

TABLE OF CONTENTS

APPROVAL PAGE	II
DECLARATION OF ORIGINALITY	III
ABSTRACT	IV
ABSTRAK	V
DEDICATION	VI
ACKNOWLEDGEMENTS	VII
PREFACE	VIII
TABLE OF CONTENTS	IX
LIST OF FIGURES	XII
LIST OF TABLES	XIV
LIST OF SCENARIOS	XV
1. INTRODUCTION.....	1
1.1. FORMAL VERIFICATION IN INTERACTION SYSTEM DESIGN	2
1.2. FORMAL SEMANTICS OF UML DIAGRAM	3
1.3. LIMITATION OF CURRENT TECHNIQUE AND TECHNOLOGIES.....	4
1.4. VERIFYING INTERACTION SYSTEM USING COLOURED PETRI NETS	5
1.5. RESEARCH OBJECTIVE: AN APPROACH TO VERIFY A UML-BASED INTERACTION	6
1.5.1. <i>Verification Approach</i>	7
1.5.2. <i>Scope of Research</i>	8
1.5.3. <i>Contribution</i>	9
1.5.4. <i>Case Study</i>	10
2. REVIEW OF LITERATURES	11
2.1. THEORY OF INTERACTION.....	11
2.1.1. <i>Introduction of Interaction</i>	11
2.1.2. <i>Type of Interaction</i>	12
2.1.3. <i>Theory, Model and Framework</i>	12
2.1.4. <i>User Characteristic</i>	13
2.1.5. <i>User Error</i>	14
2.2. SYSTEM DESIGN	16
2.2.1. <i>Scenario</i>	16
2.2.2. <i>System Requirement</i>	Error! Bookmark not defined.
2.3. SYSTEM MODELING	17
2.3.1. <i>Use Case Diagram</i>	17
2.3.2. <i>Class Diagram</i>	17
2.3.3. <i>Sequence Diagram</i>	18
2.3.4. <i>Basic Petri Nets</i>	18
2.3.5. <i>Coloured Petri Nets</i>	20
2.4. ANALYSIS TECHNIQUES IN CPN	21
2.4.1. <i>State Space</i>	21
2.4.2. <i>Strongly-Connected-Component Graph</i>	21
2.4.3. <i>Liveness Properties</i>	22
2.4.4. <i>Fairness Properties</i>	22
3. RESEARCH METHODOLOGY	23
3.1. PROPOSED APPROACH DESIGN	23
3.2. CASE STUDY OF CHOCOLATE MACHINE	24
3.3. EXPERIMENT PLAN	25
3.3.1. <i>Elicit The Requirement</i>	26
3.3.2. <i>Develop the Use Case Diagram</i>	26

3.3.3.	<i>Develop the Class Diagram</i>	27
3.3.4.	<i>Develop the Sequence Diagram</i>	27
3.3.5.	<i>Develop the PN Model of Use Case Diagram</i>	27
3.3.6.	<i>Develop the PN Model of Sequence Diagram</i>	27
3.3.7.	<i>Develop the CPN Model of Sequence Diagram</i>	27
3.3.8.	<i>Verify Interaction in CPN</i>	28
3.4.	TOOLS AND DATA COLLECTION	28
3.4.1.	<i>Scenario Form</i>	28
3.4.2.	<i>Microsoft Visio Professional 2013</i>	29
3.4.3.	<i>PIPE2 Version 4.2.1</i>	29
3.4.4.	<i>CPN Tools Version 4.0</i>	29
3.4.5.	<i>Personal Computer</i>	29
4.	FORMAL SEMANTICS OF UML DIAGRAMS	30
4.1.	FORMAL SEMANTICS OF USE CASE DIAGRAM	30
4.1.1.	<i>Formal Definition of Use Case Diagram</i>	30
4.1.2.	<i>Consistency Rules of Use Case Diagram</i>	31
4.2.	FORMAL SEMANTICS OF SEQUENCE DIAGRAM	32
4.2.1.	<i>Formal Definition of Sequence Diagram</i>	32
4.2.2.	<i>Formal Definition of Lifeline</i>	33
4.2.3.	<i>Consistency Rules of Sequence Diagram</i>	34
4.3.	DISCUSSION	35
5.	TRANSFORMATION RULES	36
5.1.	TRANSFORMATION RULES FROM USE CASE DIAGRAM INTO PETRI NETS	36
5.2.	CONDITIONS FOR TRANSFORMATION RULES FROM USE CASE DIAGRAM INTO PETRI NETS.....	36
5.3.	PROVING THE CORRECTNESS OF TRANSFORMATION RULES FROM USE CASE DIAGRAM INTO PETRI NETS	39
5.4.	TRANSFORMATION RULES FROM SEQUENCE DIAGRAM INTO PETRI NETS	44
5.5.	CONDITIONS FOR TRANSFORMATION RULES FROM SEQUENCE DIAGRAM INTO PETRI NETS.....	44
5.6.	PROVING THE CORRECTNESS OF TRANSFORMATION RULES FROM SEQUENCE DIAGRAM INTO PETRI NETS	49
5.7.	TRANSFORMATION RULES FROM SEQUENCE DIAGRAM INTO COLOURED PETRI NETS.....	53
5.8.	CONDITIONS FOR TRANSFORMATION RULES FROM SEQUENCE DIAGRAM INTO COLOURED PETRI NETS	54
5.9.	PROVING CORRECTNESS OF TRANSFORMATION RULES FROM SEQUENCE DIAGRAM INTO COLOURED PETRI NETS	61
5.10.	DISCUSSION	63
6.	VERIFYING THE INTERACTION.....	64
6.1.	ANALYSIS TECHNIQUES IN COLOURED PETRI NETS.....	64
6.1.1.	<i>State Space Analysis</i>	64
6.1.2.	<i>Strongly-Connected-Component Graph</i>	66
6.1.3.	<i>Liveness Properties</i>	67
6.1.4.	<i>Fairness Properties</i>	68
6.2.	ERROR IDENTIFICATION TECHNIQUE	68
6.2.1.	<i>Technique to Identify Initialization Error</i>	68
6.2.2.	<i>Technique to Identify Order Error</i>	69
6.2.3.	<i>Technique to Identify Post-Completion Error</i>	69
6.3.	DISCUSSION	70
7.	CASE STUDY OF CHOCOLATE MACHINE.....	72
7.1.	ELICITE THE REQUIREMENTS	72
7.1.1.	<i>Description of Chocolate Machine</i>	72
7.1.2.	<i>Description of Types of Machine and User</i>	72
7.1.3.	<i>Requirement of Normal Chocolate Machine</i>	74
7.1.4.	<i>Requirement of Non-Informative Chocolate Machine</i>	75
7.1.5.	<i>Scenario of Reactive User</i>	75
7.1.6.	<i>Scenario of Goal-based User</i>	76
7.1.7.	<i>Scenario of Impatience User</i>	77

7.1.8. Scenario of Habituated User.....	78
7.2. DEVELOP USE CASE DIAGRAM.....	79
7.3. DEVELOP CLASS DIAGRAM.....	80
7.4. DEVELOP SEQUENCE DIAGRAM.....	81
7.5. DEVELOP PETRI NETS MODEL OF USE CASE DIAGRAM.....	84
7.6. DEVELOP PETRI NETS MODEL OF SEQUENCE DIAGRAM.....	86
7.7. DEVELOP COLOURED PETRI NETS MODEL OF SEQUENCE DIAGRAM.....	94
7.8. VERIFY COLOURED PETRI NETS MODEL OF SEQUENCE DIAGRAM.....	98
7.8.1. State Space Analysis.....	98
7.8.2. Strongly-Connected-Component Graph.....	99
7.8.3. Liveness Properties.....	99
7.8.4. Fairness Properties.....	99
7.8.5. Error Identification.....	100
8. CONCLUSION.....	101
BIBLIOGRAPHY.....	103
APPENDIX 1 THE SCENARIOS.....	105
APPENDIX 2 THE SEQUENCE DIAGRAMS.....	122
APPENDIX 3 THE VERIFICATION RESULT OF CPN MODELS.....	155