FACE DETECTION USING PROBABILISTIC NEURAL NETWORK (PNN)

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This report is submitted in partial fulfilment of requirement for the award of Bachelor Electronic Engineering (Electronic Telecommunication) with Honours.

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2010

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **Face Detection Using Probabilistic Neural Network (PNN)**

Sesi Pengajian :

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ACKNOWLEDGEMENTS

Alhamdulillah , I am most grateful to Almighty ALLAH s.w.t. for blessing me with good health and ideas in completing this research successfully.

Thousand of thanks to my supervisor, En. Khairul Azha b A. Aziz for giving me a chance to do my project under his supervises. I would like to show my highest gratitude for his invaluable support, patient, assistance and especially his encouragement to this project. I truly have learnt a lot and all this would not be without his guidance.

I also would to thanks to my family for their supporting especially my parents. Lots of love for them. To my siblings and family members who were always stand by my side to encourage, advice and support me during this entire project.

Last but not least, to all my fellow friends, thank you very much for your contribution in giving me a moral support throughout my project development period.

Lastly, I really appreciate to have this responsibility to finish this project. This task has taught a lot of lesson and knowledge which is much valuable for me in the future.

ABSTRACT

Face recognition is a popular research topic in the biometric identification area. Face detection and localization is the most important pre-processing module of a face recognition system. The purpose of face detection is to search and localize the positions of faces in an image in the varied background. In this paper, a face detection system using neural network (NN) with Probabilistic Neural Network (PNN) method is proposed. The training speed of PNN can be orders of magnitude faster [1] than the well known back propagation (BP) paradigm, and yet the ability of the network to generalize to detect the face is approximately the same [2]. In this project, PNN method is to test with number of face and non-face. Then, calculate the percentage of output that the system can detect.

ABSTRAK

Mengenal pasti muka merupakan kajian yang amat popular dalam bidang biometrik. Mengesan muka merupakan modul pra-proses yang amat penting dalam kajian untuk mengenal pasti muka. Tujuan utama mengesan muka adalah untuk untuk menetapkan posisi pada sesebuah latar belakang. Pada kertas kerja ini, tujuan utama adalah untuk mengesan muka menggunakan kaedah Rangkaian Saraf Kebarangkalian (PNN). Kelajuan pada set latihan PNN adalah lebih pantas [1] daripda paradogma perambatan balik (BP) yang lebih dikenali di kalangan penganalisis. Selain itu, PNN juga berkebolehan untk mengesan muka dengan lebih tepat berbanding kaedah lain [2]. Tujuan utama kaedah PNN dalam projek ini adalah untuk menguji beberapa muka dan bukan muka kedalam sistem serta mengira peratusan muka dan bukan muka yang dikesan oleh sistem PNN sebagai hasilnya.

CONTENT

LIST OF TABLE

LIST OF FIGURE

LIST OF ABBREVIATION

NN	-	Neural Network
PNN	-	Probabilistic Neural Network
RBFNN	-	Radial Basis Function Neural Network
HMM	-	Hidden Markov Model
FAR	-	False Acceptance Rate
FRR	-	False Rejection Rate
BP	-	Back Propagation

CHAPTER 1

INTRODUCTION

This chapter will briefly discuss on the project overview. The objective, scope, problem statement, summary of methodology and thesis outline will be presented in this chapter.

1.1 Project Background

Face detection is the first step in face recognition system as the output will be used as the input to the face recognition system. The face detection is an important preprocessing step for face recognition. To make the face recognition system practical, it is necessary to detect the faces effectively and correctly.

One of the methods for face detection is Neural Networks (NN) which lies under the category of image based approach. The advantages using NN are adaptive in nature, use of a training phase for learning the relationships in the input data, generalization capabilities provide a means of coping with noisy or incomplete data [3].

Face detection is concerned with finding whether or not there are any faces in a given image. In this project, Probabilistic Neural Networks (PNN) method is use to detect frontal views of faces in a grayscale image. Matlab software is use to develop the system.

The aim of this project is to detect the one face in one image. For training, CBCL Face Database [13] is used.

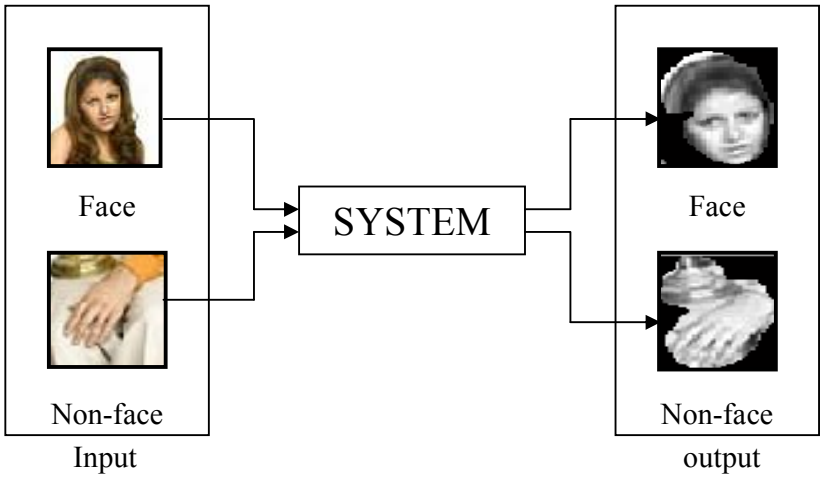

Figure 1.1: General Block Diagram for Face Detection

Based on figure 1.1, it shows how the system works generally. In this system a number of face and non-face are enter to the system. As a result, the percentage of face and non-face is calculated to see how many faces and the effectiveness that the system can detect.

1.2 Project Objectives

The objectives in this project are to develop a face detection system using Probabilistic Neural Networks (PNN) and to compare the result using PNN method with other neural network method such as Radial Basis Function Neural Network (RBFNN). This system will develop using Matlab software. Besides that, other objectives are:

- To apply Matlab programming for face detection such as algorithm development.
- To apply and improve the knowledge about image processing which are widely use in face detection project.

- To develop the PNN in face detection successfully.
- To understand the face detection using PNN system.

1.3 Problem Statement

As we know, face detection always related with security system. We can see the criminals are increases in Malaysia lately. For PNN project, I want to prove that this system is suitable to use for face recognition project to prevent the criminals.

1.4 Scope of Project

The scope in this project is use Matlab software to develop the project. Matlab programming is use for face detection. Besides that, this project focuses in Neural Network method using Probabilistic Neural Networks (PNN). The aim is to detect one image for one face. For face detection, grayscale is use as an input. The CBCL database [13] is use as a data base for network training and testing.

1.5 Summary of Methodology

In this project, there are several method used for PNN system. Firstly, Matlab software is used to develop the system. This software expressed in mathematical notation. For image processing, pre-processing image is used. In pre-processing, several algorithms are used such as grayscale image, extract window, histogram equalization for lighting balancing and filter image. Then PNN system is used to develop this project. There are four layers in PNN's architecture. This system is trained with 2429 data and 4548 data from [13]. For testing, only 999 data face and 899 non-face data from [13] are used and other testing the picture from [14] is taken using sliding window process.

1.5 Report Structure

Chapter one briefly introduces the overall of the project title face detection using Probabilistic Neural Networks (PNN). The introduction consists of overview, objective, problem statement, scope of work and structure report.

Meanwhile chapter two discuss about the background of study related to face detection using PNN method. Literature review will produce overall structure of the face detection which shows the relationship between project research and theoretical concept.

Chapter three will explain about the project methodology. Project methodology give details about the method used to solve the problem to complete the project. The method used such as collecting data method, process and analysis data method, modelling and etc.

Chapter four consists of result and discussion of the project, finding and analysis throughout the research and project development.

Lastly, chapter five is the project conclusion. This chapter rounds up the final achievement of the whole project and reserves suggestions for possible future researches.

CHAPTER 2

LITERETURE REVIEW

This project is divided into few parts; consist of neural network (NN) method, focusing on Probabilistic Neural Networks (PNN), other methods of neural network (NN) and advantages and disadvantages of neural network and Probabilistic Neural Networks (PNN).

An approach to complete this project will be discussed in this chapter. It consists only in software part only.

2.1 Neural Network (NN)

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as face detection or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. [4]

A neural network is a powerful data modeling tool that is able to capture and represent complex input and output relationships. The motivation for the

development of neural network technology stemmed from the desire to develop an artificial system that could perform intelligent tasks similar to those performed by the human brain. Neural networks resemble the human brain in the following two ways; they acquire knowledge through learning and the knowledge is stored within inter-neuron connection strengths known as synaptic weights. The true power and advantage of neural networks lies in their ability to represent both linear and non-linear relationships and in their ability to learn these relationships directly from the data being modeled. Traditional linear models are simply inadequate when it comes to modeling data that contains non-linear characteristics. [5]

The most common neural network model is known as a supervised network because it requires a desired output in order to learn. The goal of this network type is to create a model that maps the input to the output using historical data so that the model can then be used to produce the output when the desired output is unknown [5]. A graphical of neural networks is shown in figure 2.1.

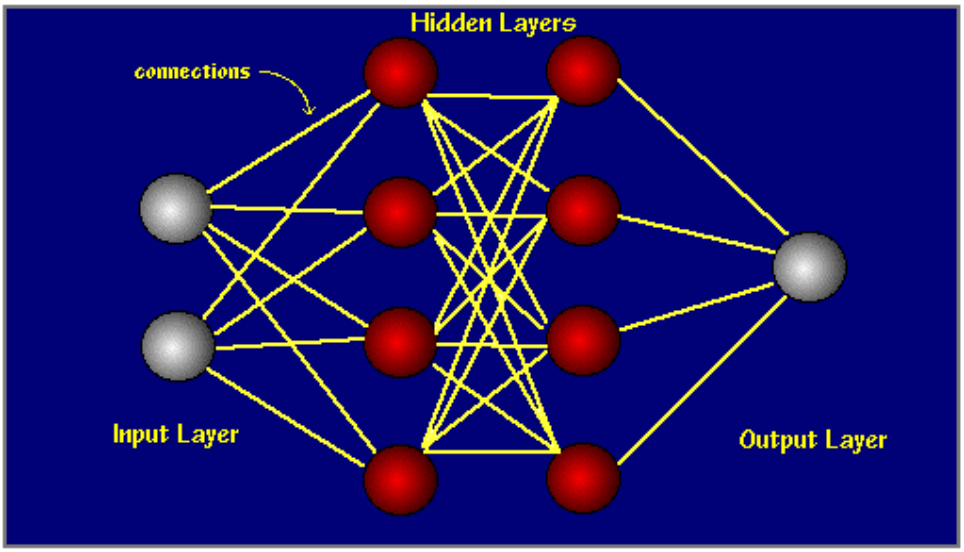

Figure 2.1: Graphical of Neural Networks (NN)

Artificial neurons with information processing abilities somewhat comparable to the human neuron were therefore made to suit this design. These neurons receive inputs from other sources, combine them in some way, perform a generally nonlinear operation on the result, and then output the final result. The neurons are typically organized in layers, each consisting of a large number of interconnected nodes. Data

is presented to the network through the input layer, which communicates to one or more hidden layers where the actual processing is done by a system of weighted connections. These hidden layers then link to an output layer which produces the output [5].

2.1.1 Advantages of Neural Networks

Neural networks, with their 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. A trained neural network can be thought of as an expert in the category of information it has been given to analyze. Other advantages include: [4]

- Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
- Self-Organization: An ANN can create its own organization or representation of the information it receives during learning time.
- Real Time Operation: ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
- Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

2.1.2 Disadvantages of Neural Networks

Besides with the advantages of neural networks, it still has several disadvantages in this system. The disadvantages of neural networks are this system need lots of training to analyze the data, it also need lots of work to select appropriate data. Besides that, neural network system has to take much more time [4].

2.2 Probabilistic Neural Network (PNN)

Probabilistic neural networks can be used for classification problems (i.e. face detection). When an input is presented, the first layer computes distances from the input vector to the training input vectors, and produces a vector whose elements indicate how close the input is to a training input. The second layer sums these contributions for each class of inputs to produce as its net output a vector of probabilities. Finally, a compete transfer function on the output of the second layer picks the maximum of these probabilities, and produces a 1 for that class and a 0 for the other classes [6].

The following diagram illustrates a block diagram of PNN Network:

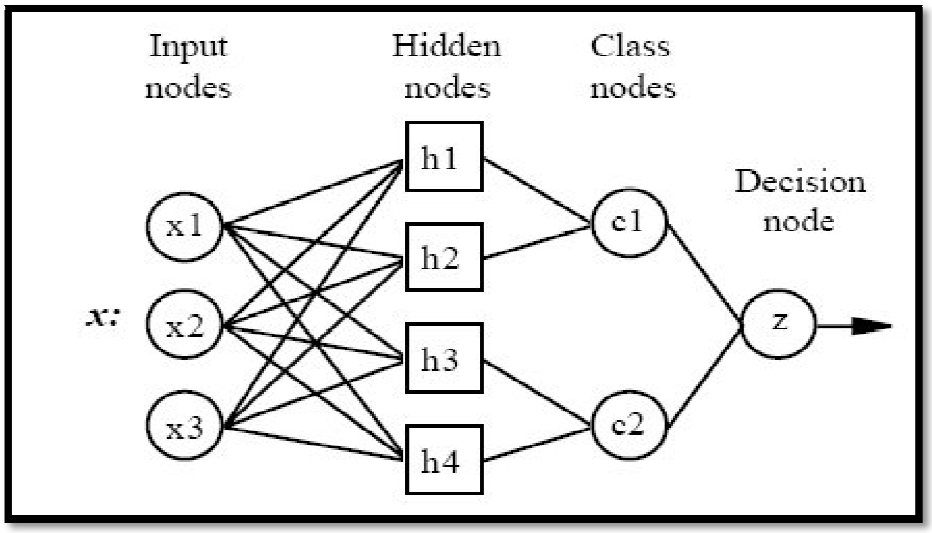

Figure 2.2: Block Diagram of PNN Networks have Four Layers

- **Input layer:** There is one neuron in the input layer for each predictor variable. In the case of categorical variables, *N*-1 neurons are used where *N* is the number of categories. The input neurons (or processing before the input layer) standardize the range of the values by subtracting the median and dividing by the interquartile range. The input neurons then feed the values to each of the neurons in the hidden layer.

- **Hidden layer:** This layer has one neuron for each case in the training data set. The neuron stores the values of the predictor variables for the case along with the target value. When presented with the *x* vector of input values from the input layer, a hidden neuron computes the Euclidean distance of the test case from the neuron's center point and then applies the RBF kernel function using the sigma value(s). The resulting value is passed to the neurons in the pattern layer.
- **Pattern layer / Summation layer:** The PNN network there is one pattern neuron for each category of the target variable. The actual target category of each training case is stored with each hidden neuron; the weighted value coming out of a hidden neuron is fed only to the pattern neuron that corresponds to the hidden neuron's category. The pattern neurons add the values for the class they represent (hence, it is a weighted vote for that category).
- **Decision layer:** The decision layer compares the weighted votes for each target category accumulated in the pattern layer and uses the largest vote to predict the target category.

Besides face detection, typical uses for PNN such as optical character recognition, facial recognition, texture analysis, data validation, sales forecasting, shape recognition, pattern recognition and etc [12].

2.2.1 Advantages and Disadvantages of PNN

Probabilistic Neural Networks have found their way into countless applications that require static pattern classification. Their main advantage is that they are easy to use and that they can approximate any input or output map [7]. Other advantages of PNN are:

- The training speed of PNN is faster than back propagation (BP) paradigm [1].
- The ability of the network to generalize to detect the face is approximately the same [2].
- The networks are nonlinear hybrid networks, typically containing a single hidden layer of processing elements (PEs) [7].

- All the weights of the network are calculated analytically [7].
- PNN networks approach Bayes optimal classification.
- PNN networks generate accurate predicted target probability scores.

While the disadvantage by using PNN is training is slowly and impractical for a large amount of training data, which are typically three times more training samples than network weights [7]. Other than that, PNN networks require more memory space to store the model.

2.3 Grayscale Image

A grayscale image (also called gray-scale, gray scale, or gray-level) is a data matrix whose values represent intensities within some range. Matlab stores a grayscale image as an individual matrix, with each element of the matrix corresponding to one image pixel. By convention, this documentation uses the variable name *I* to refer to grayscale images.

The matrix can be of class uint8, uint16, int16, single or double. While grayscale images are rarely saved with a colormap, Matlab uses a colormap to display them.

For a matrix of class single or double, using the default grayscale colormap, the intensity 0 represents black and the intensity 1 represents white. For a matrix of type *uint8, uint16*, or *int16*, the intensity *intmin(class(I))* represents black and the intensity *intmax(class(I))* represents white [6]. For *uint8*, the integer values in the range [0,255] while *uint16,* the range is [0, 65535].