DESIGN AND DEVELOPMENT OF LINUX-BASED FINGER-VEIN RECOGNITION SYSTEM

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Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
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BORANG PENGESAHAN STATUS LAPORAN
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Tajuk Projek : DESIGN AND DEVELOPMENT OF LINUX-BASED FINGER-VEIN RECOGNITION SYSTEM

Sesi Pengajian :

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DEDICATION

Sincere thanks to my supervisor for her guidance and support in completing this project. Special thanks to my family member and friend for their encouragement and moral support.

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ABSTRACT

In this era of growing technology, finger-vein recognition system is believed to play a vital role for security purposes. Although there were no many researches done regarding this, it has be started a few years back and proven to be one of the safest biometric systems in compare with others such as finger-print, iris, face and so on. This is because veins are an internal structure of our body and almost impossible to be forged and replicated. This project is basically about designing and developing a finger-vein recognition system in Linux platform. The recognition part of the finger-vein is applying Convolution Neural Network and work similar as pattern recognition. Convolution Neural Network technique gives the recognition accuracy at almost 100%. The whole system was developed in C Language and works in Ubuntu Operating System. The databases of the finger-veins images of are sources of Universiti Teknologi Malaysia (UTM) Laboratory.

ABSTRAK

Pada era teknologi yang semakin berkembang, sistem pengesahan urat-jari dipercayai memainkan peranan yang penting dalam sistem sekuriti. Walaupun tidak terdapat banyak kajian yang dilakukan mengenai ini, ia telah dimulakan beberapa tahun lalu dan terbukti salah satu sistem biometrik paling selamat jika dibandingkan dengan yang lain seperti cap-jari, iris, muka dan sebagainya. Ini adalah kerana urat merupakan struktur dalaman badan kita dan hampir mustahil untuk dibentuk dan direplika. Secara asasnya, projek ini adalah mengenai pembentukan dan pembanguanan sistem pengesahan urat-jari dalam platform Linux. Teknik Rangkaian Konvolusi Neural (CNN) telah digunakan untuk proses pengecaman urat-jari yang berfungsi sama seperti pengesahan corak (pattern recognition). Teknik Rangkaian Konvolusi Neural (CNN) memberi ketepatan menghampiri 100%. Keseluruhan sistem ini telah dilaksanakan dalam Ubuntu menggunakan Bahasa C. Pangkalan data imej urat-jari telah sumber daripada Makmal Universiti Teknologi Malaysia (UTM).

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ABBREVATION	MEANING
CNN	Convolution Neural Network
MLP	Multilayer perceptron
GUI	Graphical User Interface
GTK	Graphical Toolkit

CHAPTER 1

INTRODUCTION

1.1 Project Background

Biometric identification system has become one of the most effective tools used for security and privacy purposes nowadays. Biometric system is where a person's biological and behaviour characteristics are used in identification and verification purposes. Some of the famous biological characters used are fingerprint, face, voice, iris, and so on. Other than these, finger-vein is becoming more popular in these days as it can overcome the drawbacks of the previous biological characteristics in recognition purposes. Some of those drawbacks are like for finger print system, it has been proven that the artificial fingerprint can successfully bypass the system and the condition of the finger like dryness and sweat will affect the accuracy. The iris system can cause inconvenience to the user during the capturing process as the brightness of the light intensity, thus it is considered being less user-friendly.

Convolution Neural Network (CNN) is a feed-forward artificial neural network which is used in image recognition. It consists of multiple convolution and subsampling layer alternatively and ends with Multilayers Perceptron (MLP). In this project, the fused CNN method will be used where it consists of fused convolution

and subsampling layers comprised of 4 layers without considering the input layer which will end with MLP also. This MLP will be using the back propagation algorithm in achieving the desired output with highest accuracy possible.

Therefore this Convolution Neural Network (CNN) method will be used to recognize the finger-vein image [1]. The CNN algorithm will be developed in Linux-based C language. The pre-processing part of this system has already been developed in Windows-based MATLAB which will be translated to Linux-based C language. This is to improve the performance of the finger-vein recognition system in compare with the existing one. GUI using GTK will also be design and develop as a user interface for the system in Linux-based GLADE software.

1.2 Objectives

1. To translate the algorithm in Windows-based MATLAB to Linux-based C language for the pre-processing part.
2. To develop a Graphical User Interface (GUI) using GIMP Toolkit (GTK) in Linux-based system by GLADE software.
3. To develop a Linux-based finger recognition system which uses Convolution Neural Network (CNN)

1.3 Problem Statement

The main problem in the existing system is that the coding for the overall system are in different operating system where the pre-processing part is in Windows-based MATLAB and the CNN algorithm in LINUX-based C Language. Although these two algorithms can be synchronised manually for simulation purpose but it is not convenient for the users. Moreover, when the training of neurons was carried out in MATLAB can reduce the speed of the recognition operation.

1.4 Scope of Project

The scope of this project will be as follows:

1. The pre-processing part coding in the Windows-based MATLAB will be translated to Linux -based C language
2. The performance of the neural network is measured in percentage of accuracy.
3. A Graphical User Interface (GUI) using Graphical Toolkit (GTK) will be developed as a user interface in GLADE software.
4. The finger-vein databases that are going to be used are the ones that have been developed in-house by Universiti Teknologi Malaysia (UTM).
5. The design and development of the finger-vein capturing device is not included.

1.5 Significant of Project

The finger-vein recognition system in Linux-based Operating System which uses the Convolution Neural Network (CNN) for recognition purposes is suitable to be implemented in security system such as bank lockers, authorized place door lock, prison locks and luxury house and vehicles. In this case, the number crimes such as break in, hacking bank lockers and robbing or stealing can be reduced. This is because finger-vein as a biometric feature is hard to be replicated or duplicated. Unlike, password or keys, they are easy to be stolen and duplicated. In fact, the present fingerprint system is also not as effective as this finger-vein because the accuracy of fingerprint recognition can be affected by the condition of the finger like dryness and blur fingerprint. Furthermore, the accuracy of CNN recognition is very high where it is very close or almost 100% which makes the system nearly impossible to be forge.

1.6 Report Overview

There are overall 5 chapters in this report which are Introduction, Literature Review, Project Methodology, Result and Analysis and lastly Conclusion and

Suggestion. Chapter 1 discuss about the project background, problem statement, objective, scope of project and significant of project.

Chapter 2 is mainly about the literature review on the previous study of Biometric system, Convolution Neural Network, Finger-vein Recognition Method and reviews on the existing work.

Chapter 3 is the Project Methodology where all the method used to complete the project will be discussed. It also states the flow of the steps in completing this project.

Chapter 4 will brief regarding all the result obtain and result analysis to justify the performance of the project.

Lastly, Chapter 5 concludes the project and gives some suggestion the project produce for further improvement in future.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss about study related to this project such ad biometric system, Convolution Neural Network and finger-vein recognition methods.

2.1 Biometric System

In this era of technology, biometric system has gain more popularity in many fields. A biometric system is where a person's biological characteristics are used to identify a person. This is because biological characteristics are unique where it is different for each person. Biometric characteristics can be divided into two categories which are physiological characteristics such as finger-print, face, iris, DNA and finger-veins and behavioural characteristics voice, keystroke and signature as presented in Figure 2.1 [6].

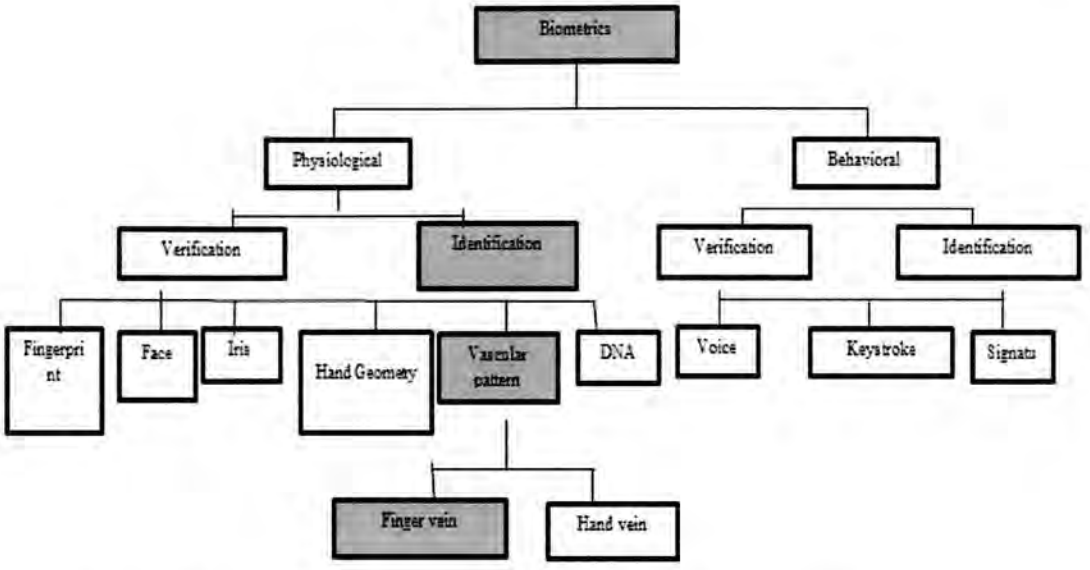

Figure 2.1: Taxonomy of biometric methods and characterization

The biometric system can be used for several purposes but identification and verification are the common ones. Biometric data extracted from the user will be compare with the templates saves it the database of a system for both identification and verification process [15]. In identification method the input data extracted from the user will be compared with the entire existing user in the database by searching through the entire database. It acts more like a matching process to find the identity of the input user. In verification process, the input data extracted from the user will be compared with a specific user template in the database.

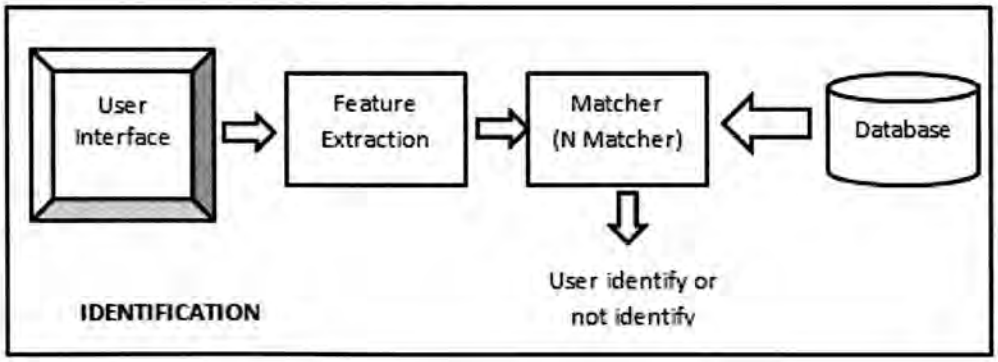

Figure 2.2: Example of identification Method [15]

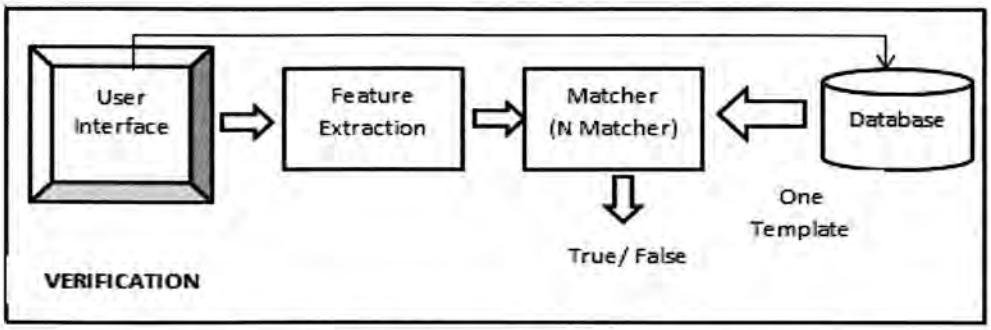

Figure 2.3: Example of identification Method [15]

Biometric system has become important in security system in compare with other types of security. This is because it has high reliability as biometric characteristics are difficult to be duplicated or lost in compare with securities such as key, smartcard and passwords are more likely to be stolen and duplicated. Among all the biometric characters, finger-vein has become the most advantage over others. Unlike finger-print, finger-vein is not exposes and it is inside the body makes it impossible to be duplicated. Furthermore, finger-veins are unique for each of us and do not change with time. It is consider being user friendly as the capturing device is contactless and does not cause any discomfort like iris detecting that might cause uncomfortable situation for the user due to the brightness of the light during capturing [12]. Face recognition are consider to be not accurate as it is influence by the facial expression during the capturing process whereas finger-vein has nearly accurate recognition system [8].

Table 2.1: Summary of biometric systems

Biometric Traits	Cost	Accuracy of recognition	Security Level
Fingerprint	Low	High	High
Face	Low	Moderate	Moderate
Voice	Low	Moderate	Moderate
Iris	High	Very High	Very High
Finger-vein	Low	Very High	Very High

2.2 Convolution Neural Network

Convolution Neural Network (CNN) is a feed-forward artificial neural network which is used in pattern recognition which was proposed by LeCun in handwriting characters recognition [13] .CNN consists of multiple convolutions and subsampling layers alternatively and ends with multilayer perceptron (MLP). This MLP will be trained by the back propagation algorithm in achieving the desired output. The feature extraction will be performed in convolution layer whereas local averaging is performed at subsampling layer.

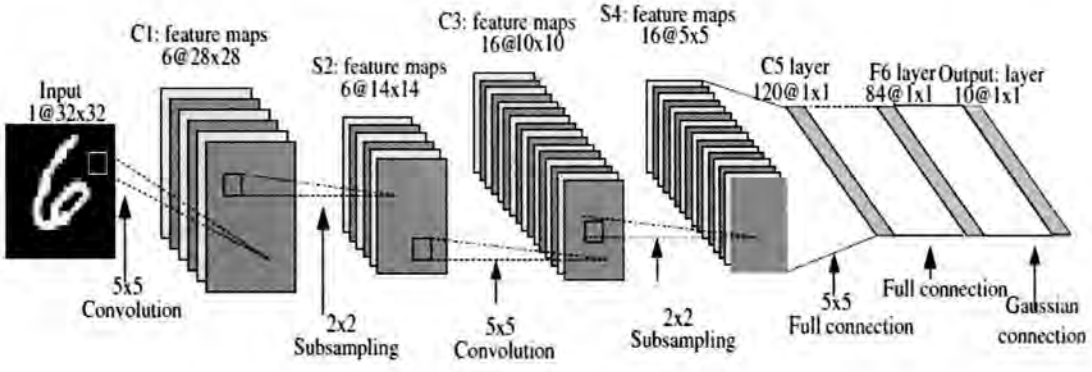

Figure 2.4: The equivalent LeNet-5 CNN architecture [8]

The proposed method used in this project was inspired from Simard [12] and used in finger-vein recognition [8]. The proposed topology is a fused convolution and subsampling layers comprised of 4 layers without considering the input layer. This architecture is known as the *5-13-50* model, implying that there are 5, 13 and 50 feature maps in layers C1, C2, and C3 respectively. Layer 4 (i.e. the output layer) is fixed at 50 neurons [8].

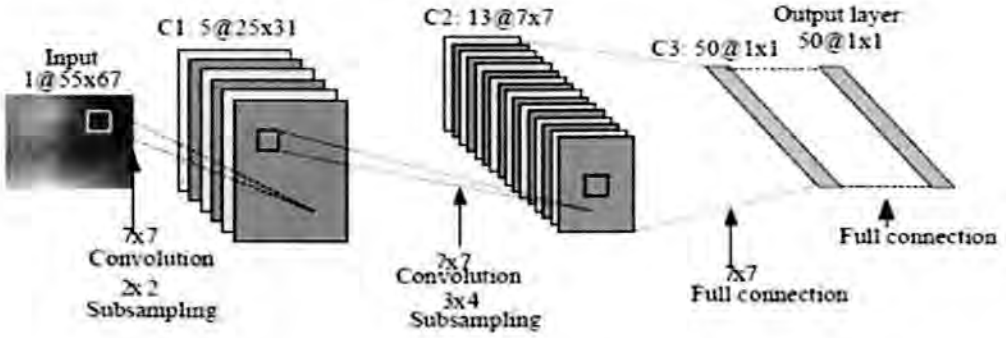

Figure 2.5: Topology of fused CNN architecture in finger-vein recognition [8]

The advantages of using fused CNN in compare with the conventional CNN are the ability to extract features and reduce data dimension. The extracted section will be train through CNN by learning the weights for the extracted features using back propagation method at the MLP layer. Only minimal pre-processing is required as CNN is able to ability to extract topological properties from raw image [3][15]. Moreover, CNN is robust to noise thus only minimal pre-processing are required for the recognition system where noise removal and image enhancement can be avoided.

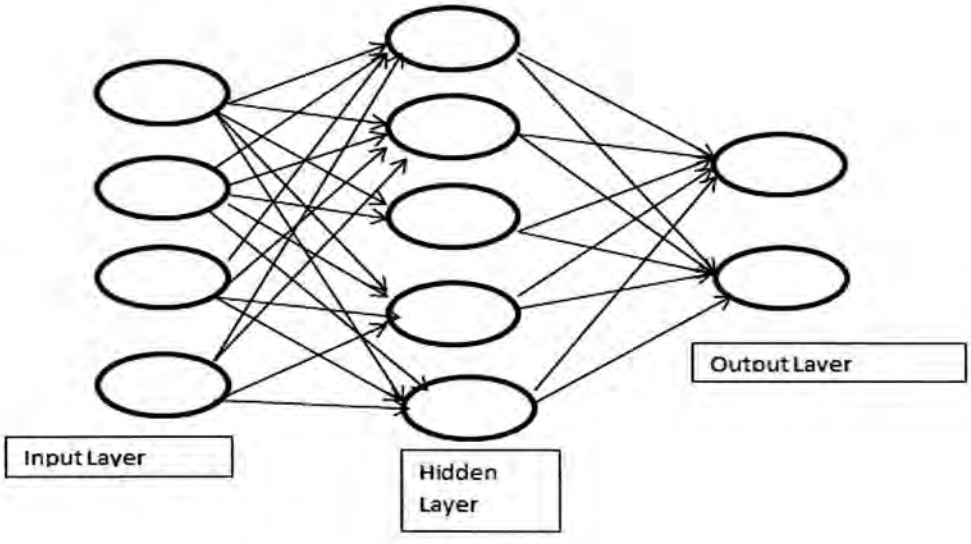

Figure 2.6 : The Architecture of Simple Neural Network