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ON-LINE RECOGNITION OF DEVELOPING CONTROL CHART PATTERNS

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Date 10 NOVEMBER 2016

ACKNOWLEDGEMENT

In preparing this thesis, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Professor Dr. Mohd Shariff Nabi Baksh, for encouragement, guidance, critics and friendship. I am also very thankful to my co-supervisor Professor Dr Awaluddin Mohd Shaharoun and Associate Professor Dr. Hishamuddin Jamaluddin for their guidance, advices and motivation. Without their continued support and interest, this thesis would not have been the same as presented here.

I am also indebted to Universiti Teknologi Malaysia (UTM) for funding my Ph.D study. Librarians at UTM, Cardiff University of Wales and the National University of Singapore also deserve special thanks for their assistance in supplying the relevant literatures.

My fellow postgraduate student should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family member.

ABSTRACT

The purpose of this study is to investigate the application of genetic algorithm (GA) in modelling linear and non-linear dynamic systems and develop an alternative model structure selection algorithm based on GA. Orthogonal least square (OLS), a gradient descent method was used as the benchmark for the proposed algorithm. A model structure selection based on modified genetic algorithm (MGA) has been proposed in this study to reduce problems of premature convergence in simple GA (SGA). The effect of different combinations of MGA operators on the performance of the developed model was studied and the effectiveness and shortcomings of MGA were highlighted. Results were compared between SGA, MGA and benchmark OLS method. It was discovered that with similar number of dynamic terms, in most cases, MGA performs better than SGA in terms of exploring potential solution and outperformed the OLS algorithm in terms of selected number of terms and predictive accuracy. In addition, the use of local search with MGA for fine-tuning the algorithm was also proposed and investigated, named as memetic algorithm (MA). Simulation results demonstrated that in most cases, MA is able to produce an adequate and parsimonious model that can satisfy the model validation tests with significant advantages over OLS, SGA and MGA methods. Furthermore, the case studies on identification of multivariable systems based on real experiment t al data from two systems namely a turbo alternator and a continuous stirred tank reactor showed that the proposed algorithm could be used as an alternative to adequately identify adequate and parsimonious models for those systems. Abstract must be bilingual. For a thesis written in Bahasa Melayu, the abstract must first be written in Bahasa Melayu and followed by the English translation. If the thesis is written in English, the abstract must be written in English and followed by the translation in Bahasa Melayu. The abstract should be brief, written in one paragraph and not exceed one (1) page. An abstract is different from synopsis or summary of a thesis. It should states the field of study, problem definition, methodology adopted, research process, results obtained and conclusion of the research. The abstract can be written using single or one and a half spacing. Example can be seen in Appendix 1 (Bahasa Melayu) and Appendix J (English).

ABSTRAK

Kajian ini dilakukan bertujuan mengkaji penggunaan algoritma genetik (GA) dalam pemodelan sistem dinamik linear dan tak linear dan membangunkan kaedah alternatif bagi pcmilihan struktur model menggunakan GA. Algorithma kuasa dua terkecil ortogon (OLS), satu kaedah penurunan kecerunan digunakan sebagai bandingan bagi kaedah yang dicadangkan. Pcmilihan struktur model mengunakan kaedah algoritma genetik yang diubahsuai (MGA) dicadangkan dalam kajian ini bagi mengurangkan masalah konvergens pramatang dalam algoritma genetik mudah (SGA). Kesan penggunaan gabungan operator MGA yang berbeza ke atas prestasi model yang terbentuk dikaji dan keberkesanan serta kekurangan MGA diu t arakan. Kajian simulasi dilakukan untuk membanding SGA, MGA dan OLS. Dengan meggunakan bilangan parametcr dinamik yang setara kajian ini mendapati, dalam kebanyakan kes, prestasi MGA adalah lebih baik daripada SGA dalam mencari penyelesaian yang berpotensi dan lebih berkebolehan daripada OLS dalam menentukan bilangan sebutan yang dipilih dan ketcpatan ramalan. Di samping itu, penggunaan carian tcmpatan dalam MGA untuk menambah baik algorithma tersebut dicadang dan dikaji, dinamai sebagai algoritma mcmetic (MA). Hasil simulasi menunjukkan, dalam kebanyakan kes, MA berkeupayaan menghasilkan model yang bersesuaian dan parsimoni dan mcmenuhi ujian pengsahihan model di samping mcmperolehi beberapa kelebihan dibandingkan dengan kaedah OLS, SGA dan MGA. Tambahan pula, kajian kes untuk sistcm berbilang pcmbolehubah menggunakan data eksperimental sebenar daripada dua sistem iaitu sistem pengulang-alik turbo dan reaktor teraduk berterusan menunjukkan algoritma ini boleh digunakan sebagai alternatif untuk mcmperolehi model termudah yang memadai bagi sistcm tersebut.

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LIST OF ABBREVIATIONS

ANN	-	Artificial Neural Network
GA	-	Genetic Algorithm
PSO	-	Particle Swarm Optimization
MTS	-	Mahalanobis Taguchi System
MD	-	Mahalanobis Distance
TM	-	Taguchi Method
UTM	-	Universiti Teknologi Malaysia
XML	-	Extensible Markup Language
ANN	-	Artificial Neural Network
GA	-	Genetic Algorithm
PSO	-	Particle Swarm Optimization

LIST OF SYMBOLS

δ	-	Minimal error
D, d	-	Diameter
F	-	Force
v	-	Velocity
p	-	Pressure
I	-	Moment of Inersia
r	-	Radius
Re	-	Reynold Number

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

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1.2 Problem Statement

Behind every great solution lies a well-defined problem statement. Please state your problem in this section. Your problem is not my problem.

1.3 Research Objectives

The ultimate aim of this project is to improve the performance of the PIM-based BNN using boosted 10T GC-eDRAM topology. The objectives in this project are:

(a) To design the GC-eDRAM memory cell for Multiply Accumulate (MAC) operation in BNN.

(b) To improve the issue of high-power consumption for PIM BNN macros.

(c) To benchmark and assess the performance of boosted 10T GC-eDRAM PIM BNN.

1.4 Inserting Captions

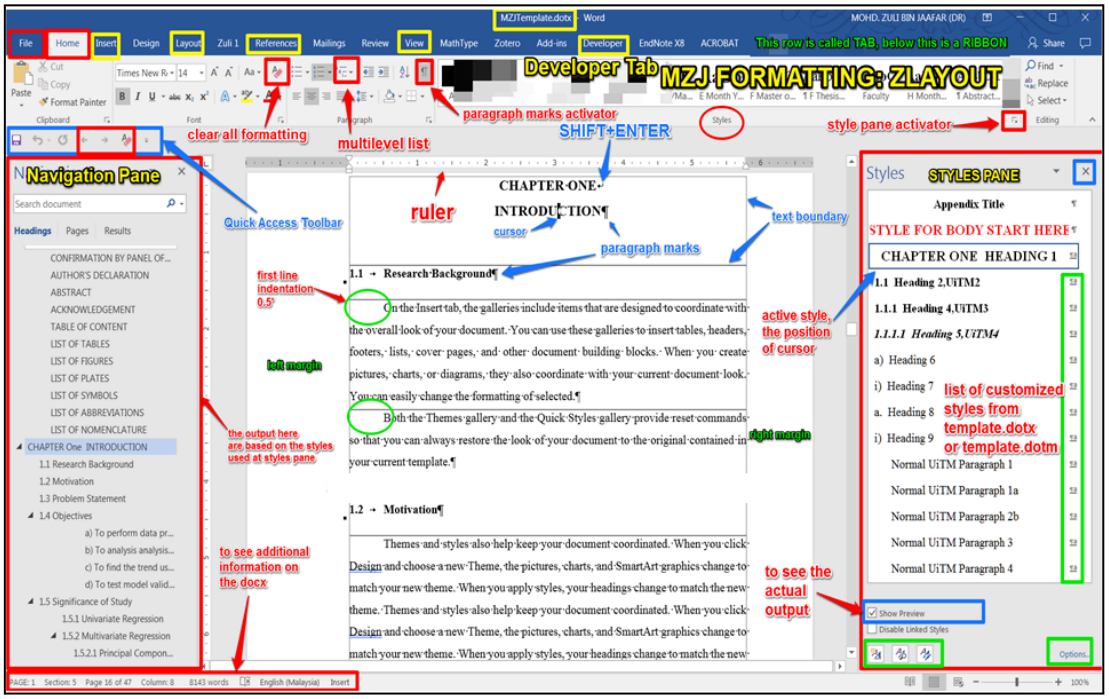

Figure 1.1 Trends leading to the problem using MZJ Formatting Method.

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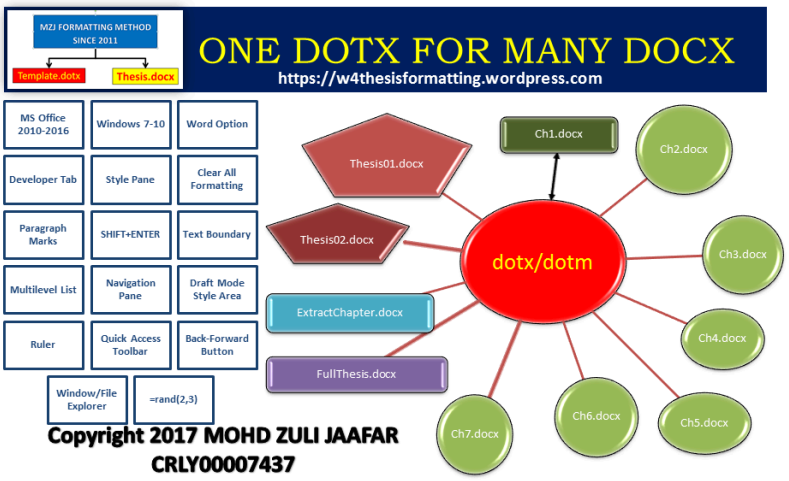

Figure 1.2 Design and development phases of the proposed scheme (Muhamad, 2018)

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Table 1.1 Basic ANN models used for control chart pattern recognition and classification.

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1.5 Equation

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$$y = mx + c \tag{1.1}$$

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CHAPTER 2

LITERATURE REVIEW

1.6 Theoretical Review

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Table 2.1 Regression analysis for the results of preliminary feature screening

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Figure 2.1 Continuous variability reduction using SPC chart

1.7 Review on Design/Method/Structure/Architecture/etc.. 1

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Figure 2.2 Typical fully developed patterns on Shewhart control chart (Cheng, 1989)

1.8 Review on Design/Method/Structure/Architecture/etc.. 2

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Table 2.2 Estimated effects and regression coefficients for the recogniser's performance (reduced model)

1.9 Review on Design/Method/Structure/Architecture/etc.. 3

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CHAPTER 3

RESEARCH METHODOLOGY

1.10 Project Workflow

1.11 Proposed Method

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1.12 Tools and Platforms

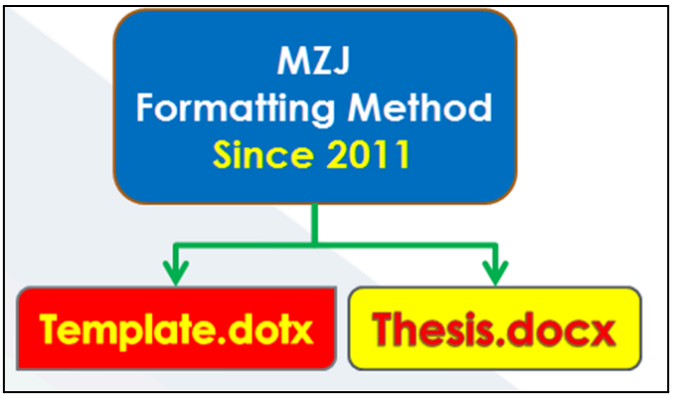

Figure 3.1 Example of Formatting Method

3.1 Cost of Project

Tabulate and discuss the cost required for this project.

Table 3.1 Cost of project.

Tools/Software/Equipment	Price (RM)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 The Big Picture

4.2 Analytical Proofs

4.3 Result and Discussion

4.4 Chapter Summary

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

5.2 Contributions to Knowledge

Describe the potential impact of this proposed work on societal and environmental contexts (university-industry-government-public-environment).

5.3 Future Works

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Appendix C Time-series Results Long Long Long Long Long Long Long Long Long Long