

# CONTENTS

**APPROVAL PAGE**

**SELF DECLARATION AGAINST PLAGIARISM**

<b>ABSTRACT</b>	<b>i</b>
<b>ACKNOWLEDGMENTS</b>	<b>ii</b>
<b>PREFACE</b>	<b>iii</b>
<b>CONTENTS</b>	<b>iv</b>
<b>LIST OF FIGURES</b>	<b>vii</b>
<b>LIST OF TABLES</b>	<b>viii</b>

<b>I INTRODUCTION</b>	<b>1</b>
1.1 Background . . . . .	1
1.2 Problem Identification and Objective . . . . .	3
1.3 Scope of Work . . . . .	3
1.4 Research Methodology . . . . .	4
1.5 Structure of The Thesis . . . . .	5
<b>II LITERATURE REVIEW AND BASIC THEORY</b>	<b>6</b>
2.1 Related Research . . . . .	6
2.2 Electroencephalography (EEG) . . . . .	9
2.3 Event-Related Potential (ERP) . . . . .	11
2.4 Channel Selection . . . . .	12
2.5 Metaheuristic Algorithm . . . . .	13
2.5.1 Genetic Algorithm (GA) . . . . .	13
2.5.2 Particle Swarm Optimization (PSO) . . . . .	15
2.5.3 Ant Colony Optimization (ACO) . . . . .	17
2.5.4 Grey Wolf Optimizer (GWO) . . . . .	20
2.5.5 Whale Optimization Algorithm (WOA) . . . . .	21
2.5.6 Binary Stochastic Fractal Search (BSFS) . . . . .	24

2.6	Classifier . . . . .	26
2.6.1	Logistic Regression . . . . .	26
2.6.2	Voting Classifier . . . . .	27
<b>III SYSTEM MODEL AND THE PROPOSED DESIGN</b>		<b>28</b>
3.1	Materials . . . . .	29
3.1.1	Respondent Criteria . . . . .	29
3.1.2	The Device Used . . . . .	29
3.1.3	Data Acquisition Procedure . . . . .	31
3.1.3.1	Preparation for Data Acquisition . . . . .	31
3.1.3.2	Data Acquisition . . . . .	33
3.1.4	Dataset . . . . .	36
3.1.4.1	Removal of Eye Artifacts using ICA . . . . .	36
3.1.4.2	Filtering Process with Fourth-Order Butterworth Bandpass Filter (1-40 Hz) . . . . .	37
3.1.4.3	Signal Segmentation and Data Labeling . . . . .	39
3.2	System Design . . . . .	40
3.2.1	Testing Dataset Without Channel Selection . . . . .	41
3.2.2	Testing Dataset Using Metaheuristic Algorithms . . . . .	41
3.2.3	Testing Dataset Using Hybrid Metaheuristic Algorithms . . . . .	41
3.3	System Performance Parameters . . . . .	42
3.3.1	Accuracy . . . . .	42
3.3.2	Sensitivity . . . . .	42
3.3.3	Specificity . . . . .	43
3.3.4	T-Test . . . . .	43
<b>IV PERFORMANCE EVALUATIONS</b>		<b>44</b>
4.1	Testing Dataset Without Channel Selection . . . . .	44
4.1.1	PR02 . . . . .	44
4.1.2	PR04 . . . . .	45
4.1.3	PR06 . . . . .	45
4.1.4	PR07 . . . . .	46
4.1.5	PR09 . . . . .	46
4.2	Testing Dataset Using Metaheuristic Algorithm . . . . .	46
4.2.1	PR02 . . . . .	46
4.2.2	PR04 . . . . .	47
4.2.3	PR06 . . . . .	49
4.2.4	PR07 . . . . .	49

4.2.5	PR09 . . . . .	51
4.3	Testing Dataset Using Hybrid Metaheuristic Algorithm . . . . .	52
4.3.1	PR02 . . . . .	52
4.3.2	PR04 . . . . .	54
4.3.3	PR06 . . . . .	56
4.3.4	PR07 . . . . .	57
4.3.5	PR09 . . . . .	59
4.4	Testing Summary . . . . .	61
<b>V</b>	<b>CONCLUSIONS AND FUTURE WORKS</b>	<b>64</b>
5.1	Conclusions . . . . .	64
5.2	Future Works . . . . .	65
	<b>REFERENCES</b>	<b>67</b>

**Appendices**

**Appendices 1**