FACE DETECTION APPROACH FOR VIDEO SURVEILLANCE

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Bachelor of Engineering with Honors
(Electronics & Computer Engineering)
2009/2010

UNIVERSITI MALAYSIA SARAWAK

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FACE DETECTION APPROACH FOR VIDEO SURVEILLANCE

TING SING CHUNG

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ABSTRACT

Nowadays, computer has been acts an important role in our human life. Computer has been used for purposes such as television streaming, business confidential information storage, home security monitoring, home appliances controlling and etc. All of these usages are mainly based on the computer. Hence, our computer security system has makes an important roles in preventing unauthorized access to the computer. Thus, a real time face recognition system is proposed. In this report, a real time face detection and recognition system is presented. Basically, this system applied skin colour detection to allocate the face. The system allocates the face through skin colour sensing and further focused image processing on the specific area in the image. The system converted the facial information to grayscale image and performing face recognition using neural network. Neural network is used for storing the facial information of the training images. The Radial Basis Function Network is used for the particular purposes. The system is able to detect and recognize the face trained. The system would show the matching percentage of target with the training images. The system can perform well in recognizing the target faces with variation of poses and facial expression with at least 60% matched the target. The system proposed a direct webcam video input in real time based for the real time face recognition system.

ABSTRAK

Kini, komputer telah memainkan peranan yang penting dalam hidup kita. Komputer telah digunakan untuk menonton television, penyimpanan data-data sulit perniagaan, pemantauan keselamatan rumah, pengendalian peralatan rumah and sebagainya. Semua kegunaan tersebut kebanyakan bergantung kepada komputer. Jadi, system keselamatan komputer kita memainkan peranan yang penting untuk mengelakkan pengaksesan komputer. Oleh demikian, satu sistem pengesanan muka masa sebenar dicadangkan. Dalam laporan ini, satu sistem pengesanan dan pengecaman rupa bentuk muka telah dibentangkan. Asasnya, sistem ini menggunakan deteksi warna kulit untuk mendapatkan kawasan muka. Sistem ini mendapatkan kawasan muka menerusi warna kulit dan sejurusnya menumpukan pemprosesan gambar pada kawasan yang tertentu. System tersebut menukarkan maklumat muka kepada gambar hitam-putih dan menjalankan pengecaman rupa bentuk muka melalui rangkaian neural. Rangkainan neural digunakan untuk menyimpan maklumat muka dalam gambar. Rangkaian neural model Radial Basis Function digunakan untuk tujuan tersebut. Sistem ini dapat mengesan dan mengecam rupa bentuk muka yang disimpan. Sistem ini dapat mempamerkan peratusan kepadanan dengan gambar yang disimpan. Sistem ini dapat berfungsi dengan baik dalam pengecaman rupa bentuk sasaran dengan gaya yang berbeza dan mimik muka dengan sekurang-kurangnya 60% padan dengan sasaran. Sistem tersebut mencadangkan satu kamera web sebagai input video dalam sistem pengesanan dan pegecaman rupa bentuk muka masa sebenar.

CHAPTER 1

INTRODUCTION

1.1 Introduction to Artificial Neural Network

The Artificial Neural Network (ANN) is an information processing paradigm that inspired by the human brain. ANN is formed by information processing units, called neurons which are interconnected by links. Each link has its own algorithm designed to alter the weight of connections. In generally, ANN has three layers: input layer, hidden layer and output layer. Figure 1.1 shows architecture of a typical ANN.

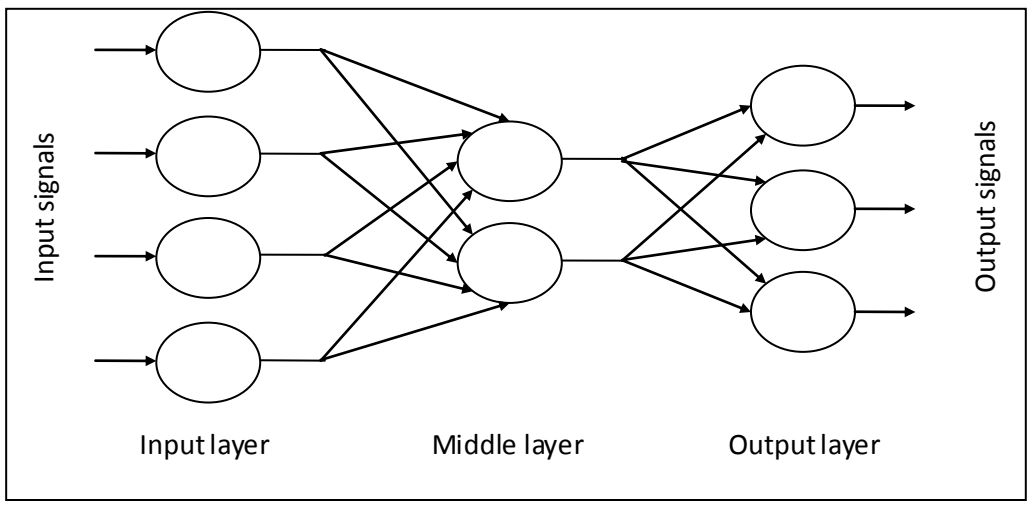

Figure 1.1 Architecture of a Typical ANN

1.2 History of ANN

The history of ANN is simplified as follows:

1943	-	McCulloch and Pitts modeled a simple neural network using electrical circuits.
1949	-	Hebb pointed out the fact that neural pathways are strengthened each time they are used.
1958	-	Rosenblatt developed his perceptron brain models.
1969	-	Minsky and Papert demostrated a discouraging analysis on perceptrons.
1985	-	Back-propagation learning was discovered independently by Parker and LeCun.
1988	-	Broomhead and Lowe exploit the use of radial-basis functions in ANN.

1.3 Application of ANN

ANN is able to learn and store knowledge and it has broad applicability in practical. Currently, it has been used on the following field:

i. Design and create a computer game.

ii. Analysis and predicting the weather, earthquake, and etc.

iii. Detecting and recognition of handwriting, vehicles plates, objects and etc.

iv. Detecting and navigation-sensing for car system.

1.4 Future of Artificial Neural Network

ANN is simulating the fundamental of human brains. ANNs currently still have a great potential in various applications. In future, Artificial Neural Networks may develop in the following areas:

i. I-Robot,
   which can recognize human identity through face and thumbprint recognition and further communicate with human uniquely.

ii. I-Truck which can recognize its owner and able to reaching target destination by self-navigating.-

1.5 Face Detection

Face detection system is to allocate the facial features from an image and has been widely used in information technology such as cameras to focus the face expression. There are three main approaches for face detection: feature based, template matching and image based. Feature-based is detecting using face feature such as eyes, nose and mouth. Template matching is matching the image with the face model. Image-based is detecting by using 2 class patterns as face classifier and non-face classifier.

1.6 Face Recognition

Face Recognition is to extract facial features in order to identify the owner of the face. Face recognition are drawn much attention to researcher especially in security purpose and face identification for criminals. Face recognition method can be categorized to 2D-based approach and 3D-based approach.

1.7 Real Time Video Surveillance

Video surveillance is defined as a video which is monitoring on a particular area. Generally, video surveillance is done by using a closed-circuit television or through webcam. The resolution of Closed-Circuit Television (CCTV) and the image quality commonly low. Besides, the noise level in CCTV is quite high and not suitable to use in automation system.

1.8 Objective

The objectives of this project are:

i. To study the performance of several types of neural network algorithms for real time face recognition application.
ii. To train the human faces using Radial Basis Function Network (RBFN).
iii. To develop the face detection and recognition system using RBFN.
iv. To simulate the real time face recognition system.

1.9 Scope of Work

The video surveillance systems are widely used over the world but the systems are able to monitor particular area only. The systems relied on human being to monitor screens physically. Hence, this project tends to implement face recognition algorithm with RBFN into video surveillance systems.

1.10 Chapter Outline

Chapter 1 introduces an overview of face detection, face recognition, video surveillance, history of ANN, application and future work of ANN, and objective of the project. It also includes the project scope and chapter outline of this report.

Chapter 2 contents the summary of the research study done for this project. It is about the works that have been done before in relevant topic.

Chapter 3 is providing the overall methodology of this project. It also included the approach and tools used in this project.

Chapter 4 discusses on the implementation of the real time face recognition system and the simulation results.

Chapter 5 is doing the conclusion for the whole project and future recommendation to be implemented to the system.

CHAPTER 2

LITERATURE REVIEW

2.1 ANN Fundamental

ANN is developed based on the concept of biological neurons. Biologically, the neurons connected to each other by synapses and the interconnections are constantly changing. In Artificial Neural Network, the neurons are connected by weighted links. Figure 1.1 in Chapter 1 shows the basic model of the architecture of an Artificial Neural Network, each neuron contains specific function. An ANN model is a structure that can be map to a set of data to demonstrate the relations between data. The model can be adjusted or trained using a set or few sets of data from a given source as input which called as training sets. The trained ANN model may used for classification, estimation, prediction or simulation on new data from same source or similar sources.

2.2 Biological Neural Networks

The brain is principally composed of a very large number of *neurons*, massively interconnected. Each neuron is a specialized cell which can propagate an electrochemical signal. Each neuron has a branching input structure called dendrites, a cell body called soma, and a branching output structure called axon. Figure 2.1 shows biological neuron.

The axons are connected to the dendrites of other neurons through a synapse. Each synapse actually contains a gap, with neurotransmitter chemicals poised to transmit a signal across the gap. Donald Hebb postulated that learning consisted principally in altering the strength of synaptic connections. [1]

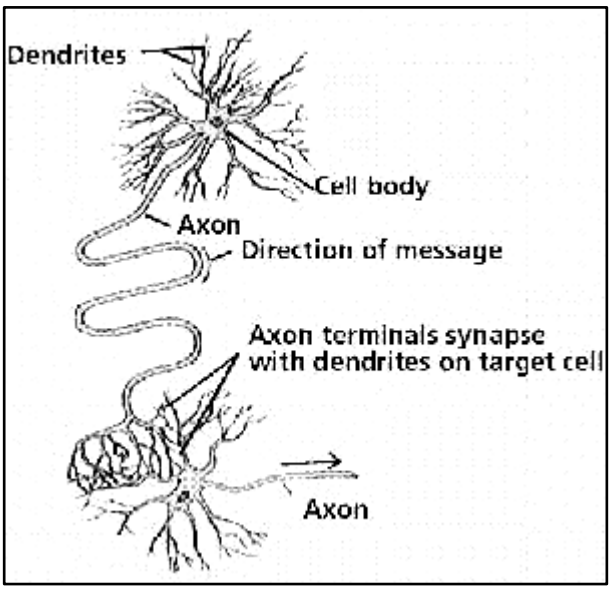

Figure 2.1 Biological Neuron

2.3 Types of Artificial Neural Network

There are many types of Artificial Neural Networks have been developed. The types of the Artificial Neural Networks consist of different types of neural architecture, learning and also activation functions.

2.3.1 Hopfield Network

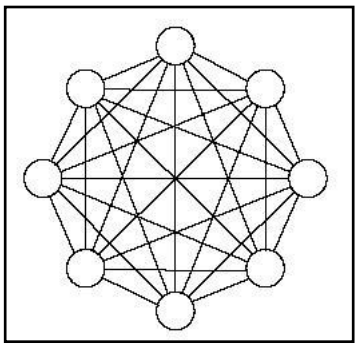

Figure 2.2 A typical Hopfield Architecture

Hopfield network is a type of Artificial Neural Networks in which nodes values are iteratively updated based on a local computation principle: the new state of each node depends only on its net weighted input at a given time. The network is fully connected and its weights are determined by the Hebbian principle. [2] Hebbian principle is described as a method of determining how to alter the weights between model neurons. The weight between two neurons will increase if the two neurons activate simultaneously, but it is reduced if they activate separately. [3]

2.3.2 Multilayer Perceptron (MLP) Network

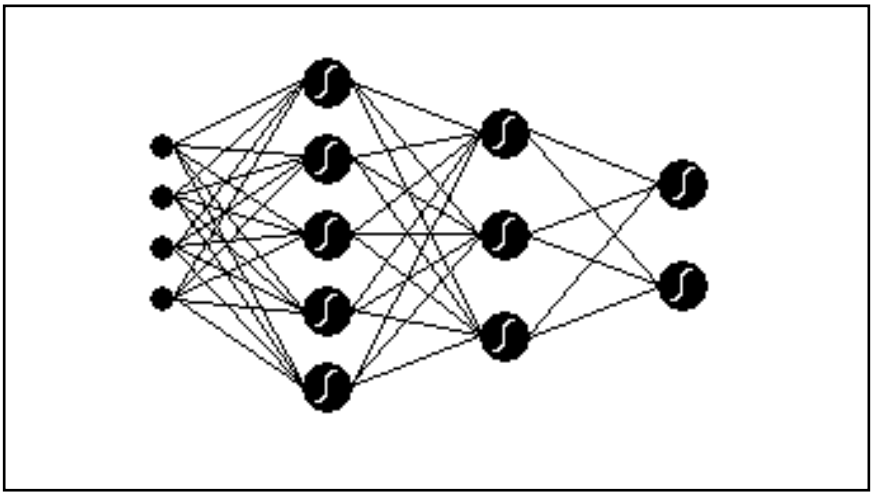

Figure 2.3 A Typical Multilayer Perceptron Architecture

MLP is a feed-forward network that trained with back-propagation algorithm. It is a supervised network that trained the desired responses with back-propagation technique. MLP consists of only one input layer and one output layer, but it can have one or more hidden layers. [1]

2.3.3 Self Organizing Feature Map (SOFM/ Kohonen) Network

Kohonen network is primarily designed for unsupervised learning. As in supervised learning, the training data set contains cases featuring input variables together with the associated outputs. However, in the unsupervised learning, the training data set contains only the input variables. A Kohonen network is trained using an iteration algorithm and it consists of two layers only, which are the input layer and the output layer of radial units. [4]

2.3.4 Radial Basis Function (RBF/ Gaussian) Network

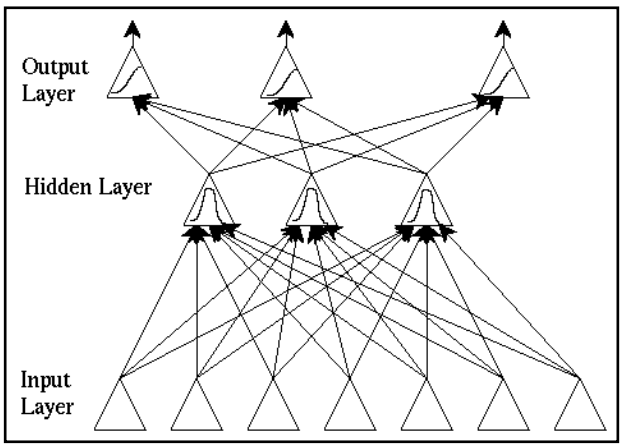

Figure 2.4 A typical Radial Basis Function Network

It is a type of feed-forward Artificial Neural Networks that use Gaussian function as its activation function. RBF network consists of one input layer, one hidden layer and one output layer. However, the hidden layer is consisting of two stages, where the first stage is supervised learning and second stage is unsupervised learning. It is usually known as hybrid supervised-unsupervised topology. [5]

2.4 Learning of Artificial Neural Networks

In Artificial Neural Networks, learning refers to the method of modifying the weights of connections between the nodes of a specified network. Neurons are connected by links and each link has a numerical weight associated with it. Weights are the basic means of long-term memory in Artificial Neural Networks. An Artificial Neural Networks learns through repeated adjustment of these weights. The neurons of the neural network are elementary-processing unit. It computes its weight level given the inputs and desired output . [4, 5]

2.4.1 Supervised Learning

In supervised learning, the network is trained by providing it with input and matching output patterns. These input-output pairs can be provided by an external teacher [1, 5]

2.4.2 Unsupervised Learning

The network is trained to respond to clusters of pattern within the input. In this paradigm the system is supposed to discover statistically salient features of the input population. Unlike the supervised learning paradigm, there is no a prior set of categories into which the patterns are to be classified, rather the system must develop its own representation of the input stimuli. [1, 5]

2.4.3 Reinforcement Learning

This type of learning may be considered as an intermediate form of the above two types of learning. It does some action on the environment and gets a feedback response from the environment. The learning system grades its action good or bad based on the environmental response and accordingly adjusts its parameters. Generally, parameter adjustment is continued until an equilibrium state occurs, following which there will be no more changes in its parameters. [1, 5]

2.5 Activation Function

Activation functions for the hidden units are needed to introduce nonlinearity into the network. Without nonlinearity, hidden units would limit to plain perceptrons. Almost any nonlinear function does the job, except for polynomials.

There are many types of activation function used in Artificial Neural Networks. The main activation functions available have been classified as follow:

Table 2.1 Activation Functions of Artificial Neural Networks [4]

Activation Function	**Definition**	**Range**
Sigmoid	$f(x) = \frac{1}{1-e^{-x}}$	(0, +1)
Hyperbolic	$f(x) = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}$	(-1, +1)
Softmax	$f(x) = \frac{e^{x}}{\sum_i e^{x_i}}$	(0, +1)
Unit Sum	$f(x) = \frac{x}{\sum_i x_i}$	(0,+1)
Sine	$f(x) = \sin(x)$	(0, +1)
Ramp	$f(x) = \begin{cases} -1; x \leq -1 \\ x; -1 \leq x < 1 \\ +1; x \geq +1 \end{cases}$	(-1, +1)
Step	$f(x) = \begin{cases} 0; x < 0 \\ +1; x \geq 0 \end{cases}$	(0, +1)
Gaussian	$f(x) = ae^{-\frac{(x-b)^2}{2c^2}}$	(0, +1)

2.5.1 Sigmoid Function

It is one of the most popular activation functions with S-shaped function. These functions are continuous and differentiable everywhere, are rotationally symmetric about some point and asymptotically approach their saturation values. The advantage of these functions is that their smoothness makes it easy to devise learning algorithms and understand the behavior of large network whose nodes compute such functions. [5]

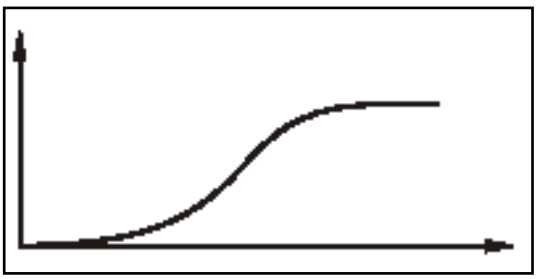

Figure 2.5 Property of Sigmoid Function

2.5.2 Gaussian Function

It a Bell-shaped function that also known as radial basis function. This function is also continuous, f(net), asymptotically approaches 0 (or some constant value) for large magnitudes of net, and f(net) has a single maximum for net equal the mean, μ. [5]

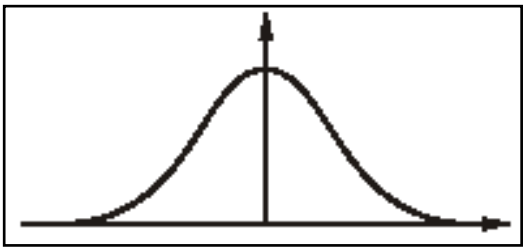

Figure 2.6 Property of Gaussian Function

2.6 Advantages and Disadvantages of Artificial Neural Networks

An Artificial Neural Networks is a system based on the operation of biological neural networks, in other words, is an emulation of biological neural system. Although computing unit these days is truly advanced, there are certain tasks that a common microprocessor is unable to perform. Even so, a software implementation of an Artificial Neural Networks can be made with their advantages and disadvantages. [4, 6]

Table 2.2: ANN Advantages and Disadvantages

Advantages	Disadvantages
• An Artificial Neural Networks can perform nonlinear task.	• The Artificial Neural Networks needs training to operate.
• When an element of the Artificial Neural Networks fails, it can continue without any problem by their parallel nature.	• The Artificial Neural Networks architecture is different from the microprocessor architecture, hence emulation needed.
• An ANN can learn and does not need to be reprogrammed.	• Required high processing time for large ANN subject.
• It can be implemented in any application without any problem.	

2.7 Comparison of types of Artificial Neural Networks

There are varieties of Artificial Neural Networks model used for different purpose and each model has their advantages and limitations. The most common Artificial Neural Networks model used for pattern recognition is the RBF network and the MLP network. [7]

Comparing the RBF network with the MLP network, the both Artificial Neural Networks are feed-forward networks that used in pattern recognition. However, RBF network shows more advantages in pattern recognition compare with MLP network. The differences between the two networks are as follow [8]:

Table 2.3: Comparison table between MLP and RBF network

MLP network	**RBF network**
• Unlimited of hidden layers.	• Has only a single hidden layer.
• Computational nodes in different layers share a common neuronal model, but not necessary the same activation function.	• Hidden layer nodes operate very differently, and have a very different purpose to the output nodes.
• The hidden layer activation function is the inner product of the input and the weights.	• The hidden layer activation function is the distance between the input and the weights.
• Network constructs global approximation to non-linearities input-output mappings with distributed hidden representations.	• Network tends to use localized non-linearities (such as Gaussian) at the hidden layer to construct local approximations.