# CHARACTER RECOGNITION USING NEURAL NETWORK

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## PROJEK SARJANA MUDA II

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I hereby, declare this thesis entitled "Character Recognition using Neural Network" is the result of my own research except as cited in the references.


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# ABSTRACT

Humans have the ability to recognize characters. For example, human can distinguish between different characters and recognize them easily as an A or a B and so on. Therefore, project is intended to develop a neural network system that is able to perform character recognition, particularly English alphabets. Neural network is a system inspired by human brain function; consists of neurons connected in parallel with the ability to learn. A basic design of neural network has input layer, hidden layer, and output layer. The use of neural network can improve the quality of recognition while achieving good performance. A total of 650 samples characters are used with 25 samples of each character. The performance of evaluation is divided to 80% of training and 20% for testing. Scaled conjugate gradient training function is used as this function can perform faster in pattern recognition as well as its small memory requirement. Two training methods are used. The first one is the Gradient Technique with 39 neurons in hidden layer. The second training method is Geometric Feature Extraction with 35 neurons in hidden layer. Gradient Technique and Geometric Feature Extraction; both show an excellent recognition rate of 94.6% and 94.3% respectively. The output of recognized characters is shown in a .txt file.

# ABSTRAK

Manusia mempunyai keupayaan untuk mengenal pasti abjad. Sebagai contoh, manusia boleh membezakan antara abjad-abjad yang berbeza dan dengan mudah dapat mengenali sama ada abjad tersebut adalah A atau B dan sebagainya. Oleh itu, projek ini bertujuan untuk membina satu sistem rangkaian neural dengan keupayaan untuk melaksanakan pengecaman abjad, terutamanya huruf bahasa Inggeris. Rangkaian neural adalah satu sistem yang diilhamkan oleh fungsi otak manusia; yang terdiri daripada neuron-neuron yang disambung secara selari yang berkebolehan untuk belajar. Reka bentuk rangkaian neural yang asas mempunyai lapisan input, lapisan tersembunyi, dan lapisan output. Penggunaan rangkaian neural boleh meningkatkan kualiti pengecaman abjad disamping mencapai prestasi pengecaman yang baik. Sejumlah 650 sampel abjad yang telah digunakan bersamaan dengan 25 sampel bagi setiap abjad. Penilaian prestasi dibahagikan kepada 80% latihan dan 20% untuk ujian. Skala konjugat kecerunan digunakan sebagai fungsi latihan kerana fungsi ini mempunyai keupayaan yang lebih cepat dalam pengecaman corak serta memerlukan memori yang kecil. Terdapat dua kaedah latihan yang digunakan. Yang pertama adalah teknik kecerunan yang mempunyai 39 neuron di lapisan tersembunyi. Manakala kaedah latihan yang kedua adalah pengekstrakan ciri geometri yang mengandungi 35 neuron di lapisan tersembunyi. Teknik kecerunan dan pengekstrakan ciri geometri ini masing-masing menunjukkan kadar pengenalpastian abjad yang sangat baik iaitu 94.6% dan 94.3%. Output bagi abjad yang dapat dikenalpasti dipaparkan dalam fail .txt.

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# LIST OF ABBREVIATIONS

**FYP**    Final Year Project

**NN**    Neural Network

**SVM**    Support Vector Machine

**ANN**    Artificial Neural Network

**MDA**    Multi-linear Discriminant Analysis

**MSE**    Mean squared error

**PSNR**    peak signal-to-noise ratio

**RGB**    Red-Green-Blue (True color compound)

**GUI**    Graphical User Interface

# CHAPTER 1

# INTRODUCTION

This chapter discusses the project introduction, objectives of project, the problem statement, and the scope of work and limitations of project, proceeding with a brief explanation of project methodology and the report structure.

## 1.1 Project Background

Character recognition is described as an easy way for machine to read scripts and digits. Neural network is a design of computational model based on human brain to solve certain kinds of problems.

The idea is developing a system with neural network training that can helps performing character recognition process. Due to the limitations of classical computing, applying neural network serve for the emulation of human thinking in computations.

This project aims to feed specifically handwritten English alphabets an input, process the characters, train the characters using neural network algorithm, to recognize the structure of characters, and matches the outputs with the desired targets.

To be more specific, this project is mainly focused on the development of a neural network algorithm by using MATLAB software as the platform. The detailed study of the performance of neural network through learning from its environment and the accuracy of the system would be carried out.

## 1.2 Problem Statement

Conventional computers use an algorithmic approach which defines the procedural term to solve problems. The algorithmic approach means that a computer

follows a set of instructions in order to solve problems. The procedural term means; a program starts at the first line of code, executes it, and goes to the next instruction in linear pattern.

Unless the specific steps that the computer needs to follow are known the computer cannot solve the problem. That restricts the problem solving capability of conventional computers to problems that already been understand.

Neural networks, with its remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. Therefore, neural network can be utilized to reduce humans' errors while performing mundane tasks like digitization and statistical analysis. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. This expert can then be used to provide project and implementations given new situations of interest and answer "what if" questions.

## 1.3 Objectives

The main requirement of this project is to develop a system that can recognize character using the neural network method. Therefore, the following objectives need to be achieved to satisfy the development of the project.

   i. To study Neural Network algorithm and develop a system that is able to recognize characters using MATLAB.
  ii. To detect, extract and recognize characters, particularly English alphabets using Neural Network.
 iii. To analyze performance of the neural network.

## 1.4 Scope and Limitation

This project is only focusing in developing neural network algorithm for character recognition application. For this project, characters are freely written in Paint tools, saved the characters in any image format, and later is took as samples for training

and testing purposes. The entire process of completing the project will be done in MATLAB. The MATLAB is chosen because it is a user friendly tool and easy to understand the coding implementation.

There are several limitations that have been considered while completing this project. The first limitation is in data collecting. Handwritten data will not be included to perform the process of recognizing characters. No scanned handwritten image character will be used. There is also limitation in training approach method. Due to the high difficulty and deep learning of unsupervised training, the supervised training is chosen as the desired output has been provided for the network.

## 1.5 Project Methodology

There are three main components to be concerned to complete this project. There are:

    i.    Pre-processing
   ii.    Feature extraction
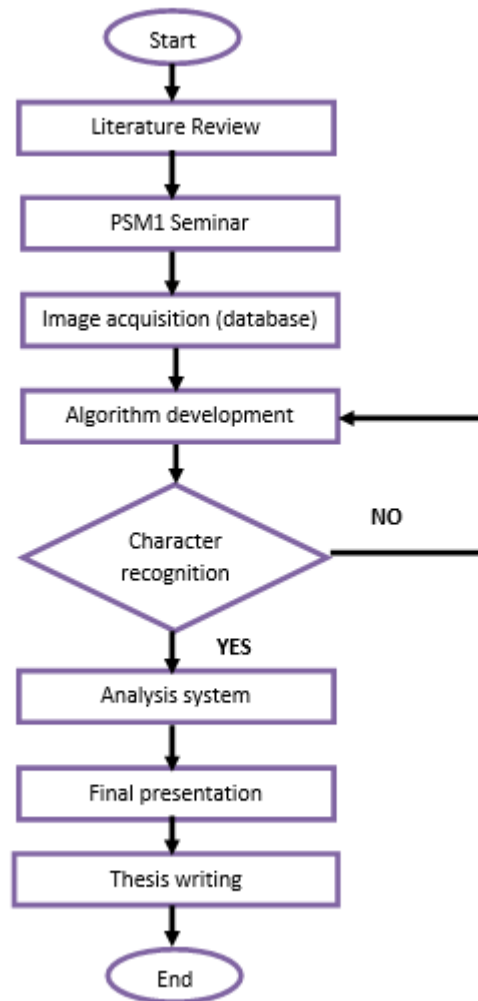  iii.    Classification and recognition

Figure 1.1: Process flow for Final Year Project (FYP)

## 1.6 Report Structure

The report consists of five chapters that conclude a complete discussion of the project. Chapter 1 describes an overview of the project. In Chapter 1, the objectives, problem statement, and scope of work are explained. The objectives define the desired and expected outcome to be achieved from the project. Problem statement discusses the related issues to be solved while improving the current solved problems. Scopes of work define the limitations and consideration taken throughout the project completion.

Chapter 2 is the background study of the project. Previous studies and researches that have been done are reviewed to help in processing data while conducting the project. The relevant researches are taken from journals, technical papers, and books.

Chapter 3 consists of the procedures and methodology performed in order to complete the project. This chapter will also describe the project flow in details.

The outputs from the project is discussed in Chapter 4. All the results will be stated in this chapter in details explanation. The performance of proposed model will be discussed briefly.

The last part, Chapter 5 concludes the project following some recommendations to help improving the project in future. This chapter will also state either the objectives of the project are effectively achieved or partially achieved with some comments.

# CHAPTER 2

## LITERATURE REVIEW

This chapter describes the background studies related to the development of project. Some important ideas and findings from previous researches are presented in order to provide better understanding on the subject. It also helps to formulate new ideas, methods and act as the benchmark for this project. Also the basic theories of character recognition and neural network will be review.

## 2.1 MATLAB

MATLAB or Matrix Laboratory is a fourth-generation programming language and numerical computing analysis environment. MATLAB is used in many fields include image processing, communications, control design, and robotics. MATLAB allows matrix calculation, developing and running algorithms, creating user interfaces, data visualization, and interfacing with programs developed in other languages including Java and FORTRAN. MATLAB's built-in graphics make it easy to visualize and gain insights from data. A vast library of prebuilt toolboxes lets users get started right away with algorithms essential to required domain.
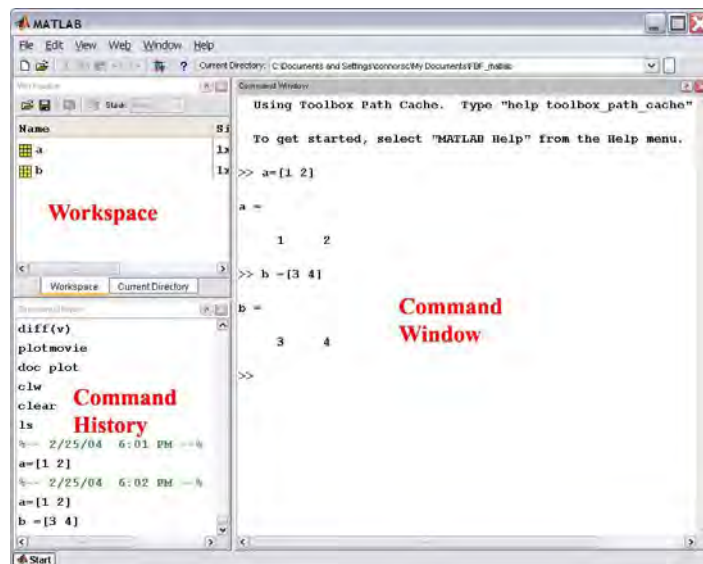


Figure 2.1: MATLAB symbol

Figure 2.2: MATLAB platform

## 2.2 Image processing

A process that deals with manipulating digital images through digital computer as processing tool is known as digital image processing. Digital Image Processing focuses on developing a system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output.

Two branches of digital image processing are pre-processing and post-processing. Pre-processing includes image acquisition, binarization, noise filtering, and many other methods. Post-processing includes edge detection, segmentation, pattern recognition, and many other methods.
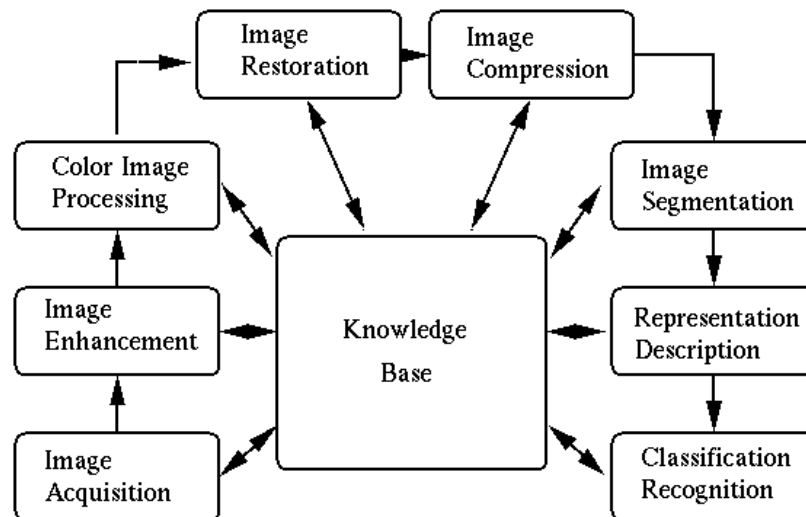
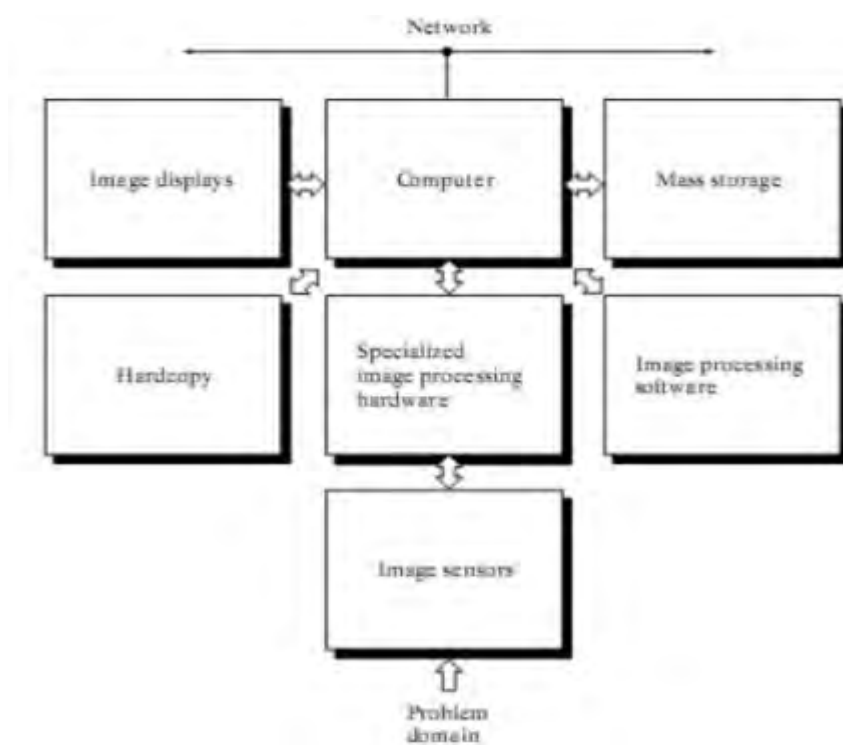Figure 2.3: Fundamental of digital image processing



Figure 2.4: The components of image processing system

Data preprocessing converts raw data and signals into data representation suitable for application through a sequence of operations. The objectives of data preprocessing include size reduction of the input space, smoother relationships, data normalization, noise reduction, and feature extraction.

Research in the field of pre-processing on character recognition using neural network is an improvement of the image data that suppresses unwanted distortion. Image pre-processing is the technique of enhancing data images prior for further processing.

### 2.2.1 Image processing in MATLAB

Digital image processing is the use of computer algorithms to create, process, communicate, and display digital images. Digital image processing algorithms can be used to convert signals from image sensor into digital images, improve clarity, remove noise, compress images for communication across a network, and extract the size, scale, or number of objects in a scene. Effective techniques for processing digital images include using algorithms and tools that provide a comprehensive environment for data analysis, visualization, and algorithm development.



Figure 2.5: The example of image processing using MATLAB for counting circular objects in an image

### 2.3 Character Recognition

Character recognition has been a topic of interest recent few years. The ability to identify machine printed characters in an automated or semi-automated manner has obvious applications in numerous fields. It is impossible to develop an algorithm with perfect correct recognition rate, hence while designing algorithms it is important to consider failures of a system so that it will at least be predictable when mistakes are made. Different algorithms and approaches can be performed with these failures in mind to create a very low error system.

### 2.3.1 Handwritten character recognition

Handwritten character recognition takes handwritten input from sources such as touch screens and paper documents to be interpreted by a computer. The written text image may be sensed as offline from a piece of paper by intelligent word recognition. For a pen-based computer screen surface, the movements of the pen tip may be sensed online and the recognition task is easier.
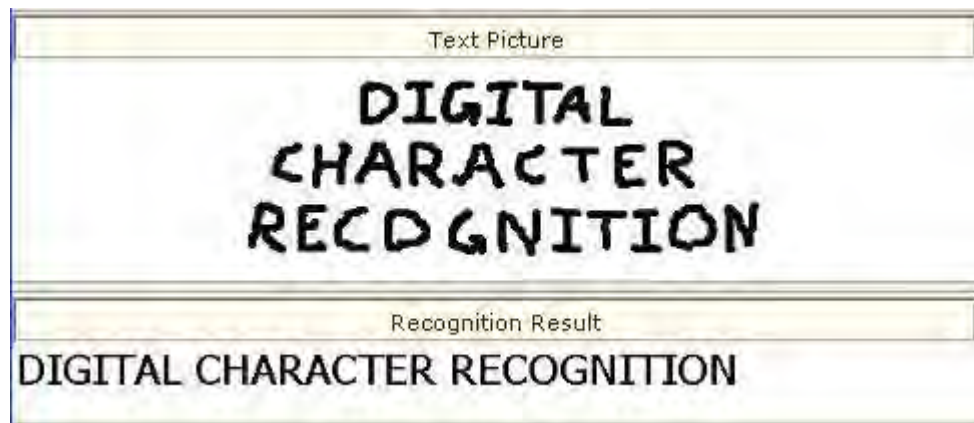


Figure 2.6: Example of handwriting recognition

## 2.4 Neural Network

Today, neural network has been a very popular computer tool used for solving lot of different practical problems. Neural network provides the best solutions to many problems in image recognition, natural language processing, and speech recognition. The basic idea of neural network is to simulate interconnected brain cells inside a computer so it can learn things all by itself, recognize patterns, and make decisions just like human way. One of the advantages of using neural network is the network learning. Network learning provides an efficient ability in recognition.