PERFORMANCE OF SCALED CONJUGATE GRADIENT ALGORITHM IN FACE RECOGNITION

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) With Honours

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Universiti Teknikal Malaysia Melaka

APRIL 2009

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Performance of Scaled Conjugate Gradient Algorithm in Face Recognition

Sesi Pengajian : 2008/2009

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To my beloved father and mother

ACKNOWLEDGEMENT

Alhamdulillah and thanks to Allah, because finally this Porjek Sarjana Muda II (PSM II) thesis finished successful. PSM II took a semester to be completed which is from December 2008 till May 2009. It is a continuance from PSM I.

First of all, I would like to give a very a big appreciation and millions of thanks to my faculty dean, Prof. Madya Muhammad Syahrir Bin Johal, and a lot of thanks to my supervision lecturer, Pn Norazlina Binti Abdul Razak who help a lot during my PSM period by giving their advices and guidance. I would also like to thank my friends: Mohd Azril Aliff Bin Jusoh; Norjuliana Binti Abdul Hadi and Suhada Binti Mohammed Sapardi, for their sincere efforts in helping, giving advice and for being my friend for the past few years. I would also like to thank my classmate BENT, for give a great cooperation taking their picture and being my best friends for the past four years. The contributions from these people help to make this thesis possible.

ABSTRACT

A supervised learning algorithm (Scaled Conjugate Gradient, SCG) with superliner convergence rate is introduced. The algorithm is based upon a class of optimization techniques well known in numerical analysis as the Conjugate Gradient Methods. SCG uses second order information from the neural network but requires only (N) memory usage, where N is the number of weights in the network. The performance of SCG yields a speed-up of at least an order of magnitude relative to BP. The speed-up depends on the convergence criterion, i.e., the bigger demand for reduction in error the bigger the speed-up. SCG is fully automated including no user dependent parameters and avoids a time consuming line-search, which CGB and BFGS uses in each iteration in order to determine an appropriate step size. The smaller the complexity of the neural network relative to the problem domain, the bigger the possibility that the weight space contains long ravines characterized by sharp curvature. While BP is inefficient on these ravine phenomena, it is shown that SCG handles them effectively.

ABSTRAK

(*Scaled Conjugate Gradient*, *SCG*) adalah salah satu algoritme yang menjalankan proses pembelajaran terhadap data dan berdasarkan kadar penumpuan. Algoritme ini sebenarnya berasal dari beberapa teknik penambah-baikan dalam analisis berangka yang dikenali sebagai kaedah naik-turun. *SGC* menggunakan maklumat atau data pekali kedua yang terdapat di dalam rangkaian *neural* tetapi hanya menggunakan (N) jumlah daya ingata sahaja, dimana N adalah nilai berat rangkaian. Prestasi algoritme ini ditafsirkan dalam bentuk kelajuan, kecepatan atau dalam erti kata yang lain ialah jumlah masa yang diambil untuk memproses data. Jumlah masa tersebut berkadar dengan magnitud *backpropagation (BP)*. Jumlah masa yang diambil juga bergantung kepada beberapa criteria penumpuan; semakin tinggi nilai permintaan untuk mengurangkan kadar ralat, semakin lama masa pemprosesan. Jika nilai komplek dalam rangkaian neural kecil berbanding dengan lingkungan masalah, nilai jangkaan akan meningkat dan menghasilkan lebar jurang yang besar berdasarkan perincian terhadap lekuk yang ada pada graf prestasi. Berdasarkan kepada fenomena ini, *SCG* lebih efektif berbanding dengan *BP*.

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LIST OF ABBREVIATION

SCG	Scaled Conjugate Gradient
BP	Backpropagation
SPSS	Statistically Analysis
CMOS	Complementary metal–oxide–semiconductor
CPU	Control Processing Unit
RAM	Random Access Memory
2D	2 Dimensions
W	Weight
b	Bias
STRUCT	Structure
STRCMP	String compares
NEWFF	feed forward neural network
GUI	Graphical user interface

LIST OF APPENDIX

CHAPTER I

INTRODUCTION

1.0 Overview

This chapter consists of the project background, the objective and scope of project, the problem statement, methodology and the work schedule. It will give the overview of the whole project, from the beginning until the implementation part.

1.1 Project Background

Faces have been used by humans to recognize each other for thousands of years. With the increased need for fast and reliable authentication systems, the used of advanced automated systems based on biometrics technology become necessity and this is now growing rapidly. So, this project is proposed in order to see the performance of scaled conjugate gradient algorithm for face recognition system. The factors which are going to affect the recognition are variations in pose, light intensity and expression of faces.

1.2 Problem Statement

The problem is the recognition process can not be done in few second because its depends on many factors, including the complexity of the problem, the number of data points in the training set, the number of weights and biases in the network, the error goal, and whether the network is being used for pattern recognition (discriminate analysis) or function approximation (regression).

1.3 Project Objectives

The objective of this project is to analyze the performances of the algorithm in the face recognition system.

1.4 Scope Work

The scope of work for this project can be focused into three parts; first is literature review - The literature review is important to collect the actual result from past research. This task is conceptually independent from the other, but it is necessary in order to get the expected result in final work.

Then second is design a programming code - I used the software like Matlab because it has a data acquisition toolbox, database toolbox, image acquisition toolbox, image processing toolbox and neural network toolbox. The software has 2 main features, first to store a database for learning session and second for testing part. The 10 people with 10 different images were collected to complete this process. 50 images was used as a learning or teaching the program and the other half of images was used as a performance testing. The images was focused on their face only, any background that can disturb the process will be crop before we train the images.

Last part for this project is to design a graphical user interface (GUI) of the programming. The software that I used is also Matlab. Matlab version 7.6 2008 have a toolbox to create a GUI.

1.5 Methodology

The project planning and development divided into six (6) stage which are data acquisition, creating database, writing program, training phase, testing phase and analyzing data. The research part will consist about what I’ve do before writing the program which I find anything related to determine the factor that can affect the performance of algorithm. In data acquisition stage, I will collect all 100 images includes with their name and number id. Next after completing in collecting data, I must create a database that can function with Matlab. The third stage is writing the programming, the program will divide in two parts. The first program was creating to teach the algorithm and second to testing it. Last part is analyzing data. All the data that I get will be analyze using statistic method to determine the performance and speed processing.

1.6 Report Overview

In this part, it will discussed about the summary or overview for each chapter contained in this report. Chapter I will be discussed about about the introduction of this project. There are problem statements, objectives of the project, project scope and project methodology. In chapter I also consists the summary of this report.

Chapter II is discussing about literature research and review which contains of Scaled Gradient Conjugate algorithm, Neural Network, Image Processing, Matlab and Statistically Analysis (SPSS). The function of the several components in Matlab toolbox such as neural network toolbox and image processing toolbox. Chapter II will make us clear about the algorithm.

For chapter III, the methodology and development of the research will be discussed. Covering in this chapter are the flowchart of research methodology which will summarize the overall application of the system.

Result and discussion of the research is covering in chapter IV. All the findings and analysis will be discuss in this chapter to determine whether it has cover the overall objectives of the research.

Finally, in chapter V the conclusion for the research is made and suggestion and enhancement are discussed for further implementation and upgrading the algorithm itself.

1.7 Project Planning

PERANCANGAN PROJEK																																							
Senaraikan aktiviti-aktiviti utama bagi projek yang dicadangkan. Nyatakan jangka masa yang diperlukan bagi setiap aktiviti.																																							
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Literature review	PSM 1 briefing	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	Study leave	Final exam				Semester Break									Mid Term Break										
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CHAPTER II

LITERATURE REVIEW

2.1 Neural Network

Traditionally, the term neural network had been used to refer to a network or circuit of biological neurons. The modern usage of the term often refers to artificial neural networks, which are composed of artificial neurons or nodes. Thus the term has two distinct usages:

1. Biological neural networks are made up of real biological neurons that are connected or functionally-related in the peripheral nervous system or the central nervous system. In the field of neuroscience, they are often identified as groups of neurons that perform a specific physiological function in laboratory analysis.
2. Artificial neural networks are made up of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Artificial neural networks may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real biological nervous system is highly complex including some features which may seem superfluous to the understanding of the working of artificial networks.

This article focuses on the relationship between the two concepts; for detailed coverage of the two different concepts refer to the separate articles: Biological neural network and artificial neural network.

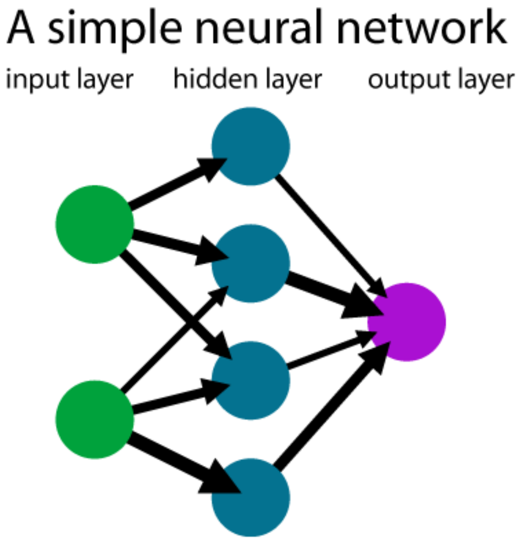

Figure 2.1 Simplified view of an artificial neural network

This circuit diagram show how a ATMEL89C4051 IC microcontroller is configured function as main brain in this circuit. The AT89C4051 is a low-voltage, high-performance CMOS 8-bit microcontroller with 4K bytes of Flash programmable and erasable read-only memory. The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C4051 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89C4051 provides the following standard features: 4K bytes of Flash, 128 bytes of RAM, 15 I/O lines, two 16-bit timer/counters, a five-vector, two-level interrupt architecture, a full duplex serial port, a precision analog comparator, on-chip oscillator and clock circuitry.

In addition, the AT89C4051 is designed with static logic for operation down to zero frequency and supports two software-selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

2.1.1 History

The concept of neural networks started in the late-1800s as an effort to describe how the human mind performed. These ideas started being applied to computational models with Turing's B-type machines and the Perceptron.

In early 1950s Friedrich Hayek was one of the first to posit the idea of spontaneous order in the brain arising out of decentralized networks of simple units (neurons). In the late 1940s, Donald Hebb made one of the first hypotheses for a mechanism of neural plasticity (i.e. learning), Hebbian learning. Hebbian learning is considered to be a 'typical' unsupervised learning rule and it (and variants of it) was an early model for long term potentiation.

The Perceptron is essentially a linear classifier for classifying data $x \in R^n$ specified by parameters $w \in R^n, b \in R$ and an output function *f* = *w*'*x* + *b*. Its parameters are adapted with an ad-hoc rule similar to stochastic steepest gradient descent. Because the inner product is a linear operator in the input space, the Perceptron can only perfectly classify a set of data for which different classes are linearly separable in the input space, while it often fails completely for non-separable data. While the development of the algorithm initially generated some enthusiasm, partly because of its apparent relation to biological mechanisms, the later discovery of this inadequacy caused such models to be abandoned until the introduction of non-linear models into the field.

The Cognitron (1975) was an early multilayered neural network with a training algorithm. The actual structure of the network and the methods used to set the interconnection weights change from one neural strategy to another, each with its advantages and disadvantages. Networks can propagate information in one direction only, or they can bounce back and forth until self-activation at a node occurs and the network settles on a final state. The ability for bi-directional flow of inputs between neurons/nodes was produced with the Hopfield's network (1982), and specialization of these node layers for specific purposes was introduced through the first hybrid network.

The parallel distributed processing of the mid-1980s became popular under the name connectionism.

The rediscovery of the backpropagationn algorithm was probably the main reason behind the repopularisation of neural networks after the publication of "Learning Internal Representations by Error Propagation" in 1986 (Though backpropagation itself dates from 1974). The original network utilised multiple layers of weight-sum units of the type $f = g(w'x + b)$, where g was a sigmoid function or logistic function such as used in logistic regression. Training was done by a form of stochastic steepest gradient descent. The employment of the chain rule of differentiation in deriving the appropriate parameter updates results in an algorithm that seems to 'backpropagate errors', hence the nomenclature. However it is essentially a form of gradient descent. Determining the optimal parameters in a model of this type is not trivial, and steepest gradient descent methods cannot be relied upon to give the solution without a good starting point. In recent times, networks with the same architecture as the backpropagation network are referred to as Multi-Layer Perceptrons. This name does not impose any limitations on the type of algorithm used for learning.

The backpropagation network generated much enthusiasm at the time and there was much controversy about whether such learning could be implemented in the brain or not, partly because a mechanism for reverse signalling was not obvious at the time, but most importantly because there was no plausible source for the 'teaching' or 'target' signal.