

DEVELOPING A FACE RECOGNITION SYSTEM USING CONVOLUTIONAL NEURAL
NETWORK

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PROJEK SARJANA MUDA II

Tajuk Projek : DEVELOPING A FACE RECOGNITION SYSTEM USING
CONVOLUTIONAL NEURAL NETWORK

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This thesis is dedicated to
my beloved parents, Khalid Nordin and Baizura Hassan,
and my one and only sister, Syazwani Itqan Khalid.

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ABSTRACT

The research on face recognition still continues after several decades the study of this biometric trait exists. This project is focusing on developing a face recognition system. Convolutional Neural Network (CNN) technique was used for face identification process. In CNN, the segmentation, feature extraction and classification process are combined in one processing module with minimal pre-processing task on the input image. In this system, a General User Interface (GUI) is the main component of the system. The image preprocessing steps were implemented in MATLAB, while the CNN algorithm was implemented in C language (using GCC compiler). The GUI linked all the steps from image preprocessing to face recognition. A user-friendly system was successfully developed.

ABSTRAK

Kajian terhadap pengecaman muka telah berlanjutan selepas beberapa dekad sejak kajian terhadap ciri biometrik wujud. Projek ini memfokus terhadap mencipta satu system pengecaman muka. Teknik Rangkaian Konvolusi Neural (CNN) telah digunakan untuk proses mengenalpasti muka. Teknik CNN menggabungkan proses segmentasi, pengekstrakkan ciri dan pengelasan ke dalam satu modul pemprosesan, di mana tugas pre-pemprosesannya ke atas imej input adalah minima. Sistem ini mempunyai sistem penguana umum antara muka (GUI) sebagai komponen utama. Langkah pre-pemprosesan imej telah dilaksanakan dalam MATLAB, sementara algoritma CNN telah dilaksanakan dalam Bahasa C. GUI menghubungkan kesemua langkan dari pre-pemprosesan imej sehingga pengecaman muka. Akhirnya, satu system yang mesra pengguna telah berjaya dicipta.

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LIST OF ABBREVIATION

1. Multilayer perceptron (MLP)
2. Convolutional Neural Network (CNN)
3. General user interface (GUI)
4. Olivetti Research Laboratory (ORL) database
5. Independent component analysis (ICA)
6. Elastic bunch graph matching (EBGM)
7. Hidden Markov model (HMM)
8. Neural Network (NN)
9. Portable Gray Map (PGM)
10. MATLAB Executable (MEX)

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, people are using combinations of alphabets and numbers as their secret code to access to their account. Although the passwords are unique, the safety is not guarantee as it can easily be forgotten or stolen by identity fraud criminals. Biometric method is a method to identify individuals by unique biological features that individual possesses. For example, features of face, finger print and finger vein, iris, blood type, DNA and many more. There are few biometric methods such as face recognition method, finger vein and finger print recognition method, iris recognition method, etc. These methods are safe because the account cannot be accessed by any other individuals without the present of the account owner.

Face recognition identify individuals by features of face including the position of eyes, nose, mouth, cheekbones, jaws or skin color. However, face recognition has a few limitations; such as variation of facial expression, pose invariant, illumination invariant, occlusion and others.

Neural network is a very common method in pattern recognition field. Neural network is ideal in handling non-linear problems due to its ability to learn. A typical neural network is using multilayer perceptron (MLP). This method, however, has massive connection. It also ignores the neighbouring pixels and only handles classification.

In this project, Convolutional Neural Network (CNN) method of face recognition is used to develop a real time face recognition system. CNN was proposed by Yann LeCun in 1989. CNN is using LeNet-5 architecture. There are so many applications of CNN; face detection and recognition, gender recognition, object recognition, etc. The proposed method is a simplified version of CNN, with lesser layers. It has a complex algorithm but with minimal preprocessing steps.

1.2 Objectives

The following statements are the objectives of the project.

- To develop a face recognition system by using CNN.
- To merge the preprocessing stages that has been designed in MATLAB with the CNN that has been designed in C language.
- To develop a general user interface (GUI) for the system.

1.3 Problem Statement

The algorithms of face recognition by using Convolutional Neural Network (CNN) are already developed. However, it is not well connected for a face recognition system as the image preprocessing steps were implemented in MATLAB and CNN algorithm was in C language. The system needs to be manually clicked to process each steps. Besides that, the system is based on Olivetti Research Laboratory (ORL) database, where the numbers of images are limited to 40 individuals.

1.4 Scope Of Project

The scope of this project is to develop a face recognition system by using Convolutional Neural Network (CNN). The image preprocessing is developed in MATLAB and the CNN algorithm is implemented in C language. A GUI was also developed in MATLAB software. The system is based on 40 images from ORL database and 10 images from JAFFE database combined together.

1.5 Report Structure

This thesis consists of five chapters that includes introduction, literature review, project methodology, results and discussion, and conclusion and recommendation of the project.

Chapter 1 is the introduction to the project. In this chapter, there are 5 components including background, objectives of the project, problem statement, scope of project and report structure. Chapter 2 is on the literature review of the project. This chapter consists of a few components including reviews on biometric technology, the difference between face verification, face identification and face authentication, reviews on face recognition system and reviews on CNN method.

Chapter 3 is about the methodology of the project. This chapter consists of the method to develop a face recognition system by using CNN method. Chapter 4 contains the final results of the project. The results must meet the objectives of the project. Lastly, Chapter 5 contains the conclusion of the project and suggestion of future work of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Biometric Technology

In this millennium era, a human identity authentication system is no longer safe. A combination of alphabets and numbers as password to have access to one's account is vital. Ones may have more than one password to memorize as they have more than one account. Thus, those passwords tend to be forgotten. Other than that, the number of crime and identity fraud was increasing [1]. That traditional system that was supposed to protect one's account safety is no longer adequate. A biometric technology has then becoming an important element in developing user identification system [2].

Biometrics is an evolving technology, with potential to make human's lives easier and safer. Biometric has a wide range application especially in surveillance; security monitoring, immigration, for identification and recognition [3]. Biometric is a unique biological and behavioral traits or characteristics possessed by human being. Implementation of various biometrics traits can be the most reliable and accurate identification system. Features of face, fingerprint and finger vein, iris, palm print and DNA are examples of unique biometric characteristics of a person. There are many factors that are considered when choosing a biometric, including the trait must be unique and different for different person, the trait must be permanence where it does not affected by age or diseases, the trait cannot be reproducible and many more.

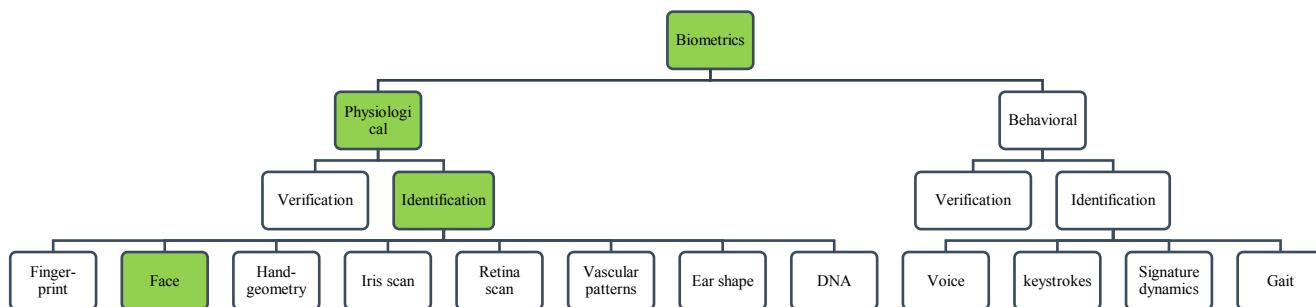


Figure 2.1: Biometry technology

2.2 The Difference between Face Verification, Identification and Authentication

Verification is a process to determine whether the two inputs of the system are belong to the same group or identity [4]. Face verification is the process of verifying whether two faces are of the same person or not. There are some challenges in this process, such as variation of pose, hairstyle and face expression [5]. There are two types of face verification approach which are face matching and face representation [6]. The face verification involves two stages classifier. When two faces are set as input for verification, the classifiers are applied to each face. The outputs of this

classifier are used as features for the second-stage classifier. At the second stage, the ‘same-or-different’ verification decision occurs [7].

Face identification and authentication share the same preprocessing and feature extraction steps [8]. Identification is the process of providing a user identity, which normally provided in the form of user ID. A face identification is a technique to identify or verify a person by his physical characteristic or personal unique traits, without intervention from a user [9]. Face Authentication is the process of determining and validating user identity. Authentication always considered has two phases; which are identification and authentication. It verifies user-provided evidence to ascertain claimed user identity.

2.3 Face Recognition

Face recognition is a biometric method that uses features of face to identify individuals. This technology has been evolved since long ago. This technology has a wide range of application such as security system, criminal identification and other. However, face recognition is hard to handle due to pose invariant, illumination invariant and many more.

- Illumination invariant

The illumination invariant that might due to the direction of light source, will effects the brightness of an image. Thus, causing a face recognition system to not identify accurately [10].

- Facial expression

Facial expression of a person is different from others. It is an expression of one’s emotions, for example smiling. A good face recognition algorithm must be able to recognize with variability of facial expression [11].

- Pose invariant

Invariant in facial pose will cause some feature of an individual's face to be occluded in the image [1].

- Partial occlusion

This refers to the presence/absence of structural component. The structural components are challenging factor because they have variability of size, shape and color. For example moustaches, beards and spectacles [1].

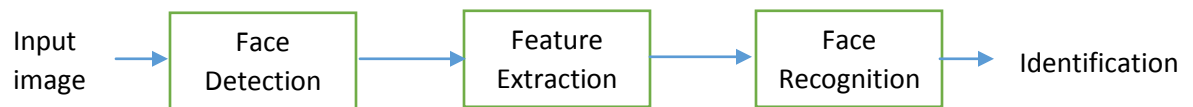


Figure 2.3: Face recognition steps [1]

There are three different approaches for existing face-recognition which are holistic (appearance-based) approach, feature-based approach and hybrid approach [12]. These approaches are differentiated based on the method of feature extraction [1].

In appearance-based approach, the whole face is the input data to the face recognition system [12]. There are a number of methods categorized under this approach, including eigenface, frequency domain, fisherface, support vector machines, independent component analysis (ICA), Laplacian and probabilistic decision based neural network method [1].

In feature-based approach, the features of face; for example nose and eyes are segmented, and used as input data [1]. There are a number of methods lie under this category, including geometrical feature, elastic bunch graph matching (EBGM), hidden

Markov model (HMM), active appearance model, 3D morphable model and convolutional neural network (CNN) [2].

In hybrid approach, combines both appearance-based approach and feature-based approach. In this approach, both features of face and the whole face are taken into account as the input to the system.

2.4 Convolutional Neural Network Method

Convolutional Neural Network (CNN) was first proposed by Yann LeCun. The proposed method has a very wide range of applications; such as face detection and recognition, gender recognition, object recognition, character recognition and texture recognition.

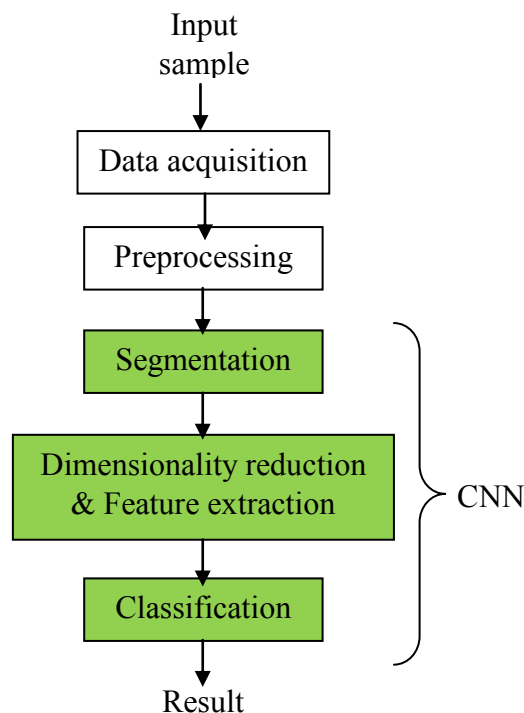


Figure 2.3.1: CNN process