

**UNIVERSITI TEKNOLOGI MARA**

**A MUTATED HYBRID CUCKOO  
SEARCH-ARTIFICIAL NEURAL  
NETWORK FOR GRID-CONNECTED  
PHOTOVOLTAIC SYSTEM OUTPUT  
PREDICTION**

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Thesis submitted in fulfilment  
of the requirements for the degree of  
**Master of Science**  
**(Electrical Engineering)**

**Faculty of Electrical Engineering**

**January 2019**

## ABSTRACT

This thesis presents a hybrid technique for predicting the AC power output from a Grid-Connected Photovoltaic (GCPV) system. Initially, the prediction was conducted using six classical Multi-Layer Feedforward Neural Network (MLFNN) models. These models were developed based on different sets of inputs. A key feature for developing these models is the inclusion of time-series inputs. The inclusion of time-series inputs to the network is important as the solar irradiance, ambient temperature and module temperature have different time-constant; i.e. they have different rate of change as the climate changes. The results showed that the classical MLFNN with time-series inputs had outperformed the other five classical MLFNNs by producing the lowest Root Mean Square Error (RMSE). In addition, the study also showed that the classical MLFNN with no time-series input was found to be the worst MLFNN for the prediction. Upon completion of classical MLFNN, Hybrid Multi-Layer Feedforward Neural Network (HMLFNN) was developed to facilitate the training process and thus reducing the overall training period of classical MLFNN. A Cuckoo Search Algorithm (CSA) was proposed as a new meta-heuristics for the HMLFNN. CSA was used to determine the optimal number of neurons in hidden layer, learning rate and momentum rate of the MLFNN such that the RMSE was minimized. At this stage, the best classical MLFNN with time-series inputs was selected to be hybridized with CSA. The results showed that CSA is more accurate than Evolutionary Programming (EP) and Firefly Algorithm (FA) as it produced lowest RMSE with highest coefficient of determination,  $R^2$ . CSA was found to be 42.86% and 47.55% more accurate than EP and FA respectively. In addition, CSA was also found to be 81.14% and 82.21% faster than EP and FA respectively. Besides that, Mutated Cuckoo Search Algorithm (MCSA) was introduced to reduce the computation time during the search of the optimal solution. At this stage, each cuckoo was mutated to produce a mutant which carries the information from the parent cuckoo. As a result, the information of the previous search can be incorporated during the current search such that the global optimal solution can be discovered at a faster rate. The results showed that MCSA outperformed the conventional CSA by producing 8% lower RMSE and 15.5% lower computation time. Therefore, the proposed MCSA for the prediction is justified.

## ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, the Most Merciful, all the praises and thanks be to Allah for His blessing, guidance and strength throughout my Masters studies. Alhamdulillah, I have completed writing this thesis with the help and support from fantastic peoples around me.

First and foremost, I would like to express my sincere gratitude to my supervisor, Dr. Shahril Irwan Bin Sulaiman for his patience, motivation, enthusiasm and immense knowledge. His guidance and continuous support helped me in all the time of research and writing of this thesis. The ideas and knowledge presented in this thesis was shaped by countless discussions with him. He has been a constant source of advice and encouragement during this research.

I would like to extend my sincere gratitude to my co-supervisor Assoc. Prof. Dr. Haji Ahmad Maliki Bin Omar for his support, guidance and assistance during the research of my work. His knowledge in renewable energy and in technical part was a great asset to this research. I really appreciate the opportunity to study and doing research under his expert supervision. Thanks also for the constructive suggestions, criticism and comments to improve the quality of this work.

My sincere thanks also go to my entire family members especially my husband and my parents for their continuous prayers, love, encouragement, always being there for me and giving me help and support during this study. They have been blessing me with their unfailing support throughout my years of study. This accomplishment would not have possible without them.

I would like to take this opportunity to sincerely acknowledge the Ministry of Education and Universiti Teknologi MARA (UiTM) Shah Alam for their help in financing my studies. Their funding helped me to perform my work comfortably.

Last but not least, my appreciation goes to all Green Energy Research Centre (GERC) members who always making a time to answering my question and helped me to understand my research area better. Thanks for their generous advice and ideas to this work. Thank you for their kindness and moral support during my study. Also, thanks for the friendship and memories.

# TABLE OF CONTENTS

	<b>Page</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	<b>ii</b>
<b>AUTHOR'S DECLARATION</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>ACKNOWLEDGEMENTS</b>	<b>v</b>
<b>TABLE OF CONTENT</b>	<b>vi</b>
<b>LIST OF TABLES</b>	<b>xi</b>
<b>LIST OF FIGURES</b>	<b>xii</b>
<b>LIST OF SYMBOLS</b>	<b>xv</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xviii</b>
<b>CHAPTER ONE: INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Problem Statement	3
1.3 Objectives	5
1.4 Scope of Work	5
1.5 List of Contributions	6
1.6 Organization of Thesis	7
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>8</b>
2.1 Introduction	8
2.2 Definitions	8
2.3 Prediction Methods	9
2.3.1 Conventional Methods	9
2.3.2 Computational Intelligent-based Methods	12
2.4 Artificial Neural Network	15
2.4.1 Classical Artificial Neural Network	15
2.4.2 Hybrid Artificial Neural Network	16
2.5 Optimization Methods	17
2.6 Output Prediction of Grid-Connected Photovoltaic System	20

2.7 Summary	23
<b>CHAPTER THREE: METHODOLOGY</b>	<b>25</b>
3.1 Introduction	25
3.2 Overall Research Framework	25
3.3 Operation of Grid-Connected Photovoltaic System	29
3.4 Classical of Artificial Neural Network Models for Output Prediction	29
3.4.1 Design of Artificial Neural Network	29
3.4.1.1 <i>Selection of Architecture</i>	30
3.4.1.2 <i>Selection of Number of Neurons</i>	31
3.4.1.3 <i>Selection of Learning Rate and Momentum Rate</i>	32
3.4.1.4 <i>Selection of Activation Function</i>	33
3.4.1.5 <i>Selection of Learning Algorithm</i>	34
3.4.1.6 <i>Selection of Number of Iterative Updates</i>	34
3.4.2 Classical Multi-Layer Feedforward Neural Network Models for Output Prediction	34
3.4.2.1 <i>MLFNN Model 1</i>	35
3.4.2.2 <i>MLFNN Model 2</i>	35
3.4.2.3 <i>MLFNN Model 3</i>	36
3.4.2.4 <i>MLFNN Model 4</i>	36
3.4.2.5 <i>MLFNN Model 5</i>	37
3.4.2.6 <i>MLFNN Model 6</i>	37
3.5 Data Collection	38
3.6 Development of Classical Artificial Neural Network	40
3.6.1 Overall Implementation	40
3.6.2 Training Procedure	41
3.6.3 Testing Procedure	43
3.7 Development of Hybrid Multi-Layer Feedforward Neural Network Model	44
3.7.1 Overall Implementation	44
3.7.2 Identification of Meta-heuristics	45
3.7.2.1 <i>Prediction Model using Cuckoo Search Algorithm</i>	45
3.7.2.2 <i>Prediction Model using Firefly Algorithm</i>	48
3.7.2.3 <i>Prediction Model using Evolutionary Programming</i>	50
3.7.3 Benchmarking of Meta-heuristics	52