

THE FACE RECOGNITION SYSTEM BY USING  
THE RADIAL BASIS FUNCTION NEURAL NETWORK (RBFNN)

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Special dedication to my beloved parents, Damni Bin Taip and Siti Hawa Binti Damni, my entire siblings, Siti Nur Amni Zafirah Binti Damni, Muhammad „Asri Hijrah Bin Damni, Mohd. Qamarulnasri Bin Damni, Siti Munawwarah Binti Damni, Nurul Hadirah Binti Damni and Iwana Yusrah Binti Damni. Also, not forget a friend Azizan bin Sebri, and the other dearest friends, family members, lecturers and my supervisor Khairul Azha Bin A.Aziz. Lastly, I hope my project can be beneficial to the industry.

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## ABSTRACT

The demand in the ubiquitous applications of the face recognition system gives the inspiration to establish this project with the application of one of the artificial neural network, Radial Basis Function Neural Network (RBFNN). This report leads to the development of the face recognition system by using the Radial Basis Function Neural Network (RBFNN). It is also aims to analyze the characteristic for the training and testing of RBFNN fit with the system so that it can recognize the subject successfully. However, it limits to the MATLAB Graphical User Interface (GUI) as its interface and uses the grey scale input image with the format „jpeg“ for the image only. Therefore the methodology applies the MATLAB GUI in order to develop the system and also the adaption with the match score of the test subject is very crucial to analyze the outputs from the system. This determines its performance whereby the experiments conducted revealed that the range of 25 to 30 is the best spread value for the system with the higher pixels also gives better performance. There also another experiment which shows the comparison of the genuine match and impostor match. The outputs verified that the higher score of genuine match and lower impostor match is the best combination so that the system will recognize enrollee consistently and precisely. Lastly, conclusion for this project is that its security, relevancy and cheaper that contributes its marketability value for industry. For the recommendation, it is suggested to apply it in multimodal biometric system, or using new advanced algorithm such as Scale-Invariant Feature Transform (SIFT). The upgrade of the system from verification to identification mode also should be included for the future research.

## ABSTRAK

Permintaan tinggi untuk sistem pengenalan muka memberi inspirasi supaya mewujudkan projek ini dengan mengaplikasikan salah satu daripada jaringan saraf tiruan, iaitu *Radial Basis Function Neural Network* (RBFNN). Laporan ini menunjukkan pembangunan sistem pengenalan wajah dengan menggunakan *Radial Basis Function Neural Network* (RBFNN). Ia juga bertujuan untuk menganalisis parameter-parameter pada RBFNN yang sesuai dengan sistem itu supaya ia boleh mengenal muka seseorang dengan jayanya. Bagaimanapun, ia menghadkan kepada MATLAB *Graphical User Interface* (GUI) sebagai antara mukanya dan menggunakan imej input skala kelabu dengan format '*jpeg*'. MATLAB GUI sangat membantu dalam membangunkan sistem ini dan juga penyesuaian diri dengan markah perlawanan subjek sangat penting dalam analisis keluaran sistem itu. Ini menentukan prestasinya di mana eksperimen-eksperimen yang dijalankan telah mendedahkan bahawa julat 25 untuk 30 ialah nilai penyebaran terbaik idan nilak *pixel* lebih tinggi juga memberi prestasi lebih baik. Terdapat juga lagi satu ujian yang menunjukkan perbandingan perlawanan tulen dan perlawanan penyamar. Keluaran mengesahkan yang markah tinggi bagi perlawanan tulen dan rendah bagi perlawanan penyamar ialah gabungan terbaik supaya sistem itu akan mengiktiraf *enrollee* dengan konsisten dan tepat. Akhir sekali, kesimpulan untuk projek ini adalah keselamatannya, relevansinya dan harga yang lebih murah menyumbang kepada nilai kebolehpasarannya untuk industri. Untuk syor, ia disarankan untuk memohon ia dalam pelbagai mod sistem biometrik, atau menggunakan algoritma baru seperti *Scale-Invariant Feature Transform* (SIFT). Peningkatan sistem itu daripada mod pengesahan menjadi mod pengenalanpastian juga seharusnya diselitkan untuk cadangan penyelidikan masa depan.



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## LIST OF ABBREVIATIONS

ANN	–	Artificial Neural Network
RBFNN	–	Radial Basis Function Neural Network
MATLAB	–	Matrix Laboratory
ATM	–	Automated Teller Machine
DNA	–	Deoxyribonucleic Acid
FAR	–	False-Accept Rate
FRR	–	False-Reject Rate
SIFT	–	Scale-Invariant Feature Transform
JPEG	–	Joint Photographic Experts Group
GUI	–	Graphical User Interface
POI	–	Proof Of Identity
FRGC	–	Face Recognition Grand Challenge
FOCS	–	Face and Ocular Challenge Series
FRVT	–	Face Recognition Vendor Test
FERET	–	Facial Recognition Technology
PLN	–	Piecewise Linear Networks
MLP	–	Multilayer Perceptron
GUIDE	–	GUI Design Environment
OS	–	Operating Systems
USB	–	Universal Serial Bus

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# CHAPTER I

## INTRODUCTION

This chapter presents the overview for overall description for this project. Thus, it is including the background of project, objective and scope. The organization of the report also state in this chapter for the preview of the report ahead.

### 1.1 Background of the Project

At present, demand on the face recognition system is increasing with the needs of utilisation the system to keep the discretion, privacy and security to users. The common application can be seen in the digital chip in passports and drivers' licenses. Of course, the chip keeps information about our face grid so that no one else can use our document identification such as passport, identity card and etc.

The computer security also applies the concept of recognizing the user's face to access the computer. This is very important because some information possibly private and confidential. Thus, using the face recognition system can get rid of disclosing that information to outsiders by restricting it to certain people. In reality, we can say that the system is ubiquitous and proliferating since it appears to be most of our daily applications either directly or indirectly used.

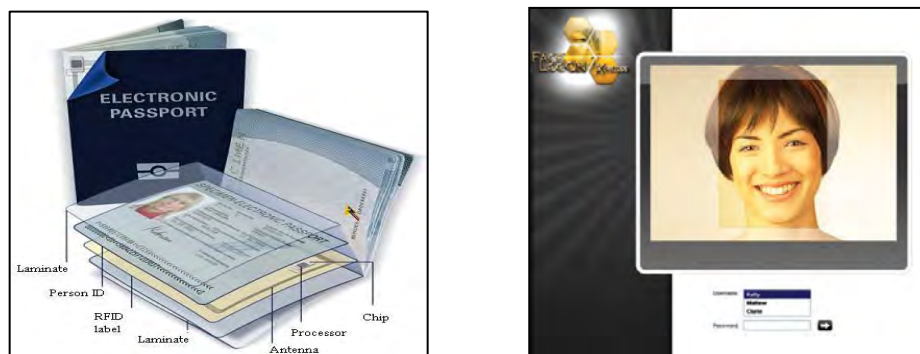


Figure 1.1: Application of Face Recognition System

The biometric system can be said that as replacement to the conventional system which only required password to secure the computer system. It is common to use biometric system in order to achieve this aim. After all, the face recognition is the most easier to develop since we does not require the owner's consent besides of having advantages in terms of privacy and universality. Therefore, this project revolves around one of the universal biometric systems that are face recognition system. However, there are some sensitivity issue to this system due to illumination, orientation of face, and other parts such as spectacles, hair style and hijab (*for Muslim women*). This is few things to be considered while completing this final year project.

Basically, the radial basis function network is an artificial neural network that uses radial basis functions as activation functions. In fact, the artificial neural network (ANN) is inspired by the biological neural network which is the neurons in our brain. The basic concept of biological neural networks uses synapses to perform the operation of receiving signals from a neuron to other neurons. This concept is, then, implemented into the artificial neural network so that it can be functioning as the neurons. It is simply fed the complex multi-inputs and hence results in one output. This is how the extent the ANN being inspired and then utilized in order to develop the face recognition system as suggested for this project. The solely output required in this project is that either the system recognized or not.

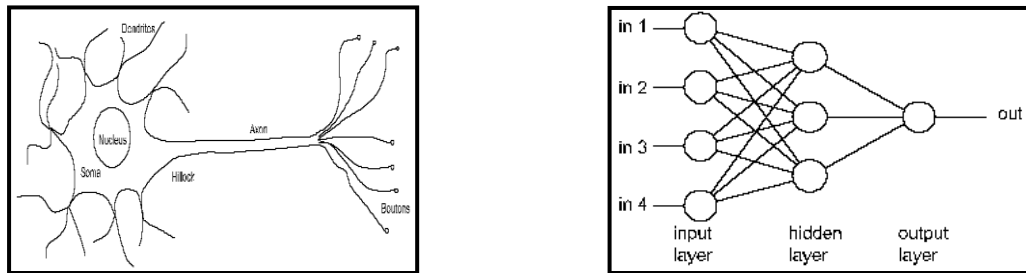


Figure 1.2: Biological Neural Network (Left), and Artificial Neural Network (Right)

## 1.2 Problem Statements

In order to keep the security of the recognition system, the development of face recognition system is being researched so that it keeps track with the other advanced technologies. Recently, the research on the face recognition system is being developed and funded in order to upgrade the technology in existed system. The innovation of the system is being synchronized into the evolution of the other technology. However, there are rarely to found the research of the face recognition system based on the neural network. It started around 1970s but it has been dynamically explored during 1990s until today. The novelty of the simple system is considered while doing the research on this project. Hence, the Radial Basis Function Neural Network (RBFNN) is chosen to be the medium of the face recognition system.

## 1.3 Objectives

- To develop the face recognition system by using the Radial Basis Function Neural Network (RBFNN).
- To analyse the characteristic for the training and testing of RBFNN fit with the system so that it can recognize the subject successfully.
- To implement the software MATLAB with the hardware of webcam.

- To utilize the Graphical User Interface (GUI) of MATLAB to interconnect with the source code (.m file) and also to connect via video input (webcam).

#### **1.4 Scope**

- MATLAB GUI as its interface.
- MATLAB source code for training and testing for RBFNN.
- Grey scale input image.
- Format 'jpeg' for the image.

#### **1.5 Organisation of Report**

The organization of this report is as follows: Chapter 2 describes the literature review for this project. It includes the vital information of the face recognition as one of biometric system. Brief descriptions of neural networks are also given here and hence the Radial Basis Function Neural Network (RBFNN) as the main component in this project. Besides, the relationship between both face recognition and RBFNN are discussed so as to enhance the understanding on how to develop the system by applying the concept of RBFNN. Chapter 3 presents the methodology by using the flowchart and block diagram to show the process for both training and testing of RBFNN. It also includes the steps to design the interface via MATLAB GUI. While Chapter 4 shows the interface of the face recognition system as its main result. It follows with the detailed description about it and the data recorded during the study on the performance of the system. The analysis of the results obtained is also discussed in Chapter 4. Lastly, the conclusion and recommendation from the project are stated in Chapter 5.

## **CHAPTER II**

### **LITERATURE REVIEW**

A literature review is a body of text that aims to review the critical points of current knowledge for any related information so as to enhance the understanding of the concept and certain terminology which is used throughout this research.

#### **2.1 Biometric System**

##### **2.1.1 Brief History**

Basically, biometric is inspired from how human recognize each other. However there is a long history behind the advance technology based upon the biometric system. Serious biometric research began in the 1960s, the techniques were developed and refined during the 1970s and 1980s, and the field became increasingly commercialized from the 1990s onwards [1].

The biometric system offer benefits in various applications with every aspect of our daily lives such as document control, transactions, computer access etc. Briefly, the biometric system offer more advantages compared to the password as a conventional system. It includes increasing confidence during transactions since we have present physically there.

Secondly, it is easier and faster to use biometric feature. It is because people tend to use short and easy-to-remember passwords so that there have less trouble each time they access the system. So this might lead to forgetfulness while accessing system with password. Then, it will give more trouble if it is disclosed to unauthorized users. Therefore someone else also can access the system while the biometric gives advantages in this issue since our biometric feature is bring over with us. With biometrics, there is no need to remember a long password by memory or to write it down.

Because people commonly use faces for establishing identity, it is perhaps the most natural biometric for authentication. However, it is also one of the most challenging for a computer. In 1965, the research by Helen Chan and Charles Bisson is one of early major paper published in the automation of face recognition. While the Cognitec, ZN, and Identics are the examples of the early commercial implementation which began to come out around mid-90s.

### **2.1.2 Overview**

Biometrics is technologies used for measuring and analysing a person's unique characteristics. It applies on how human commonly recognize each other by using uniqueness. It is acts as replacement for password which commonly used before the existing of biometric system.

There will be more secure if we use biometric instead of password. It is because it is some sort of trend to create long or alphanumeric password. Of course, we can say that it gives us security while accessing our accounts. The application of the password is varied in any field such as banking (ATM), computer security, etc. However, there are also risks come up whereby the user may forget the password or may be in worst case, it can be passing over into unauthorized person.

In fact, the biometric offer the advantage over this point. This is because our physical such as face, hand and DNA are always being with us thus there will impossible for the other person (impstor) to access our account or may be enter any

restricted building. Otherwise, the biometric system is faster than password-based system due to the scanning process. While the conventional system required more time to enter user's password.

### 2.1.3 Physiological Versus Behavioral

There are two types of traits relating to the biometric system which include the physiological and behavioural traits. Physiological are related to the shape of the body such as fingerprint, face recognition, and DNA. While behavioural are related to the behaviour of a person. It includes the typing rhythm, gait, and voice. Furthermore, the behavioural biometric is called as active features due to its acquisition of biometric information in the first category requires users to be active. However, the physiological biometric does not need any consent from the subject and hence it is called as passive features [8.]

Both types have their pros and cons. For example, the biometric based on physiological is easier to develop since they are in our body. As such, we only have to analyse them physically. While the other type, we must analyse the person behaviourally during their enrolment. Of course, it is harder because when the person changes behaviour it affect the accuracy of system as well.

Table 2.1: The Six Most Commonly Used Biometrics [4]

<b>Physiological</b>	<b>Behavioural</b>
Face	Signature
Fingerprint	Voice
Hand geometry	
Iris	

#### 2.1.4 Verification Versus Identification

There are two different ways to resolve a person's identity which is either verification or identification mode, depends on the application context. For example, this project context requires a positive recognition for one person so as to get rid the multiple people from using the same identity. In the verification mode, the system validates a person's identity by comparing the captured biometric data with her own biometric template(s) stored in the system database. The crucial point is that the system involves a claim of identity so that here are options either to accept or reject the input image and hence the subject's claim can be proved.

For the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match. Unlike the verification mode using one-to-one comparison, the identification system conducts a one-to-many comparison to establish an individual's identity without the subject having to claim an identity. Identification is also a critical component in negative recognition applications where the system establishes whether the person is who she denies to be.

Depending on the type of biometric system being evaluated, different performance measures will be appropriate. There is no one perfect biometrics that fit all needs. For this project, we used the verification mode to prove the claim of certain subject. Of course, the biometric verification is much faster than biometric identification when the number of biometric references is very high.

The figure below shows all stages involved in a biometric system. In fact, enrolment is constructed for the first learning phase. The enrolment is used to comprehend the creation of an enrolment data record of the biometric data subject and to store it in a biometric enrolment database. The enrolment data record comprises one or multiple biometric references and arbitrary non-biometric data such as a name or a personnel number.