ACKNOWLEDGEMENTS

It is a pleasure to thank the many people who made this thesis possible.

First of all, I would like to express my sincere thanks to my master supervisor, Dr. Muhammad Imran Ahmad, without his support this thesis would not have been started and, especially, would not have gone to an end. My utmost gratitude goes to him for his expertise, kindness, guidance, his capacity of insight, and most of all, for his patience.

I would also like to thank my colleague lecturer and staff, Dr. Phaklen Ehkan the Programme Chairman (postgraduate studies and research), and Professor Dr. R. Badlishah Ahmad, the Dean School of Computer and Communication Engineering (SCCE).

I am very grateful to Assc. Prof. Dr. Nor Ashidi bin Mat Isa for who worked with me for my last master period. His criticism and technical discussion helped me to improve my skills and expertise.

I would like to acknowledge the help of my colleagues and friends, including Iskandar, Haris, Megat, and Thulfiqar, who made for me the period to be more pleasant. I would also want to thank all SCCE lab staff for providing me the support every time I needed.

Lastly, and most importantly, I wish to thank to my family especially my wife Aimi Ajlaa who stood beside me every day and encouraged me constantly throughout this endeavor, my thanks to my daughter for giving me happiness and joy.

SISTEM PENGECAMAN MUKA MENGGUNAKAN CIRI-CIRI DCT DIBANGUNKAN MENGGUNAKAN PROSESSOR DSP

ABSTRAK

Sistem pengecaman wajah merupakan satu cabaran kerana muka sentiasa berubah disebabkan oleh ekspresi, arahan, cahaya, dan skala.Tambahan pula ia memerlukan teknik pengkomputeran yang baik untuk mengurangkan kerumitan. Pendekatan kami telah memberi tumpuan kepada pengekstrakan ciri tempatan. DCT telah dicadangkan sebagai algoritma pengekstrakan ciri untuk pengiktirafan muka, yang menguasai ciri-ciri penting dalam imej muka dan pada masa yang sama untuk mengurangkan ruang ciri tersebut. PCA digunakan untuk melaksanakan pengurangan ciri imej diekstrak dan menghasilkan unjuran imej kecil. kombinasi kedua-dua kaedah boleh mengurangkan dimensi ruang ciri muka. Proses pengelasan dilakukan dengan menggunakan Euclidean distance (UE) antara imej ujian unjuran dan imej unjuran latihan api. Algoritma ini diuji menggunakan prosessor DSP dan mencapai tahap sama seperti berasaskan PC. Eksperimen yang menyeluruh telah dilakukan ke atas pangkalan data muka piawaian menggunakan ORL menunjukkan prestasi yang ketara dicapai dengan kaedah ini, iaitu 98.5% untuk imej ujian terbaik dipilih dan 95% untuk imej ujian yang paling teruk dipilih. Selain itu, masa pelaksanaan yang juga diukur, di mana untuk mengiktiraf 40 orang, sistem tersebut hanya diperlukan 0.3313 saat. Kaedah yang dicadangkan bukan sahaja menawarkan sumber kurang pengiraan, tetapi juga cepat, dan tahap yang tinggi ketepatan pengiktirafan**.**

FACE RECOGNITION SYSTEM USING DCT FEATURES IMPLEMENTED ON DSP PROCESSOR

ABSTRACT

Face recognition is a challenge because the faces always change due to facial expression, direction, light, and scale. Furthermore, it needs good computing techniques for recognition in order to reduce the system's complexity. Our approach focuses on the local feature extraction in the frequency domain. DCT was proposed as the feature extraction algorithm for face recognition, which captures the important features in the face image and at the same time reduces the feature space. PCA then performs the feature reduction of the extracted image and produces a small size of feature vector. The propose method can reduce data dimension in feature space. The classification is done by using the Euclidean distance between the projection test and projection train images. The algorithm is tested using DSP processor and achieve a same performance with PC based. The extensive experimentations that have been carried out upon standard face databases such as ORL shows that significant performance is achieved by this method, which is 98.5% for best selected test image and 95% for the worst selected test image. Besides that, execution time is also measured, whereby to recognize 40 people, the system only requires 0.3313 second. The proposed method not only offers computational savings, but is also fast and has a high degree of recognition accuracy.

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LIST OF ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
AAM	Active Appearance Models
ASM	Active Shape Models
d	Distance
DCT	Discrete Cosine Transform
EU	Euclidean distance
FLD	Fisher linear discriminant
ICA	Independent Component Analysis
ILDA	Incremental Linear Discriminant Analysis
KPCA	Kernel Principle Component Analysis
KFA	Kernel Fisher Analysis
KL	Karhunen-Loeve transform
LDA	Linear Discriminant analysis
LFA	Linear Fisher Analysis
ORL	Olivetti Research Laboratory
PCA	Principle Component Analysis
RAM	Random Access Memory
RGB	Red, Green, Blue
ROM	Read Only Memory
Sb	Between class scatter matrix
SVM	Support Vector Machine
Sw	With-in class scatter matrix
Tr	Train Image
Ts	Test Image

CHAPTER 1

INTRODUCTION

1.1 Introduction

Recognition system nowadays plays an important role for future interactions between humans and machines. Machines are able to finish jobs faster, in a more accurate and secure manner. In the future, the best security machines are those that are capable of recognizing humans automatically. Reliable methods of biometric personal identification already exists, for example, an iris or a fingerprint scanner, but these methods naturally rely on the cooperation of the participants, whereas a personal identification system based on an analysis of a person's facial features is often effective without the participant's cooperation or intervention.

Face recognition system was started more than 50 years ago, which basically proposed an application to identify or verify a person, but until now it is not yet finished because of continuous improvements in both technology and technique (Ziad M. Hafed, 2001). In the last few decades, various face recognition approaches have been proposed and considerable progress has been made. However, it is still difficult for a computer to recognize human faces accurately under uncontrolled situations. Illumination, pose, facial expression and other factors constitute the main challenges faced for a computer to recognize human faces.

The unique facial characteristic of human beings allows people to recognize one another faster than recognizing a person's thumbprint. This makes facial recognition systems more important and makes it one of the most popular forms of human surveillance. In the field of biometrics, facial recognition algorithms and techniques is one of the fastest growing fields. In the last 10 to 15 years, several studies have been centered in this particular field of biometrics (R.Gross et al., 2001).

Face recognition can be classified into holistic approach and local feature approach (M. Zhou and H. Wei, 2006). C. Villegas-Quezada et al., (2008) used the holistic approach for face recognition which extracts the whole face image into a face space. Meanwhile, the local feature approach rely on the detection and characterization of face features and their geometric relationships in order to perform face recognition, which makes these methods robust to differences in illumination and position (M. Zhou and H. Wei, 2006).

Apart from those two approaches, face recognition can also be performed by a fusion of holistic and local feature approaches, which combine global with local variations of the images (C. BenAbdelkader & P. Griffin., 2005).

1.2 Problem Statement and Motivation

Face recognition system can be used to recognize human faces and there are many methods that can be applied to make the recognition more robust while improving recognition accuracy. Additionally, computational resources need to be conserved due to the increasing complexity of modern facial recognition systems.

The challenge is now to develop a face recognition system with high accuracy, less complex, and minimal computational resources. Most of the face recognition algorithm utilizes holistic features to represent face image. Holistic features are captured from the whole face image. This method has several limitations especially when the images have illumination and pose variations. Local features are believed to be an effective way to extract the important features in the face image. Local features based on a Discrete Cosine Transform (DCT) are compute in several image regions. This method separates the image into several regions that has different discrimination power. By selecting only small amount of features that produce the best performance, we are able to reduce processing time and minimize memory usage.

The local features extraction approach is the process of taking out important information from certain or local face area, which makes these approaches robust to differences in illumination and position (M. Zhou & H. Wei, 2006).

Principle Component Analysis (PCA) is an efficient way to produce low dimensional feature space. This process performs further reduction of dimensionality of the feature space extracted by Discrete Cosine Transform (DCT). Principal Components are linear combinations of optimally weighted observed variables and is less complicated compared to Linear Discriminant Analysis (LDA) and Independent Component Analysis (ICA). The classification process is done by performing the Euclidean distance classifier when the Gaussian distribution is assumed in the feature space. This assumption will reduce the complexity of the classifier algorithm and produce better processing speed.

1.3 Aim and Objective

The aim of this thesis is to develop a face recognition system by using local features extracted in face local regions. The objectives of this thesis are:

1) To study local feature extraction using low frequency information extracted in local region of face image to produce high discrimination feature vector.

2) To develop linear projection method using principle components analysis to reduce noise and redundant information exist in local features.

3) To validate the performance of the propose method using benchmark dataset tested using offline and real time DSP Processor.

1.4 Research Scope

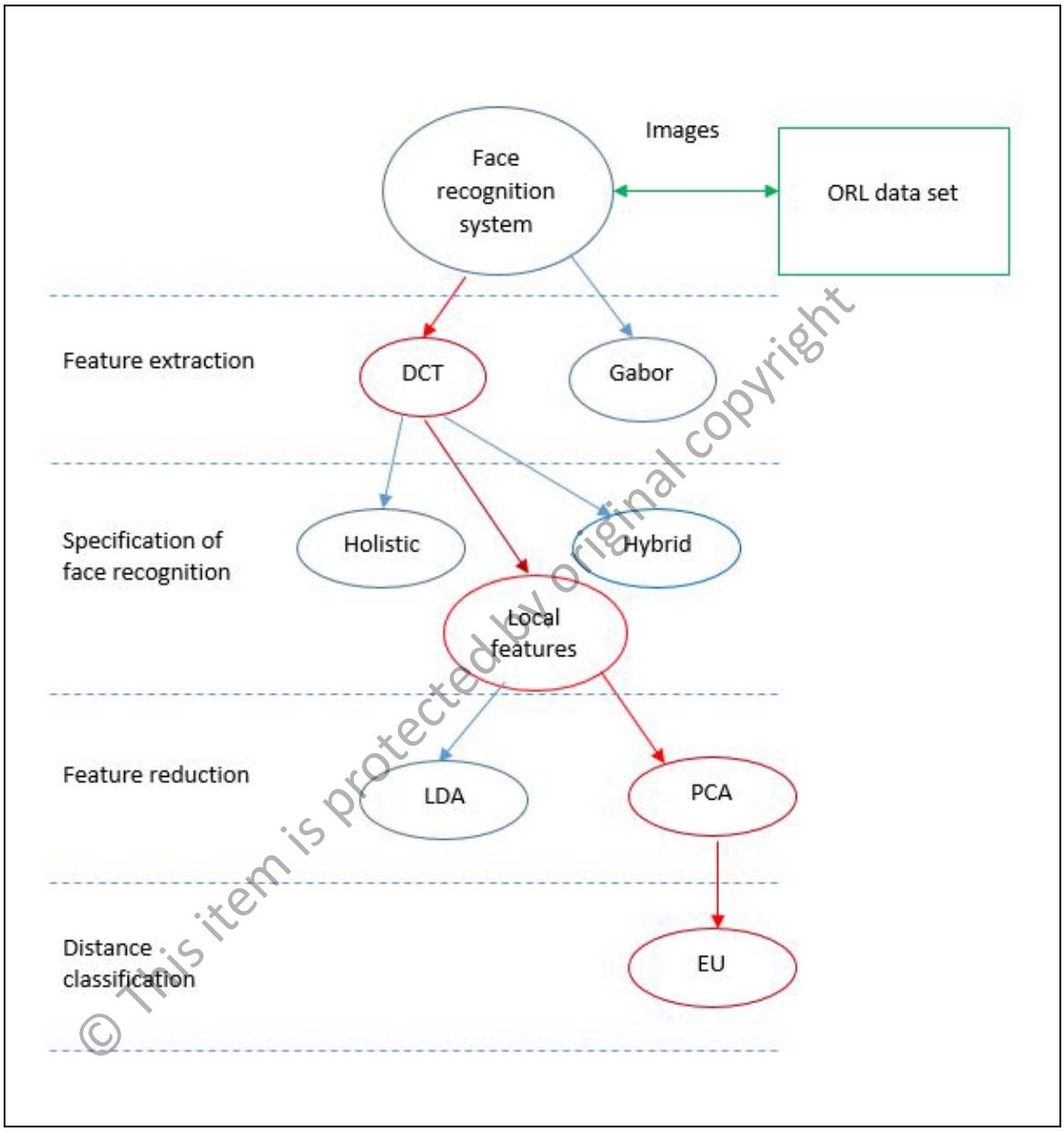

Figure 1.1: Categorization Approach To Develop Face Recognition System

In this thesis, the system is tested using the benchmark ORL dataset which contains 40 people with 10 images each. The images were taken at different times, in various lighting, different poses, multiple facial expressions such as open or closed eyes, smiling, and with additional facial details such as glasses or no glasses.

The face recognition system is divided into four stages. Face recognition systems has many methods that are used to extract image, such as DCT and Gabor. DCT is selected to perform the extraction process. The DCT extraction process is important because it can solve some of the face recognition problems by selecting high-information components from the face image. The results from the DCT extraction are robust to scaling variations and also robust to illumination. DCT can also reduce the future face space by ignoring unwanted information.

In specifying face recognition, the local feature approach is selected for extraction because it is the fastest extraction process compared to holistic approach and hybrid approach. In addition, the local feature approach is more robust to different poses of the face image.

Low features of face space are important for face recognition system, as it can reduce computational cost. This also helps in achieving the conditions for PCA linear projection which is applied to reduce face space dimension.

Finally, a Euclidean distance classifier is used to calculate distance between two vectors in feature space. The distance value between the two images will measure the similarities of both images. The lowest value indicates the similar image.

1.5 Outlines

This thesis is organized into five chapters with the content of each chapter as follows:

Chapter 2: Literature review. In this chapter, the previous works done on face recognition systems are reviewed. Face recognition challenges, feature extraction, local features approach, feature reduction method, Euclidean distance and face database are discussed.

Chapter 3: Methodology. Local feature, DCT extraction, PCA, and Euclidean distance are introduced.

Chapter 4: Result. This chapter includes the database described and all experiment conducted.

Chapter 5: Conclusion and the recommendation for future work. Appendices section shows the coding of methods are applied for off-line and real-time measurement.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Facial recognition has always been a very difficult and challenging task due to the variations and nonlinear information that exists in a face image. The challenge lies in designing an automated system which equals the human ability to recognize faces. However there exists a limitation of the human ability when dealing with multiple faces at the same time. Hence, the intelligent computerized system with almost limitless memory and high speed is necessary.

Patel, R., Rathod, N., & Shah, A. (2012) stated that among the first researchers in this area is Woodrow W. Bledsoe who proposed a computer based face recognition in the 1960's. Bledsoe et. al. (1960) worked on recognizing faces using an algorithm implemented on a computer (De Carrera P. F., 2010). He highlighted most of the problems which are still faced by researchers such as variations in illumination, pose, expressions and ageing. Goldstein et. al. (1971) used the concept of local features method measuring features such as ear protrusion, nose length, between-eye distance, etc. to recognize faces using pattern recognition techniques at the Bell Laboratories. However manual computation for measurements was the limitation with in this method. Fischler and Elschanger used local feature matching and holistic feature of fit to measure similar face features automatically (M. Fischler & R. Elschlager, 1973).

In the same year, Kenade formulated a fully automated face recognition system. He used an algorithm which extracted sixteen facial features automatically and achieved a performance rate of 45-75% (T. Kenade, 1973). Mark Nixon introduced geometric measurement for spacing between the eyes (M. Nixon, 1985). He also worked on automatic gait recognition and was the first to consider ageing in biometrics. Some researchers proposed algorithms which used artificial neural networks. Afterwards, the technique which proved to be a milestone in facial recognition using eigenfaces was brought in by L. Sirovich and M. Kirby (L. Sirovich and M. Kirby, 1990). Their methods were based on Principal Component Analysis (PCA) and showed that PCA is a dimensional reduction system that minimizes the mean squared error between the original images and the image can be reconstructed for any given level of compression. The goal of this technique was to reduce the dimensionality of the data while retaining as much as possible of the variation present in the dataset. But its performance degraded when it encountered higher changes in illumination and pose.

Eigenface approach used the Karhonen-Loeve (KL) transform for feature extraction. Kirby and Sirovich used PCA to represent faces which was then extended by Turk and Pentland to recognize faces (M. Turk & A. Pentland, 1991). In PCA, the data is dealt in its totality without paying attention to its underlying structure whereas in Linear Discriminant Analysis (LDA) or Fisherface, the differences between-classes as well as within-classes are considered. By using these scatter matrices, a set of projection vectors is formed to minimize within-class scatter and to maximize between-class scatter (P. N. Belhumeur et al., 1997).

The LDA technique required computation to a greater extent and so Incremental Linear Discriminant Analysis (ILDA) was formulated (M. S. Bartlett et al., 2002). Independent Component Analysis (ICA) is the generalization of PCA (T. K. Kim et al., 2007). The advantages of ICA are that it considers the higher-order statistics and the vectors determined by ICA are not necessarily orthogonal and therefore the performance rate is increased. Experiments show that this approach works better than PCA under most conditions. The Gabor filters are used to extract features from the images using texture component. The feature-based method proposed which is based on Gabor wavelets has good performance in general. Moreover, the illumination and pose variation problems are almost eliminated using this approach (Chengjun Liu, 2006).

The Support Vector Machines (SVM) method is a binary classification method widely applied in the biometric classification process (P. Jonathon Phillips, 1999). The Hidden Markov Model for face recognition was first conceptualized by Samaria (F. Samaria & A. Harter, 1994). It was later extended for 2D Discrete Cosine Transform (DCT) and Karhunen-Loeve transform (KL) (Aria V. Nefian, and Monson H. Hayes, 1999). Active Shape Models (ASM) and Active Appearance Models (AAM) are proposed by Cootes for face representation (T. Cootes & C. Taylor, 1999). Kernel Principle Component Analysis (KPCA) (Z. Q. Zhao et al., 2004), Kernel Fisher Analysis (KFA) (Chengjun Liu, 2006), Hidden Markov Model, Linear Fisher Analysis (LFA), Laplacianfaces (Xiaofei H et al., 2005) are also the methods which are implemented for face recognition. The 2D images has problems in face recognition due to the changes in illumination, pose and expressions thus other researchers proposed 3D face recognition (Xi Zhao et al., 2014).

2.2 Face Recognition System

Face recognition system is a kind of system to identify a specific individual in a digital image by analyzing and comparing patterns, where face is categorized as either known or unknown after comparing it with the image of a known person stored in a database.

Nowadays, face recognition system is a famous topic in the biometric research area, and as such has received significant attention. This is because the current and the future of human life style require such systems, as it has a wide range commercialization and law enforcement applications.

The current recognition system may have achieved a certain level of ability to recognize human faces, but it still has many restrictions which makes it impossible for many real-world applications, especially in security enforcement. It can be said, the capabilities of current face recognition system is still far from human expectations.

2.3 Face Recognition Challenges

The several issues that are related to the face recognition problem can be classified into hardware constraints e.g. different types of camera lens used, and environmental conditions such as image capture in the dark or in light. In fact, there are also problems related to the subject itself such difference of age, expression, and face position. The related problems are discussed in detail in this section.

2.3.1 Illumination

Illumination variation has enormous and complex effects on the face image of a subject. The feature extraction method relies mostly on pixel color and intensity. This shows that the recognition is dependent on light changes. On the face image, changing the direction of illumination leads to shifts in the location, changes in highlights, and reversal of contrast gradients. The illumination change does not only depend on the light source, but also depends on the light intensity. The light intensity can be increased and can also be decreased. The feature extraction cannot be done if the entire face regions are covered by shadows and solarization.

If two images of the same subject's face, but one captured in a lighted condition and the other one captured in a dark condition, the recognition system may detect two different subjects. The illumination is one of the big challenges for face recognition systems. This illumination problem can be solved using different approaches:

Heuristic approach

Heuristic is a mathematical optimization technique designed for solving the illumination problem. (Manuel et al., 2006) proposed a solution to the illumination problem, where there are three types of techniques that can be used to solve the problem; Simulated annealing, gradient, and random search. These techniques are used to search the maximum lighting point inside a polygon P of n vertices. The method greatly helps in solving the illumination problem.

L. Sirovich & M. Meytlis (2009) proposed a method based on the natural symmetry of face images. In their study, they determined that odd feature faces are affected by illumination. Therefore, they removed them from their syntactic face construction procedure. The result shows by reasonable criteria is nearly 100% accurate of face images regardless of illumination variation.

Statistical approach

Statistical methods for feature extraction can offer improvement or deterioration of recognition rates. Furthermore, there is a wide research that should be done. Other research that implements this approach in different lighting conditions achieved the better outcomes (R. Gross et. al., 2004).

Saratha Devi & V. Mahesh (2013) analyzed the performance of illumination normalization. They used DCT, Wavelet Denoising, Gradient Faces, Local Contrast Enhancement, and Weber's law under different lighting conditions. The result that with Weber's law shows the best performances, followed by Gradient Face, and DCT.

Virendra, Vishwakarma, et al., (2010) proposed a novel face recognition approach for illumination normalization utilizing DCT. They used a low-frequency coefficient corresponding to illumination variation in digital images. The classifier done used the k-nearest neighbor and mean nearest classifier, then the correlation coefficient distance are obtained using PCA and Euclidian distance. The analysis done on the Yale Face database achieved a 100% performance rate.