Lantaran itu, kami mencadangkan satu kaedah baru yang dinamakan sebagai pendekatan modular dalam pengecaman wajah manusia. Kaedah yang dicadangkan ini menggabungkan dua fungsi, iaitu mesin vector sokongan sebagai alat pengkelasan dan skim undian majority sebagai alat undian bagi menyimpulkan keputusan yang terlatih.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Face recognition is a biometric method which is non-intrusive and can be used even without the subject's knowledge (Bronstein et al., 2003). As one of the most important biometric techniques, face recognition has clear advantages of being natural and passive over other biometric techniques which requiring cooperative subjects such as fingerprint recognition and iris recognition (Zhang & Gao, 2009). According to Bonsor and Johnson (2001), humans have the innate ability to recognize and distinguish between faces, yet computers only recently shown the same ability. Over the past few decades, scientists began to work on using the computer to recognize human faces and since then, facial recognition software has become a continuous work (Bonsor & Johnson, 2001). Different types of facial recognition systems have developed along the years whereby most of them are computer application for automatically identifying or verifying a person from a digital image or video frame. Face recognition has become a popular area of research in computer vision as well as one of the most successful applications of image analysis and understanding (Grgic & Delac, 2007). Due to its applicability for surveillance and security purpose, it is largely applied in many applications such as personal identification, employee access to high security areas, human-machine interfaces and image retrieval (Tin & Sein, 2009).

1.2 Backgrouud

In recent year, reliable face recognition technology has become more prevalent in society finding applications ranging from security surveillance such as airport security, military applications and finding specific targets to automated online tagging of faces in social media such as Facebook, Flickr, Google+ and Twitter (Wu, 2011). Despite the availability of the commercial systems, face recognition technology continues to be an active topic in computer vision research. Most of the current face recognition systems perform well under nearly ideal circumstances, but tend to suffer when variations in expression, illumination, decoration and pose are presented (Price & Gee, 2005). As stated by Mehta, Yuan and Egiazarian (2014), the task of face recognition and identification is simple and natural for human beings, but for an automated system it is quite a challenging task. Hence, current available face recognition research aims to improve recognition performance in the presence of such confounding factors. In general, face recognition methods can be classified broadly into two categories, which is feature-based methods and template-based methods, as described by Brunelli and Poggio (1993).

1.3 Problem Statement

Face recognition presents a challenging problem in the field of image analysis and computer vision, and as such has received a great deal of attention over the last few years due to its many applications in various domains (Jafri & Arabnia, 2009). It is a difficult problem because of the generally similar shape of faces combined with the numerous variations between images of the same face. Gottumukkal and Asari (2003) claimed that the image of a face changes with facial expression, age, gender, viewpoint, illumination conditions, noise

and thus, creating a challenging task in face recognition. Over the past few decades, many different approaches have been developed for face representation. According to Mehta et al. (2014), a class of methods, called holistic approach considers a face image as a whole and extracts the global features from it. The most popular of the holistic techniques are Eigenface (Turk & Pentland, 1991) and Fisherface (Belhumeur, Hespanha, & Kriegman, 1997) which are based on Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) respectively. First method projects an image into a subspace where the individual components are ranked according to their variances. The face image is reconstructed by a linear combination of these components that satisfy the least mean square criterion (Mehta et al., 2014). However, one of the significant drawbacks of this method is that it is highly sensitive to illumination and pose changes. Whereas for the second method which proposed by Belhumeur et al. (1997), it maximizes the ratio of between-class-variance and within-class-variance. Nevertheless, the efficiency of Fisherface based recognition will reduce significantly as the number of training samples are decreased (Martinez & Kak, 2001). As suggested by Zhao et al. (2003), even though face recognition technology has transited from linear subspace methods such as Eigenface and Fisherface to nonlinear methods such as Kernel Principal Component Analysis (KPCA) and Kernel Fisher Discriminant Analysis (KFDA), many of the problems on these non-modular approaches are yet to be addressed. In the process of overcoming the problem faced in most of the face recognition techniques, a novel efficient method named as modular approach is proposed in our work for the recognition of human faces.

1.4 Objectives

a. To develop a prototype of modular 3D face recognition system which is able to perform matching process between tested subject and trained subject.

b. To analyze the success rates of face recognition for three different modules size.

c. To utilize Support Vector Machine (SVM) approach as the classifier and Majority Voting Scheme (MVS) approach to infer final result.

1.5 Scope and Limitation

a. The system focuses on three different selection of modules size proposed which used to extract the facial features.

b. The system will use the provided 3D landmark points for testing and training purpose.

1.6 Methodology

In the end of this project, rate of recognition should be obtained through analysis on the results shown in developed modular 3D face recognition system. Therefore, an appropriate research methodology should be applied. This project subdivides research methodology into several phases.

1.6.1 Define the problem

In this phase, the main objective is to identify factors and approaches used in face recognition which affect the rate of recognition. A study is conducted to identify the factors and approaches used. The problem and constraints are listed out to make sure that the suggested method is able to cope with large scale of problem subsequently.

1.6.2 Review on Existing Work

Existing work carried out by other researchers is reviewed as it can be used as comprehensive guide for synthesize existing knowledge. By exploring and analyzing former proposed face recognition work, new algorithms can be generated. Strength and weakness in each of the existing approaches is being compared and analyzed.

1.6.3 Design Algorithm

At this phase, new algorithms are designed in such a way that they are related to each other. Support Vector Machine (SVM) algorithm and Majority Voting Scheme (MVS) algorithm are designed and implemented to perform face recognition. The relationship between these two functions is indispensable overall.

1.6.4 Develop Prototype

In this phase, the method selected to perform face recognition is named as Modular Approach. The prototype of 3D modular face recognition system is designed in such a way that it is implemented with Support Vector Machine (SVM) algorithm and Majority Voting Scheme (MVS) algorithm to perform face recognition. The overall architecture of proposed algorithm is defined in the prototype. A stable and reliable back-end algorithm is needed to ensure that the data is passed to front-end interface effectively. Apart from that, Graphical User Interface (GUI) existed in Matlab is applied to develop user friendly interface for displaying the output.

1.6.5 Compntational Analysis

After the prototype is developed, several sets of data are provided for analysis towards the result. The performance of the system is tested by using different modules size of data.

1.6.6 Report Writing

The analyzed results are documented in a report.,Different sizes of modules are used to test the feasibility and limitation of the analysis. The report is used as reference and further improvement for the prototype. User manual is prepared to ensure that the system can performs as expected.

1.7 Significance of Project

Measurement of the intrinsic characteristics of the human face through face recognition is a socially acceptable biometric method which can be implemented in a non-intrusive way (Mian & Pears, n.d.). One of the most significant reasons for choosing face recognition system is that it does not need any physical interaction from the user (Al-Ghamdi & Allaam, 2010). According to Lin (2000), biometric access control is automated methods of verifying or recognizmg the identity of a living person based on some physiological characteristics like facial features. Since biometric systems identify a person by biological characteristics, they are difficult to forge. Kelly (1970) proposed that face recognition has drawn the attention of researchers in fields including security, psychology, image processing and computer vision. Face recognition system may be used for authentication or verification purposes on entry and exit to secured high-risk spaces such as military bases, border crossings, nuclear power plants and restricted resources which include personal devices, computers,

network, banking transactions, trading terminals, and medical records (Intona & Nissenbaum, n.d.). For instance, in control settings such as an airplane-boarding gate, face recognition system may be used in place of random checks merely to screen passengers for further investigation.

Additionally, some companies and corporations have developed face recognition system used to identify faces in controlling the presence and departure of their workers (Al-Ghamdi & Allaam, 2010). Furthermore, face recognition technology can be connected to video surveillance systems (CCTV) which function as monitoring outdoor public spaces like town centers. The system would alert authorities to the presence of known or suspected criminals or even terrorists whose images are already enrolled in a system's gallery, or could also be used for tracking down lost children as well as other missing persons (Intona & Nissenbaum, n.d.). Besides that, face recognition has also proven useful in other multimedia information processing areas. Chan et al. (1998) utilized face recognition techniques to browse video database to find out shots of particular people. Whereas, Li et al. (1993) codes the face images with a compact parameterized facial model for low-bandwidth communication applications such as videophone and teleconferencing. Apart from that, it is possible to construct a smartcard system in which facial image data is embedded directly in ID cards such as drivers' licenses, passports, etc. (Introna & Nissenbaum, n.d.). Application of face recognition system in Automated Teller Machine (ATM) to withdraw money in banks is feasible too, where the programs verify the client before he/she ejects the money (Al-Ghamdi & Allaam, 2010). Introna and Nissenbaum (n.d.) also mention about face recognition technology can be found in entertainment contexts as well. For instance, face recognition technology also used to facilitate human-robot, human computer interaction (HCI) or virtual-reality training programs.

1.8 Project Schedule

The project schedule for developing this project is shown in Grantt Chart *(as attached in Appendix A)*.

1.9 Expected Outcome

a. A system that can perform classification of different trained subject based on different modules size selected.
b. A system that is able to identify the trained subject and matching result with the tested subject will be displayed.

1.10 Project Outline

Chapter 1 Introduction

This chapter delineates the background, problem statement, objective, scope and limitation, methodology, significance of project, project schedule, expected outcome and outline of the project.

Chapter 2 Literature Review

This chapter contains discussion focusing on overview of research sources used in similar projects. Comparisons of the reviewed approaches are listed out to perform analysis. Algorithms and methods that decided to use are proposed in the end of the chapter.

Chapter 3 Methodology

This chapter will report on the basic concept of the method used in our work. Analysis that has been conducted is used to generate useful information and data necessary for design phase is discussed. The preliminary concept of the approach selected will be deliberated.

Chapter 4 Implementation, Testing and Analysis of Result

This chapter presents the details of implementation of the project which consists of classifier and voting functions based on the design created. Testing and analysis of result based on different modules size in face recognition is discussed.

Chapter 5 Limitation and Future Work

This chapter concludes the work that has been done in this project. Limitation and suggestion for future work of the project are discussed with the aim of improving the current accuracy and enhancing the functions of the system for future purpose.