

UNIVERSITI TEKNOLOGI MARA

**NONLINEAR AUTO-REGRESSIVE MODEL
STRUCTURE SELECTION USING BINARY
PARTICLE SWARM OPTIMIZATION
ALGORITHM**

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Thesis submitted in fulfillment
of the requirements for the degree of
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AUTHOR'S DECLARATION

I declare that the work in the thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree of qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.


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ABSTRACT

System Identification (SI) is a control engineering discipline concerned with the discovery of mathematical models based on dynamic measurements collected from the system. It is an important discipline in the construction and design of controllers, as SI can be used for understanding the properties of the system as well as to forecast its behavior under certain past inputs and/or outputs. The NARMAX model and its derivatives (Nonlinear Auto-Regressive with Exogenous Inputs (NARX) and Nonlinear Auto-Regressive Moving Average (NARMA)) are powerful, efficient and unified representations of a variety of nonlinear models. The identification process of NARX/NARMA/NARMAX involves structure selection and parameter estimation, which can be simultaneously performed using the widely accepted Orthogonal Least Squares (OLS) algorithm. Several criticisms have been directed towards OLS for its tendency to select excessive or sub-optimal terms. The suboptimal selection of regressor terms leads to models that are non-parsimonious in nature. This thesis proposes the application of a stochastic optimization algorithm called Binary Particle Swarm Optimization algorithm for structure selection of polynomial NARX/NARMA/NARMAX models. The algorithm searches the solution space by selecting various model structures and evaluating its fitness. A MySQL database was created to analyze the optimization results and speed up computations of the optimization algorithm. The proposed optimization algorithm was tested on several benchmark datasets, namely the Direct Current Motor (DCM), Mackey-Glass Differential Equation (MG) and Flexible Robot Arm (FRA). The DCM motor was the least complication dataset, followed by the FRA (medium complexity) and MG (most complexity). The results suggest that the proposed method can reduce the number of correlation violations down to between 28.57% and 69.23% at the expense of increased model size (requirement of additional regressor terms to explain the behavior of the system).

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Sincerely,

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TABLE OF CONTENTS

	Page
AUTHOR'S DECLARATION	ii
ABSTRACT	iii
ACKNOWLEDGMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	xi
LIST OF FIGURES	xiii
LIST OF ABBREVIATIONS	xxviii
CHAPTER ONE: INTRODUCTION	
1.1 Research Background	1
1.2 Problem Statement	1
1.3 Proposed Solution	2
1.4 Thesis Objectives	2
1.5 Project Scope	3
1.6 Organization of the Thesis	3
CHAPTER TWO: LITERATURE REVIEW	
2.1 Introduction	5
2.2 System Identification	5
2.2.1 Applications of System Identification	6
2.2.2 Parametric Vs. Non-Parametric Modeling	6
2.2.3 Linear Vs. Nonlinear	8
2.3 System Identification Procedure	9
2.3.1 Data Collection	9
2.3.2 Preprocessing and Data Division	10
2.3.3 Model Selection	12
2.3.3.1 Volterra Series Expansion	12
2.3.3.2 Hammerstein Model	13