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# DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my

mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

# 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. A. A. A for encouragement, guidance, critics and friendship. I am also very thankful to my co-supervisor Professor Dr A. H. A and Associate Professor Dr. H. J 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 University of Technology (UOT), Applied Science Department for funding/supporting my Ph.D/MS.c study. Librarians at UOT, university of Baghdad, and Universiti Teknologi Malaysia (UTM) 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



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500 words maximum for Ph.D 300 words maximum for Master

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ANN - Artificial Neural Network GA - Genetic Algorithm

PSO - Particle Swarm Optimization MTS - Mahalanobis Taguchi System MD - Mahalanobis Distance

TM - Taguchi Method

UOT - University of Technology XML - Extensible Markup Language ANN - Artificial Neural Network GA - Genetic Algorithm

PSO - Particle Swarm Optimization

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. **Problem Background**

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# Problem Background

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need them. To change the way a picture fits in your document, click it and a button for layout options appears next to it. When you work on a table, click where you want to add a row or a column, and then click the plus sign.

# Problem Statement

* 1. **Research Goal**

**1.4.1 Research Objectives**

The objectives of the research are :

1. To estimate the parameters
2. Item 1
3. Item 2
4. To define the best parameter estimate.

# Captions

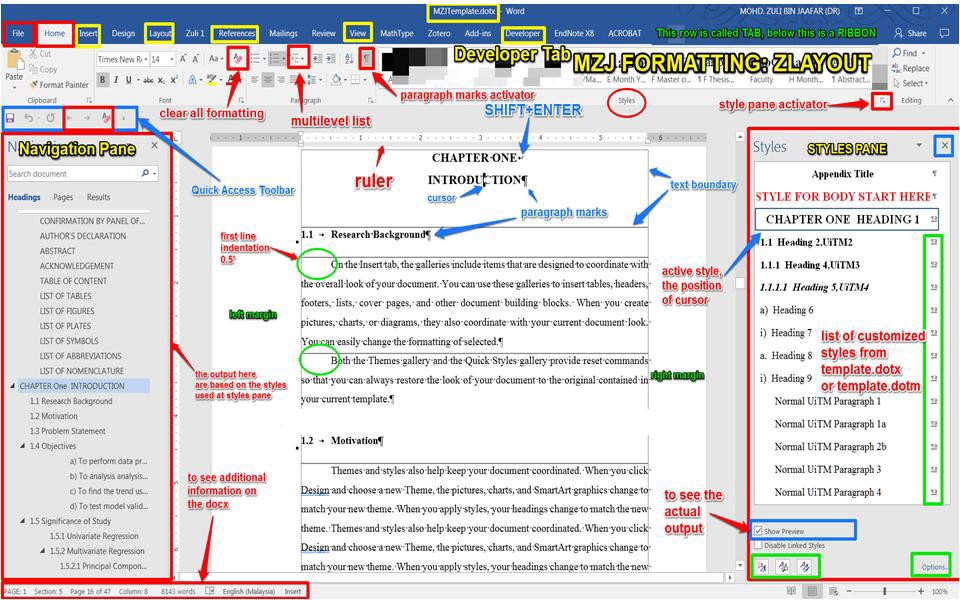
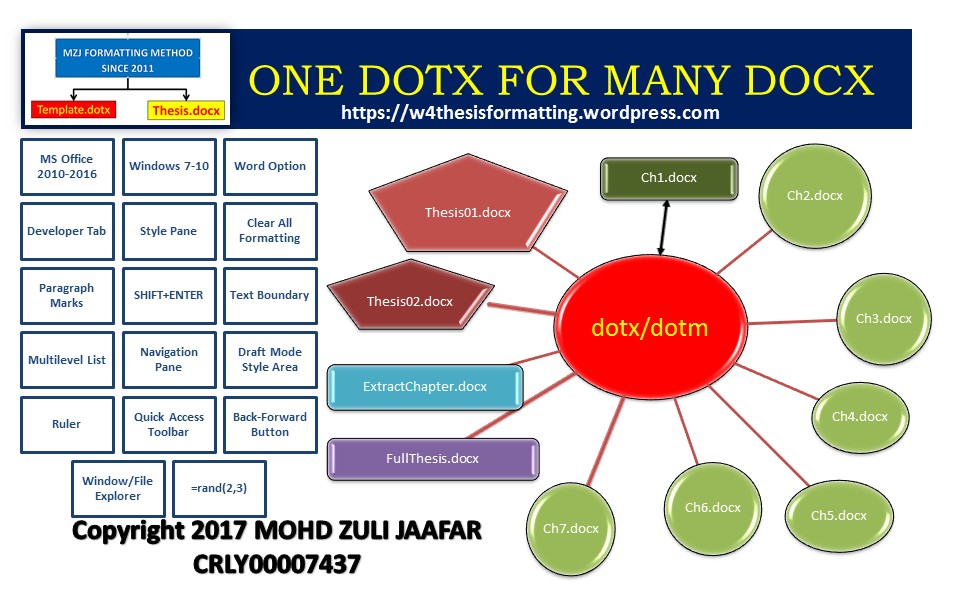


Figure 1.1 Trends leading to the problem using MZJ Formatting Method.

*(Distance between the caption and figure one line)*

**Figure 1.2** Design and development phases of the proposed scheme [1]



*(If the caption is written more than one line, use 1.5 line)*

Table 1.1 The role of statistical quality engineering tools and methodologies



*(If the caption is written in a single line)*

Table 1.2 Basic ANN models used for control chart pattern recognition

*(If the caption is written more than one line, use 1.5 line)*

# Quotation

After deliberating on doctoral education in Australia in the 1990s, one observer I Australia writes:

The lack of any significant formal course work within our Ph.D. and master degrees by research has continued for three decades. The focus of our Ph.D. research type degrees continues to be the research project, and this is almost the only medium by which education is accomplished.

# Equation

*y* *mx* *c*

(1.1)

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# CHAPTER 2 LITERATURE REVIEW

* 1. **Introduction**

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Figure 2.1 Continuous variability reduction using SPC chart (Revelle and Harrington, 1992)

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

Table 2.1 Regression analysis for the results of preliminary feature screening Table 2.2 Estimated effects and regression coefficients for the recogniser's performance (reduced model)



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# 2.1.1 State-of-the-Arts

* 1. **Limitation**
  2. **Research Gap**

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# CHAPTER 3 RESEARCH METHODOLOGY

* 1. **Introduction**

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# 3.1.1 Proposed Method

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# 3.1.1.1 Research Activities

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# Tools and Platforms

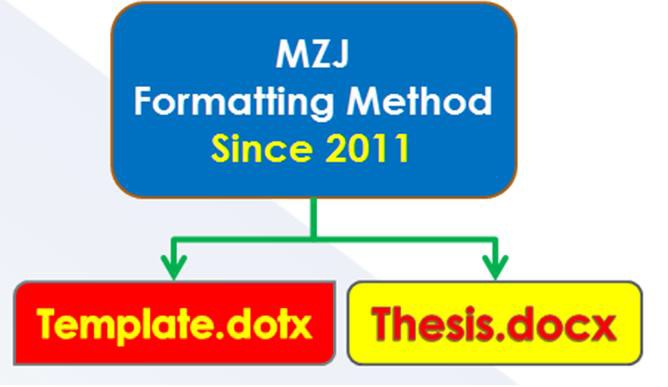


Figure 3.1 Example of Formatting Method.

# Chapter Summary

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# CHAPTER 4 PROPOSED WORK

* 1. **The Big Picture**

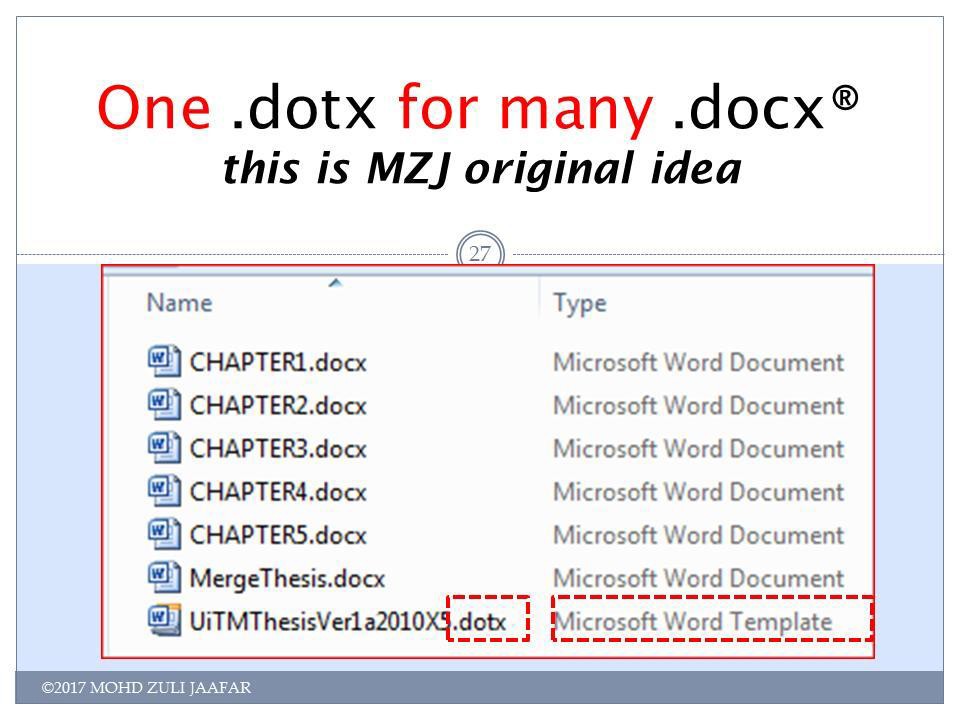


Figure 4.1 This is MZJ original idea.

# Analytical Proofs

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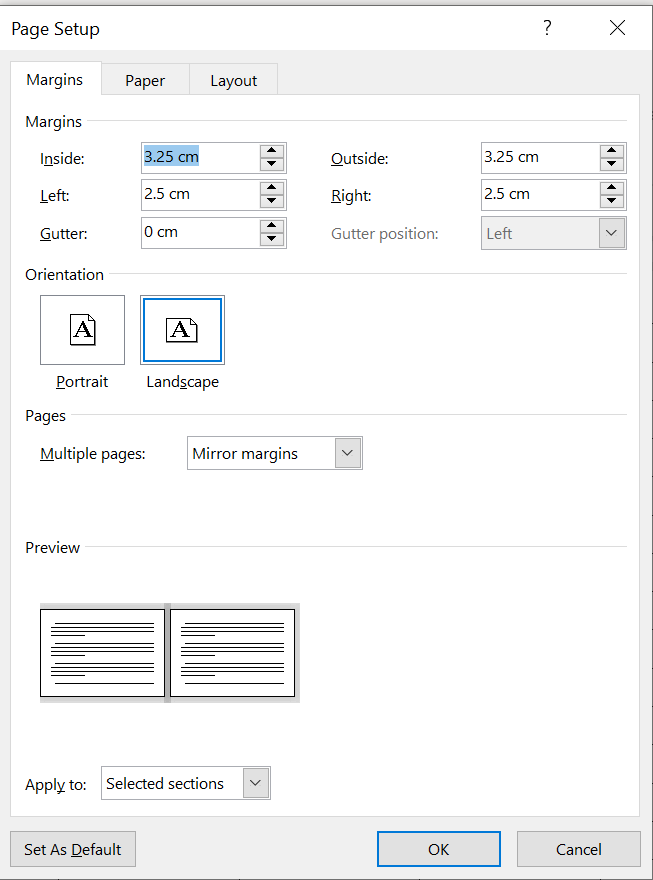
# Result and Discussion



Figure 4.2 The method for high performance formatting.

# Chapter Summary

*Chapter No. Chapter Title*



Title Title Ti Title Title

tle Title Title

11

# CHAPTER 5

**CONCLUSION AND RECOMMENDATIONS**

* 1. **Research Outcomes**
  2. **Contributions to Knowledge**
  3. **Future Works**

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Table 5.1 Example Repeated Header Table.



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**Appendix A Time-series Results Long Long Long Long Long Long Long Long Long Long**



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