



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF FACE DETECTION AND RECOGNITION  
IN HOME SECURITY USING SURF FEATURE**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the **Bachelor of Electronic Engineering Technology (Telecommunication) With Honor's**.

by

**HAIRIL HASHIMIE BIN MOHAMAD ASRI**

**B071410025**

**910402-04-5467**

FACULTY OF ENGINEERING TECHNOLOGY

2018

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DEVELOPMENT OF FACE DETECTION AND RECOGNITION FOR HOME SECURITY USING SURF**

SESI PENGAJIAN: **2017/18 Semester 7**

Saya **HAIRIL HASHIMIE BIN MOHAMAD ASRI**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **\*\*Sila tandakan (✓)**

- SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
- TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
- TIDAK TERHAD

Disahkan oleh:

\_\_\_\_\_

Alamat Tetap:

\_\_\_\_\_

Cop Rasmi:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Tarikh: \_\_\_\_\_

Tarikh: \_\_\_\_\_

\*\* Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.



## FAKULTI TEKNOLOGI KEJURUTERAAN

Tel : +606 234 6623 | Faks : +606 23406526

Rujukan Kami (Our Ref) :

Rujukan Tuan (Your Ref) :

17 DECEMBER 2017

Pustakawan  
Perpustakaan UTeM  
Universiti Teknikal Malaysia Melaka  
Hang Tuah Jaya,  
76100 Durian Tunggal,  
Melaka.

Tuan/Puan,

### **PENGKELASAN LAPORAN PSM SEBAGAI SULIT/TERHAD LAPORAN PROJEK SARJANA MUDA TEKNOLOGI KEJURUTERAAN PEMBUATAN (BETT): HAIRIL HASHIMIE BIN MOHAMAD ASRI**

Sukacita dimaklumkan bahawa Laporan PSM yang tersebut di atas bertajuk  
“**DEVELOPMENT OF FACE DETECTION AND RECOGNITION IN HOME  
SECURITY USING SURF FEATURE**” mohon dikelaskan sebagai \*SULIT /  
TERHAD untuk tempoh LIMA (5) tahun dari tarikh surat ini.

2. Hal ini adalah kerana **IANYA MERUPAKAN PROJEK YANG DITAJA  
OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.**

Sekian dimaklumkan. Terima kasih.

Yang benar,

\_\_\_\_\_  
Tandatangan dan Cop Penyelia

\* Potong yang tidak berkenaan

**NOTA: BORANG INI HANYA DIISI JIKA DIKLASIFIKASIKAN SEBAGAI  
SULIT DAN TERHAD. JIKA LAPORAN DIKELASKAN SEBAGAI TIDAK  
TERHAD, MAKA BORANG INI TIDAK PERLU DISERTAKAN DALAM  
LAPORAN PSM.**

## **DECLARATION**

I hereby, declared this report entitled “Development of Face Detection and Recognition in Home Security” is the results of my own research except as cited in references.

Signature : .....

Author's Name : HAIRIL HASHIMIE BIN MOHAMAD ASRI

Date : 26 MAY 2017

## **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 of Electronic Engineering Technology (Telecommunication) With Honor's. The member of the supervisory is as follow:

.....

(Project Supervisor)

## **ABSTRAK**

Kemajuan dalam bidang teknologi pada masa kini semakin pesat membangun. Segala sistem yang dibangunkan mempunyai satu matlamat iaitu melaksanakan suatu sistem yang beroperasi secara automatik tanpa memerlukan tenaga manusia untuk menjalankan sesuatu tugas atau perkara. Hal ini menjadi objektif utama dalam penghasilan projek tahun akhir ini. Projek ini memfokuskan penghasilan suatu sistem pengesanan dan pengecaman muka secara automatik untuk diguna pakai ke sesuatu kemudahan dan rumah atas dasar keselamatan. Penggunaan teknik pengolahan gambar dalam proses membezakan muka yang dikesan secara langsung melalui kamera turut diguna pakai untuk membolehkan muka seseorang itu dapat dikesan melalui sistem ataupun tiada maklumat mengenai muka yang dikesan tersebut. Pengolahan sistem yang digunakan didalam projek ini mungkin boleh ditambah dengan teknik-teknik lain yang berkenaan dengan pengolahan gambar untuk menghasilkan suatu sistem yang lebih efisien pada masa akan datang.

## **ABSTRACT**

The evolvement of technology nowadays is growing rapidly. Implementing a system that can operate fully automatic without requiring any manpower to carry out some task will be a main goal of building an advanced technology system. Hence, as that being mentioned, the goal of developing this project are derived from that concept. This project focuses on the creation of a system that can run a detection and recognition on faces to be used in facilities or any premises prior to safety concern. Implementation of image processing techniques are considered as a key role or major part in this process of distinguishing faces detected directly through the camera and followed by recognition process that will let the system know either the faces are known or unknown. Technique that is being used in this system can be improved in regard to give more robustness and efficiency for the system to work by implementing such related technique and do-able with the current technique used in this project for future development.

## **DEDICATION**

To my beloved parents

MOHAMAD ASRI BIN DAUD

ROHAYA BINTI OSMAN

To supervisor

MADAM SITI HARYANTI bt HAJI HAIROL ANUAR



## **ACKNOWLEDGEMENT**

I would like to express my special thanks of gratitude to my supervisor Madam Siti Haryanti binti Haji Hairol Anuar for his sincere guidance along the project. Secondly, I also would like to thank my panels, lecturer and friends for their contributions into my project by giving comments and advice to improve it.

Lastly, I would also like to thank my parents for their prayers and support along the journey of my study. I wouldn't be able to make my way without them.

# TABLE OF CONTENT

DECLARATION .....	iv
APPROVAL.....	v
ABSTRAK.....	vi
ABSTRACT.....	vii
DEDICATION .....	viii
ACKNOWLEDGEMENT.....	ix
TABLE OF CONTENT .....	x
LIST OF TABLES.....	xii
LIST OF FIGURES.....	xiii
LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE .....	xvi
CHAPTER 1 .....	1
1.0    Introduction .....	1
1.1    Neurons.....	1
1.1.1    Types of neurons.....	3
1.1.2    Synapses.....	4
1.1.3    Nerve Impulses .....	4
1.1.4    The synapse .....	5
1.1.5    Neurotransmitter .....	5
1.2    Biometric as A Security Approaches .....	6
1.2.1    Feature extraction .....	11
1.2.2    SURF algorithm .....	12
1.3    Problem statement .....	12
1.4    Objective .....	13
1.5    Work scope .....	13
CHAPTER 2 .....	14
2.0    Introduction .....	14
2.1    The Human Sense .....	14
2.2    Visual Cortex .....	14
2.2.1    Principles of Memory.....	15
2.2.2    Recall Process.....	17

2.2.3	Recognition Process .....	17
2.3	Biometric Technologies.....	18
2.4	Brief History of Biometrics.....	20
2.4.1	Timeline of Biometrics System Development.....	21
2.4.2	Basic Function of Biometrics.....	24
2.5	Face Detection .....	25
2.5.1	Face Recognition.....	28
2.6	An Approaches.....	35
2.6.1	Neural Network method:.....	35
2.6.2	SURF method: .....	45
<b>CHAPTER 3</b>	.....	<b>50</b>
3.0	Background .....	50
3.1	Flowchart .....	50
3.1.1	Ubuntu .....	53
<b>CHAPTER 4</b>	.....	<b>67</b>
4.0	Introduction .....	67
4.1	Linux trial .....	67
4.2	MATLAB as an approach .....	71
4.3	Neural Network.....	79
<b>CHAPTER 5</b>	.....	<b>105</b>
5.0	Conclusion.....	105
5.1	Recommendation.....	106
<b>REFERENCES</b>	.....	<b>107</b>

## LIST OF TABLES

Table 1 List of Biometric Characteristic	7
Table 2 Comparison Between Different Types of Biometric Characteristics	9
Table 3 Basic Function of Biometric	25
Table 4 DoubJ Pixel Values of Image	84
Table 5 DoubQ Pixel Values of Images	84
Table 6 Image into Vector Process	4
Table 7 Image Conversion from Vector into Indices	84
Table 8 Distance Test	104
Table 9 Number of Stacked Image Test	105

## LIST OF FIGURES

Figure 1.1: Erythrocyte Cell in Blood Cells	2
Figure 1.2: Hepatocyte Cell in Liver	2
Figure 1.3: Osteocyte Cells in The Bone	3
Figure 1.4: Axodendritic Synapse Cell	4
Figure 1.5: Types of Biometric Characteristics	7
Figure 1.6: Biometric System Implied on Passport for Security Purpose	7
Figure 2.0: Process of Recognizing an Object in Visual Cortex	16
Figure 2.1: Brain Part and Its Function	18
Figure 2.2: Example of structural face model	28
Figure 2.3: Principal Component Analysis Face Recognition	31
Figure 2.4: The Euclidean Distance Computation	32
Figure 2.5: A face detection by Lalendra Sumitha Balasuriya	33
Figure 2.6: Frontal view face detection model	34
Figure 2.7 Result table of “Peculiar images distribution on datasets	35
Figure 2.8: Face detection process using basic algorithm	36
Figure 2.9: Pre-processing windows step (a) Oval mask for ignoring background pixel (b) Original window (c) Best fit linear function (d) Lighting corrected window (e) Histogram equalized window	37
Figure 2.10: Images with all the above threshold detection	37
Figure 2.11: Overlapping elimination or so called “heuristic”	38
Figure 2.12: Output from two networks ANDing together to improve accuracy level	39
Figure 2.13: Inputs and architecture of the arbitration network	40
Figure 2.14: LBP code formation	41
Figure 2.15: Interested region part of face images	42
Figure 2.16: Images formation from LBP algorithm	42
Figure 2.17: Sparse and Tight histogram	43
Figure 2.18: Back propagation network architecture	44
Figure 2.19: The RBF network architecture	44
Figure 2.20: Example image from reference set (left) and test set (right). Different in color and viewpoint	46
Figure 2.21: Repeatability score for image sequences. From left to right, top to bottom	46
Figure 2.22: Precision graph from left to right, top to bottom	47
Figure 2.23: (a) The number of weak classifier at each stage of detector (b) the accumulated rejection rate over the cascaded stage of the face detector	48
Figure 2.24: Top 3 local patches selected by training procedure in the red-green-blue order	48

Figure 2.25: SIFT key point on the left and SURF key point on the right for 420x380 images	49
Figure 2.26: Performance comparison of SIFT and SURF	49
Figure 2.27: SURF feature matching on a set of images	50
Figure 3.1: Work process flowchart	52
Figure 3.2 RUFUS program for burning the ISO file	55
Figure 3.3: Boot menu to enable the installation process take part	56
Figure 3.4: Dual boot operating system	56
Figure 3.5: Ubuntu interface with command terminal to run the code	57
Figure 3.6: Python default version in Ubuntu 16.04	58
Figure 3.6: Python default version in Ubuntu 16.04	59
Figure 3.8: Tensorflow environment activated	60
Figure 3.9: MATLAB interface	61
Figure 3.10: Button add-on to install require package for specific task	61
Figure 3.11: List of package installer for hardware support	62
Figure 3.12: First step of configuring list of cameras	63
Figure 3.13: Second step of identifies the camera ID	63
Figure 3.14: Steps in configuring the camera support resolution along with installed camera in the computer in another type of command	64
Figure 3.15: Deep learning toolbox for machine learning	65
Figure 3.16: NNTOOL command line and toolbox interface	65
Figure 3.17: NNSTART command and toolbox	66
Figure 3.18: NNSTART toolbox interface	66
Figure 4.1: Real time face recognition and detection using tensor flow	69
Figure 4.2: Real time robust feed for recognition process	69
Figure 4.3: Error message on the program	71
Figure 4.4: Error message on syntax and indent used in the code line	72
Figure 4.5: Command line for object detection and recognition using Alexnet	73
Figure 4.6: Output image 1 from the recognition process	74

Figure 4.7: Output image 2 from the recognition process	74
Figure 4.8: Command line for detecting the face in images feed	75
Figure 4.9: Output from the detected faces	76
Figure 4.10: Nose detection code	76
Figure 4.11: Output for nose detection	77
Figure 4.12: Command line for extracting eyes feature	77
Figure 4.13: Output from eyes feature extraction	78
Figure 4.14: KLT algorithm face detection	79
Figure 4.15: Image capture coding for 3 images	81
Figure 4.16: Command line for neural network image preprocessing	82
Figure 4.17: First step where two images need to be pick from selected folder	83
Figure 4.18: Gray images selected to be process	83
Figure 4.19: Selecting the pattern recognition app to make a classification and recognition over the images	85
Figure 4.20: Fetch over the converted images into the input and target to be train by the neural network	86
Figure 4.21: Set the values for the required condition in training and validate the data feed inside the network	86
Figure 4.22: Set the number of neuron in the hidden layer of the network	87
Figure 4.23: Training the network and error on the class inputs feed into the network	87
Figure 4.24: Menu option	90
Figure 4.25: Refresh option 2	90
Figure 4.26: Popup windows for user detail	91
Figure 4.27: Interface of SURF face detection and recognition	97
Figure 4.28: Image classification and extraction kept inside database	97
Figure 4.29: Recognition of detected faces and display the person known from the database	98
Figure 4.30: Example of montage stacked image	98
Figure 4.31: Input image	99
Figure 4.32: Test image	99
Figure 4.33: Key point feature extractor using blobs	100
Figure 4.34: SURF matches key point	101
Figure 4.35: Test image 1	102
Figure 4.36: Test image 2	102
Figure 4.37: Key point feature extractor using blobs	102
Figure 4.38: SURF matches key point	103

# LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

SURF	-	Speeded up robust features
Nntool	-	Neural Network toolbox
SOM	-	Self-Organizing Map
GABA	-	Gamma-Aminobutyric acid
ID	-	Identity
ECG	-	Electrocardiography
EEG	-	Electroencephalogram
AdaBoost	-	Adaptive Boosting
SnoW	-	Sparse Network of Winnows
SIFT	-	Scale-invariant Feature Transform
ISO	-	International Organization for Standard
ICAO	-	The International Civil Aviation Organization
MRTDs	-	Machine-Readable Travel Documents
ABIS	-	Automated Biometric Identification System
DoD	-	Department of Defense
DNA	-	Deoxyribonucleic Acid
VOC	-	Visual Object Classes
PCA	-	Principal Component Analysis
FOI	-	FaceOnIt
LBP	-	Local Binary Pattern
FDLib	-	Face Detection Library
FSDK	-	Face Software Development Kit
AUC	-	Accurate Unconstrained Face Detector
FLD	-	Fisher Linear Discriminant
NNSTART	-	Neural Network Start
KLT	-	Kanade - Lucas -Tomasi feature track



# CHAPTER 1

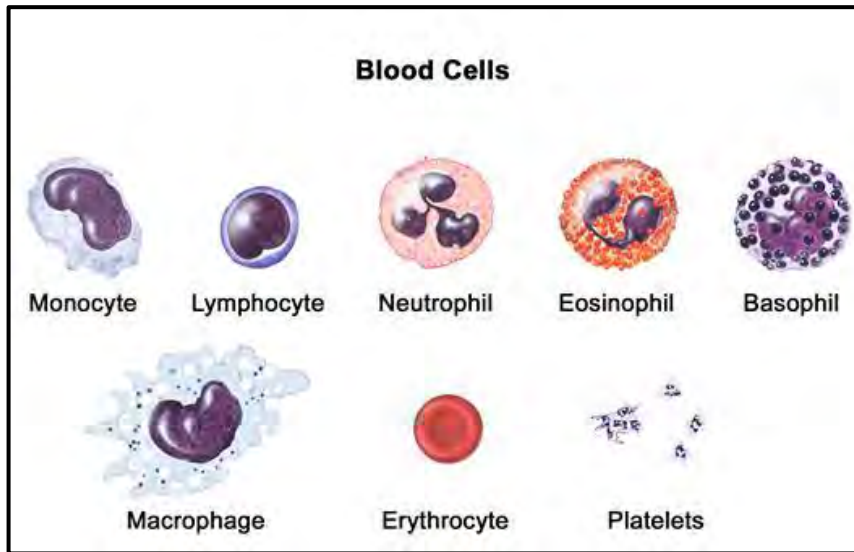
## INTRODUCTION

### 1.0 Introduction

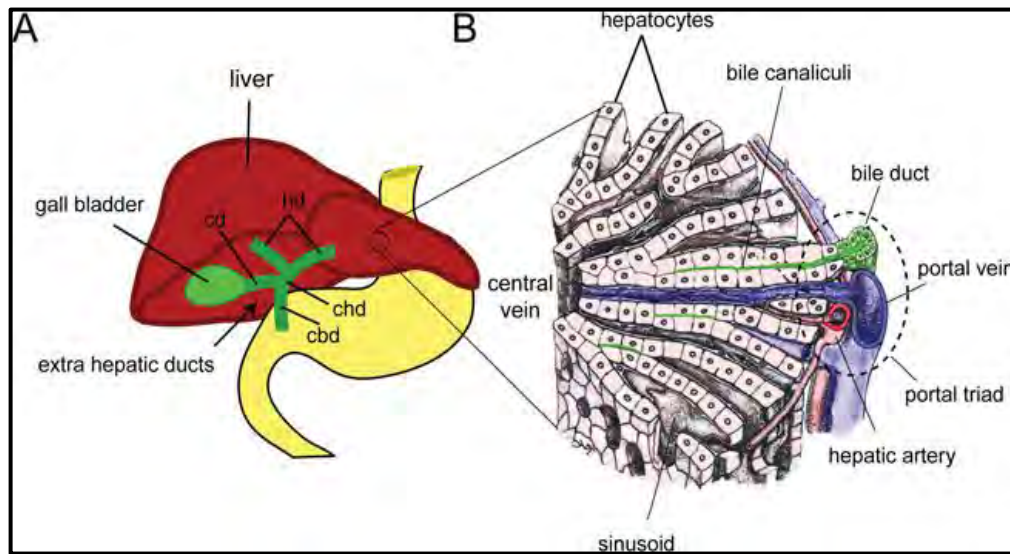
This chapter generally describe an overview of this project. Thus, it will cover out aspect like the background of the project, objective, problem statement and scope. The organization of the report are also state in this chapter for the preview of the report ahead.

### 1.1 Neurons

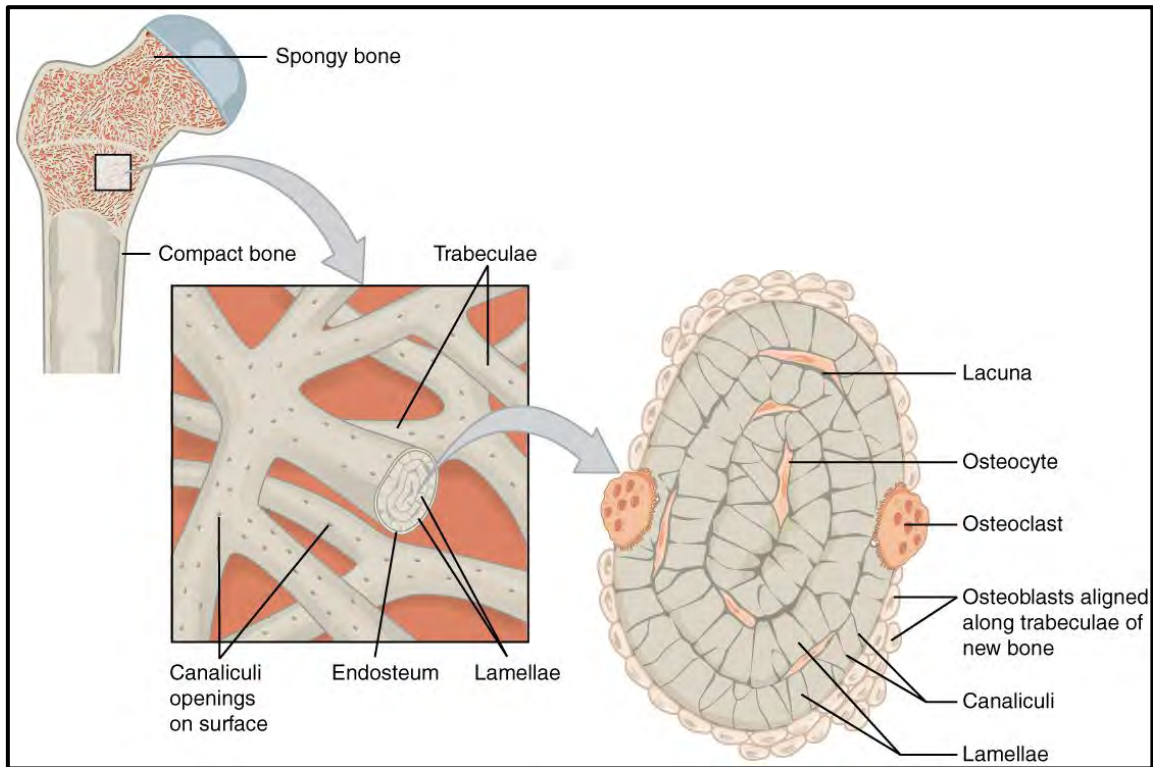
There are various of neuron such as hepatocyte cells in the liver, osteocytes in bone or may the erythrocytes in blood. For each of those neurons listed it is a self-contained functioning unit and its internal component consist of, the organelles, nucleus harboring the genetic material, energy-providing mitochondria, and protein- making ribosomes. Like most of the other type of cells, the organelles are concentrated in the main cell body and the feature characteristic are neurites- long, thin, fingerlike extensions from the cell body (soma). Categorized into two main types which are dendrites and axons. Dendrites carry out function of receiving the nerve signal while the axons send the signal received onwards.



*Figure 1.1: Erythrocyte Cell in Blood Cells*



*Figure 1.2: Hepatocyte Cell in Liver*



*Figure 1.3: Osteocyte Cells in The Bone*

### 1.1.1 Types of neurons

Categorizing the types of neuron are measure throughout the location of the neuron inside of the cell body. It relates to the axons and dendrites and also the number of dendrite and axon branches which will be one of the key factor in categorizing the type of neuron. At some part of the brain, neuron types can be easily recognized and organized like one close to the retina. Inside of this retina it consists ranks of bipolar neurons. But in some regions, this neuron is mixed in shape and eventually form an interconnected web of the complex neurons. In the cortex of brain, one neuron may receive signals from many thousands of other neurons via its multitudinous branching system.

### 1.1.2 Synapses

Represent a communication sites of where neurons are delivering the nerve impulses among themselves. Typically, it is not usually in actual physical contact because it is separated by an incredibly thin gap, called the synaptic cleft. Under microscopic view, the synapses are divided into types in relation to its sites where the neuron almost touch and the sites includes of soma, dendrites, axons, and the tiny narrow projection called dendritic spines of which can be found in some of the dendrites. Axodendritic synapses form more than 50 percent of all synapses in the brain and in addition, it covers up most of the brain part to almost 30 percent of it.

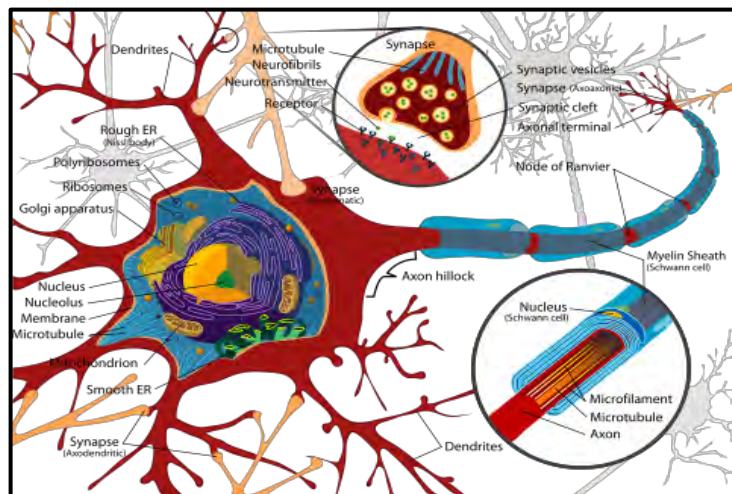


Figure 1.4: Axodendritic Synapse Cell

### 1.1.3 Nerve Impulses

Nerve impulse can be defined as a tiny, brief ‘spike’ of electricity travelling throughout a neuron. Basically, it consists of chemical particles moving across the cells out of the membrane from one side to other. For each

one of impulses, it was caused from the travelling 'wave' of the chemical particles known as ions where it has an electrical charge and are mainly made of the minerals sodium, potassium and also chloride. Inside of the brain, most impulses in most neurons are of the same strength at about 100 millivolts for one millisecond depending on the varying speed. Information signal deliver by these impulses are according to how frequents they pass in term of impulses per seconds, the origins of the impulses and where they are heading to.

#### **1.1.4 The synapse**

Synaptic cleft which separates the membranes of sending and receiving cells has a width around 20nm and it is narrow for the neurotransmitter molecules can pass across over it extremely quick through simple diffusion process. Diffusion process are where it is moving from a region of higher concentration to much lower concentration. The time taken are relying on the neurotransmitter for the impulse to pass from pre- to post synaptic membranes are typically less than 2ms. And right after then, there is a recovery delay or clearance time which occurred when the concentration of neurotransmitter subsides and right before the next impulse can be sent cross over (Carter, 2009).

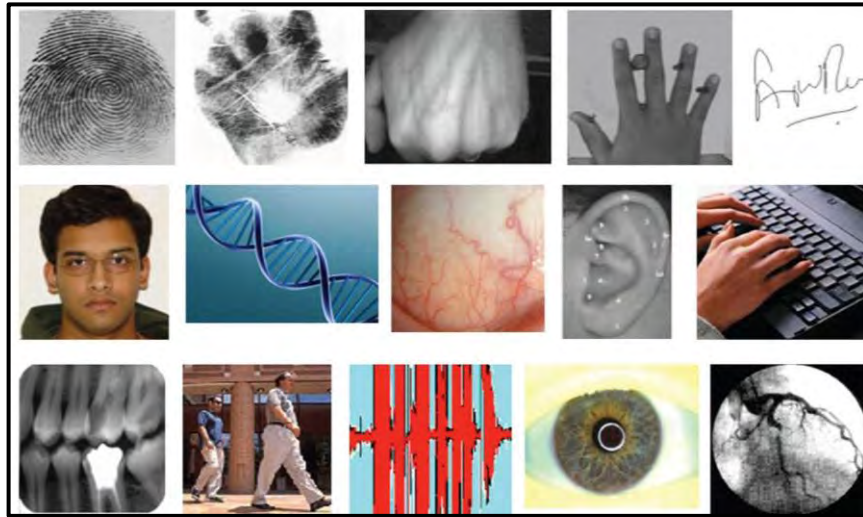
#### **1.1.5 Neurotransmitter**

Neurotransmitter are chemicals that allow signals to pass between the neuron and another cell. There are many different group of neurotransmitter molecules such as one that only have acetylcholine, second group commonly known as biogenic amines or monoamines which also includes dopamine, histamine, norepinephrine and serotonin. For the third group, it was a mixture of amino acids like GABA, glutamic acid, aspartic acid and glycine. Apart of this substances role in the neurotransmitter, it also plays another role on another part

of the body. As for example, the histamine involves in the inflammatory response, and the amino acid act as builder to the blocks for hundreds of kinds of protein molecules (Carter, 2009).

## **1.2 Biometric as A Security Approaches**

Nowadays, people are using a group of alphabet and number as their secret access to some specific account. Although it is unique as it were a combination of alphabet and numbers, yet it is not guarantee as it easily forgotten or stolen which happened because of breach in the security by the hacker. Thus, it driven the engineer to comes up with more complex and more advance security method to ensure the safeness of the account and as for example the biometric system. Biometric is a method used to identify an individual by unique approach which are the person physiological, behavioral and psychological characteristic possess by that person. Key feature that is important for this system to work are the face, finger print, iris, palm, finger vein and way many more. Each feature carried out different kind of technique like the face recognition, finger print recognition, iris recognition and others too. According to Ioan Buciu and Alexandru Gacsadi, the futuristic which best define biometrics such as the behavioral characteristic and physiological characteristic are one that will discriminate one individual from another's. and the great interest in biometrics system become of demanded system in the field of secureness. The objective in developing the biometrics recognition system is either automatic identification or verification of identities. Throughout the obtainable input varies from images, speech or may so from the video. Compare that with the traditional identification and verification method, this system is much more efficient and convenient to used where it will not be having any widespread problem like forgetting the required ID and password, and absolutely it cannot be stolen (Buciu and Gacsadi, 2016).



*Figure 1.5 Types of Biometric Characteristics*

*Table 10 List of Biometric Characteristic*

<b>Physiological</b>	<b>Behavioral</b>	<b>Psychological</b>
Face	Voice	Brain function
Fingerprint	Signature/handwriting	Cognitive-based biometric system
Iris	Keystroke dynamic	
Palm	Gait	
Ear	Heart beat	
Vein	Breath pattern	
Footprint	EEG	
retina	ECG	



*Figure 1.6: Biometric System Implied on Passport for Security Purpose*

*Table 11 Comparison Between Different Types Of Biometric Characteristics*

Face detection is a method used to determine whether there are any faces in the image and the location of each face if there is. In classic face detection, there are several types of it which include AdaBoost, Gabor neural network, neural network and SNoW. Each of it have their own specific features which might be handy for the user as for example the AdaBoost technique have much faster face detection while for a better accuracy, user can choose SNoW algorithm of which according to an evaluation made through public access database.