UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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ONLINE FACE RECOGNITION SYSTEM USING ARTIFICIAL NEURAL NETWORK

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Electronics Engineering Technology (Industrial Electronics) with Honours

by

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DECLARATION

I hereby, declared this report entitled ─Online Face Recognition System Using Artificial Neural Network" is the results of my own research except as cited in references.

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Date   :   9 DECEMBER 2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor's of Electronics Engineering Technology (Industrial Electronics) with Honours. The members of the supervisor committee are as follow:

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ABSTRACT

Biometric recognition system such as facial recognition system was widely developed over the past few years. Facial recognition system is commonly used in security system to allow user to protect their privilege. Most of users wanted their information and place to be secure with a trusted security system. The normal security like key or password is no longer relevant as people prefer an easier and flexible way. Therefore, this thesis presents a better and easier way of security system that can recognize the user successfully and give the matching percentage. By using Radial Basis Function Neural Network in MATLAB, a face recognition system can be created. RBFNN will detect face from image captured by camera; it will turn it into grayscale, cropped it and save as a dimension of 50*50 pixels sized picture. That picture will be normalized and reshaped into one column matrix form of 1*n data. The RBF system will be trained by data as reference, input image will undergo the same process and the data obtained will be used to match with the data in the RBF to obtain the matching percentage. 200 inputs of user and 160 inputs of non-users were used to test on the system for false acceptance rate and false rejection rate. A suitable matching percentage reference was chosen from this analysis as the minimum require matching to access the security system where error rate is one of the main concerns where it is the unwanted result that might occur. Different threshold number, spread value, and sizes of dimension also tested, the differences on the output matching result were observed. By using the microcontroller to control a relay to control the magnetic door lock, the system was able to successfully control the door lock. The benefits of this online face recognition system is used human own natural facial as a password for the security system. This system can be applied at office, lecturers' room, or even at house.

ABSTRAK

Sistem pengiktirafan Biometrik seperti sistem pengiktirafan muka telah dimajukan kebelangkangan ini. Sistem pengiktirafan muka adalah salah satu sistem biometrik yang sering digunakan sebagai sistem keselamatan untuk melindungi harta pengguna. Pengguna-pengguna ingin mendapatkan jaminan yang tinggi terhadap keselamatan harta benda dan sekeliling mereka dengan satu sistem yang boleh dipercayai. Sistem keselamatan yang lebih canggih dan mudah diguna diingini oleh pengguna disebabkan sistem keselamatan yang biasa seperti menggunakan kunci dan kata laluan sudah tidak relevan. Dalam tesis ini akan membentangkan satu sistem keselamatan yang lebih senang dan baik dengan mengecam muka pengguna dan vii actor pendapatan yang tepat. Satu sistem pengiktirafan dapat dicipta dengan menggunakan rangkaian saraf fungsi asas jejarian (RBFNN) dalam MATLAB. Sistem RBFNN akan mengesan muka dari gambar yang ditangkap, ia akan menukarkannya kepada skala kelabu dan timbulkan gambar tu dan simpan sebagai gambar yang berdimensi 50*50 pixel. Gambar tersebut akan dinormalkan dan dibentukkan semula menjadi data matriks yang ruangan 1*n. Data tersebut akan dilatih sebagai rujukan sistem RBF, gambar yang baru akan melalui proses yang sama dan viiactorviiing dengan sistem RBF untuk mendapat peratusan perbandingan. 200 pemasukan gambar daripada pengguna dan 160 pemasukan daripada bukan pengguna digunakan untuk menguji sistem ini untuk mendapatkan kadar kesilapan menerima dan kadar kesilapan menolak. Peratusan rujukan akan dipilih dari analisasi ini untuk menjadi syarat minimum untuk mengakseskan sistem keselamatan ini kerana kadar kesilapan merupakan salah satu vii actor penting yang akan menyebabkan pendapatan yang tidak diingini. Nilai ambang, nilai penyebaran dan saiz dimensi yang berbeza juga digunakan untuk mengaji perbezaan pendapatan yang diperoleh. Pintu magnek juga dapat dikawal relay yang dikawal dengan mikro-pengawal. Sistem pengiktirafan muka ini adalah menggunakan muka yang sedia ada pada manusia sebagai kata laluan untuk sistem keselamatan. Sistem ini boleh diaplikasikan di tempat seperti pejabat, bilik pensyarah atau rumah.

DEDICATIONS

This thesis is dedicated to:

My beloved family,

My Parents,

My Supervisors,

My Lecturers,

And all my friends,

Thank you for their encouragement and support.

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RBFNN	–	Radial Basis Function Neural Network
MATLAB	–	Matrix Laboratory
ANN	–	Artificial Neural Network
UART	–	Universal Asynchronous Receiver or Transmitter
FAR	–	False Acceptance Rate
FRR	–	False Rejection Rate
GUI	–	Graphical User Interface
DNA	–	Deoxyribonucleic Acid
PCA	–	Principal Component Analysis
DCT	–	Discrete Cosine Transform
DFT	–	Discrete Fourier Transform
DWT	–	Discrete Wavelet Transform
LDA	–	Linear Discriminate Analysis
LCA	–	Linear Discriminate Analysis
MLNN	–	Multi-Layer Neural Networks
SVMRFE	–	Support Vector Machine Recursive Features Elimination
PSM	–	‗Projek Sarjana Muda'
ICSP	–	In Circuit Serial Programming (ICSP)
LCD	–	Liquid-Crystal Display
ID	–	Identity Document

CHAPTER 1
INTRODUCTION

1.1. Introduction

In this chapter will present the all the overview description of this research by using artificial neural network (ANN) for a face recognition application on unlocking a door lock. It will embrace of the background, objectives and the scope of this project. The objectives of this project will solve the problem statement that is declared on this chapter.

1.2. Background of Project

In this technology era, biometrics is widely use for security purpose. Biometrics is extrapolate from the Greek words *bio* and *metrikos* which has the meaning of life and relating to measure. Biometric become popular in security system when the society requirement of security in the field of information, business, military, e-commerce and etc. The biometric system that existed in our daily life got hand geometry reader, fingerprint reader, iris scanner, retina scanner, voice recognition, signature recognition and facial recognition.

Facial recognition is one of the common biometric and widely used method, it may differ to many method to recognition the facial of the user. By using stored database of faces, a given still or video image is used to be identified or verified one or more persons in the picture. According to Divyarajsinh N. P. and Brijesh B. M. (2013) the first large scale application of face recognition was carried out in Florida.

Michael, J. A. Jr. (2006) discussed that in the process of recognition, recognition error rate as False Accept Rate (FAR) – type I and False Reject Rate (FRR) – type II are consequences that need to take into consideration. A FAR occurs when the system give the positive result by an unauthorized person's hand, fingerprint, iris or retina after the scan. A FRR occurs when the system give the negative result rejecting the authorized person's hand, fingerprint, iris or retina after the scan.

Shiffman, D. (2012) described Artificial Neural Network (ANN) as a complex adaptive system where it will learn and change its internal structure based on information flowing through it. ANN can use supervised learning, unsupervised learning or reinforcement learning. Online face recognition using ANN is a system that will recognize the user's face for multiples of time. The image of user will be converting to 2D matrix form and save as data for ANN to learn. A camera will be used to capture the picture of user for undergoing the ANN matching with MATLAB software. The image of user will then been capture to be undergo matching of the data using ANN to provide the percentage of similarity.
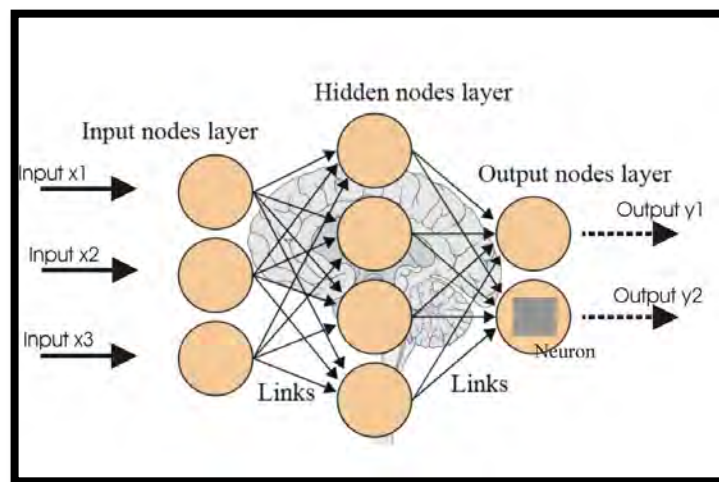

Figure 1.1: Basic Structure of an Artificial Neural Network (ANN).
(Source: < http://futurehumanevolution.com/artificial-intelligence-future-human-evolution/artificial-neural-networks> 19/4/2015)

Figure 1.1 shows how neural network function as a brain system. Our brain system will remember what we have seen and memorized it and the brain was trained as the same time. ANN work similar as brain, it will be trains several image for one subject to make the system will recognize the subject before the testing mode.

1.3. Problem Statement

Most of the users wanted their information and place to be secure with a trusted security system. The normal security like password is no longer relevant as people prefer an easier and flexible way. Face recognition system is being research to make the system more advanced. By using the neural network is more suitable for the medium of face recognition system.

1.4. Objective

The objectives of this project are as stated in below:

(a) To develop a face recognition system by using Radial Basic Function Neural Network with MATLAB.

(b) To ensure that the face recognition system integrate with microcontroller by using serial connection method to trigger the magnetic door lock.

(c) To analyze the RBF system whether can recognize the subject successfully and give the percentage of output matching.

(d) To understand how to use MATLAB ANN system to give the result of output from matching the input from camera with GUI.

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1.5. Scope of Work

This research will use MATLAB as the main software to develop the neural network system. Graphical User Interface of MATLAB will be used in this system. A camera will capture the image of user and convert the image into grayscale format. The analysis will be using grayscale image as the input where it will then convert into 2D matrix form by MATLAB for the training process of ANN. The hardware part will construct by using microcontroller with serial connection to control the magnetic door lock.

1.6. Thesis Organization

This report consists of 5 chapters that will describe the flow of this research in structure. First chapter will consists of the background of this project, problem statement, objectives and the scope and limitation of this project.

Second chapter will contain the literature review that comparing the idea and method of other researcher used to do the analysis on face recognition system.

Third chapter is the research methodology which will explicate the method of conducting the analysis of this research.

Fourth chapter will reveal the result that obtained from the analysis by using MATLAB and the discussion made through the output that obtained from the analysis made.

Last chapter will conclude all the overall progress from the beginning until the end of the project.

CHAPTER 2
LITERATURE REVIEW

2.1.   Introduction

This chapter will review the concept used in this project based on the sources and information gathered from books, website or journal. Face recognition is one of the methods from biometrics, the advantages and disadvantages of other methods from biometrics also will be discussed.

2.1.1.   Image Processing

Zhang, L. (2013) stated that in early 1920s, the news-paper industry was one of the first applications of digital imaging. Harry G. Bartholomew and Maynard D. McFalane were the invertors of ‗Bartlane Cable Picture Transmission System‗. Pictures were coded for cable transfer and reconstructed at the receiving end on a telegraph printer. Submarine cable was used to transfer images between London and New York and first used to transmit a picture across the Atlantic in 1921. While in mid to late 1920s, Bartlane system was improved and produced higher qualities images. The increment on number of tones in reproduced image. In 1960s, computing technology improved the work in digital image processing and it began to be used in medical applications in 1970s. Figure 2.1 shows that the early digital image with the improved digital at late 1920s.

Figure 2.1: Early stage and improved digital image.

Digital image can be represented in two dimensional images as a finite set of digital values, called picture elements or pixels. Pixel values typically represent gray levels, colours, heights, opacities. Digitization indicates that a digital image is an approximation of a real scene. Figure 2.2 will show that digitization of an image. The boxes represent the pixels of the image where 1 box representing 1 pixel.
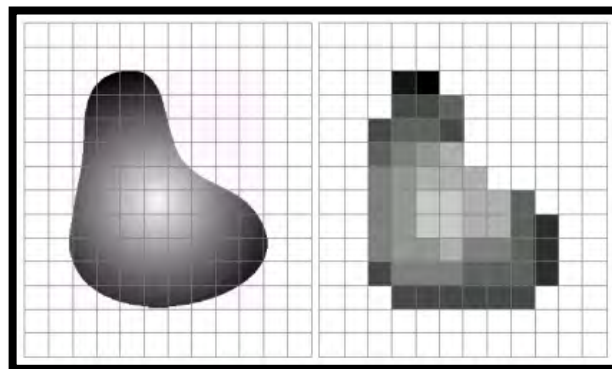

Figure 2.2: Example of digitization of image. Source: Zhang (2013)

The common image formats include:

(a)   1 sample per point (Black and White or Grayscale)

(b)   3 samples per point (Red, Green, and Blue)

(c)   4 samples per point (Red, Green, Blue, and Alpha/Opacity)

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2.1.2. Facial Recognition System

The pioneer semi-automated facial recognition system was created by Woody Bledsoe, Helen Chan Wolf, and Charles Bisson which using computer to recognize human faces. The common criterion that involve to be located in this system were eyes, ears, nose, and mouth on photograph before it was used to calculate the distances and ratios to a common reference point. The result will then compared with the reference data. *"This recognition problem is made difficult by the great variability in head rotation and tilt, lighting intensity and angle, facial expression, aging, etc. Some other attempts at facial recognition by machine have allowed for little or no variability in these quantities. Yet the method of correlation or pattern matching unprocessed optical data, which is often used by some researchers, is certain to fail in cases where the variability is great. In particular, the correlation is very low between two pictures of the same person with two different head rotations."* The phrases above was the difficulties that described by Woody Bledsoe, 1966. The automated recognition used by Goldstein, Harmon and Lesk are 21 specific subjective markers, such as hard colour and lip thickness in 1970s.

2.2. Biometric

Pato and Millett (2010) described that biometric has two meanings where both of it are wide use. The field of biometric is an automated recognition of individuals based on biological and behavioral traits. In early of 1980s, biometric refer almost synonymously to statistical and mathematical method for analyzing data in the biological sciences. By using fingerprinting as a tool for identification for criminals, to face recognition, and to the central statistical concepts of regression analysis, correlation analysis and goodness of fit was contributed by the British geneticist Francis Galton. After that biometric undergoes a wide development even involved voice and eyes. The Figure 2.3 below show shows the different type of biometric recognition that been developed lately.
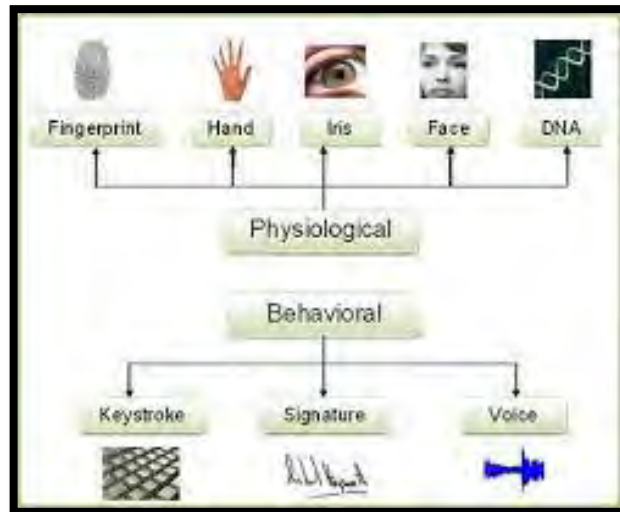
Figure 2.3: Modalities of Biometric. Source: Carlson (2014).

Physiological biometric system such as fingerprint, hand geometry, iris-scan, DNA or facial recognition is based on the measurement and data derived from direct measurement of part of the human body. Behavioral biometric system are based on the measurements and data derived from an action and indirectly measure characteristic of the human body such as voice recognition, keystroke-scan, and signature-scan.

2.2.1. Operation of General Biometric

Pato and Millett (2010) the basic operation will be divided into 3 basic steps which included ―capture‖, ―matcher‖ and ―action‖. A reference database will first to be created by storing the sample of information of biometric characteristic. ―Capture‖ through the sensor by detecting the present of biometric characteristic, the sensor will be captured and collect the data from the subject recognized. A comparison will be made after capturing sample of the characteristic and compared with the reference database. The comparator also known as the ―matcher‖ will give the result. ―Action‖ will be taken with the corresponding result by match action or non-match action. Figure 2.4 shows that the sample operation of general biometric system. Some system might have some differ due to their particulars.
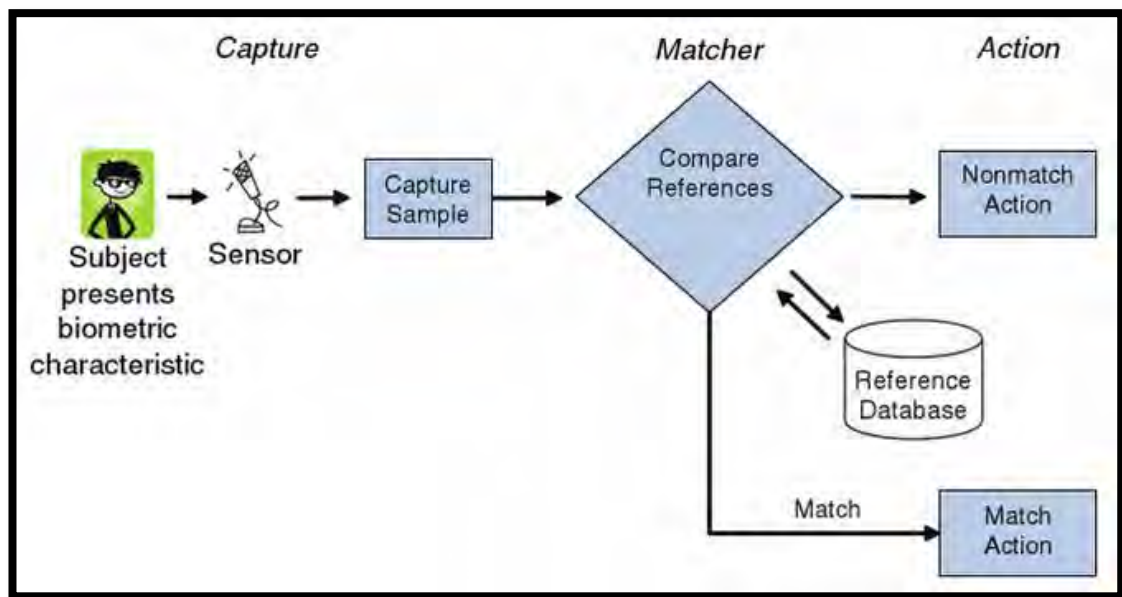
Figure 2.4: Basic operation of Biometric. Source: Pato and Millett (2010).

2.2.2. Recognition Error Rate

Michael (2006) stated that no technology is perfect; recognition error rate cannot be ignored in biometric systems. The most common errors that might occur are False Accept Rate (FAR) and False Reject Rate (FRR). These two errors occur due to the system wrongly accept or reject the input from user when matching with the sample of database. The system give the rejection when the system receiving the input from an authorized person known as False Reject; while the system accepted the input when the system receiving the input from non-authorized person known as False accept. Furthermore, there are other factors that will cause biometric system to fail. The growth of human or situations or environments or their daily activities done all will contributes to the affect the system to fail the recognition. Table 2.1 will show the criterions that affecting biometric system to fail.

Table 2.1: Factors That Cause Biometric System Fail. Source: Michael (2006).

Type of System	Factors
Hand Geometry	Jewelry, change in weight, bandages, swelling of joints
Finger Print	Cold/dry/oily finger, high/low humidity, angle of placement, pressure of placement, location of finger on platen (poorly placed core), cuts to fingerprint, activity that would mar or affect fingerprints (construction, gardening)
Iris Recognition	Too much movement of head or eye, glasses, coloured contacts
Retina Scan	Too much movement of head or eye, glasses
Voice Recognition	Cold or illness that affects voice, different enrollment and verification capture devices/environment(inside vs. outside), speaking softly, poor placement/quality of microphone/capture device, quality of capture device, variation in background noise
Signature Recognition	Signing too quickly, different signing position (sitting vs. standing)
Facial Recognition	Change in facial hair/hairstyle, lighting conditions, adding/removing hat/glasses, change in weight, change in facial aspect (angle at which facial image is captured), too much or too little movement, quality of capture device, change between enrollment and verification cameras (quality and placement), ‗Loud' clothing that can distract face location

2.2.3.   Comparison of Biometric Modalities

In biometric system, modalities of biometric have its own strength and weakness as well. Combinations of biometric devices can be implements to increase the strength of a security system. Combination of two systems such as facial recognition and fingerprint scanning is one of the examples of multimodal biometric system. The more biometric systems used in the combination, the more accurate the system will be. Only government facilities will choose to use combination of biometric due to require a high-security application and the high cost of the system. Table 2.2 below will show the strengths and weaknesses and applications of modalities of biometric systems.