

ENHANCEMENT OF RAPID OBJECT PROCESS FOR EMBEDDED SYSTEM
(ROPES) TO SUPPORT PATTERN ORIENTED DEVELOPMENT

MOHD ADHAM BIN ISA

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Science (Computer Science)

Faculty of Computer Science and Information Systems
University of Technology Malaysia

OCTOBER 2009

I declare that this project report entitled “*Enhancement of Rapid Object Process for Embedded System (ROPES) to Support Pattern Oriented Development*” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Mohd Adham Bin Isa

Date : 30 October 2009

ACKNOWLEDGEMENT

In preparing this project report, I wish to express my sincere appreciation to my supervisor Dr. Dayang Norhayati Binti Abang Jawawi for the guidance, advice and encouragement during my studying. The support and suggestion that Dr. Dayang gives inspired me to going through in this project.

I would like to thanks to Software Engineering Lab members in Universiti Teknologi Malaysia for their helps and supports.

Finally my special thanks to my parent for their love and care especially my beloved wife Mastura Md. Hassan and my beautiful daughter Elya Darwisyah for their support and cheering me up at those difficult time.

ABSTRACT

The complexity of Embedded Real Time (ERT) software development represents a challenging of analysing, designing and building ERT software. From this standpoint, the complexity of ERT software development means a challenging to adapt all ERT software requirements such as timing and resource constraints into its software lifecycle. Against these claims, a wide range of software development methodologies have been devised such as patterns. Patterns codify an effective solution for recurring problems that allows software engineers to reuse. By applying patterns into ERT software development, the complexity of ERT software development can be decreased and at the same time promote high degree of reuse through software patterns. In this project, the integrated Rapid Object Process for Embedded System (ROPES) and Pattern-oriented Analysis and Design (POAD) methodology has been developed to represent a promising way to build ERT software with software patterns reuse. To make the integrated methodology more compelling and confirm the rules of patterns oriented modelling, the integrated ROPES and POAD metamodel has been developed. The aim of the integrated metamodel is to conform the correctness of the integrated methodology modelling rules in term of pattern uses. In addition, the integrated ROPES and POAD software process also has been built as the continuity to describe concrete integrated software development process. To verify the correctness of the integrated metamodel, the mapping process of Meta-Object Facility (MOF) using graph theory has been conducted. The results of implementing the integrated metamodel and software process for Feedback Control System (FCS) shows that the complexity of ERT software development has been decreased besides promote software patterns reuse.

ABSTRAK

Pembangunan perisian Sistem Masa Nyata Terbenam (ERT) yang kompleks menunjukkan keunikan menganalisa, merekabentuk dan membina perisian ERT. Daripada ciri-ciri ini, pembangunan perisian ERT yang kompleks bermakna cabaran untuk merealisasikan semua keperluan perisian ERT seperti masa and kekekangan sumber keatas proses kitaran pembangunan perisiannya. Berpandukan kenyataan tersebut, pelbagai metodologi pembangunan perisian telah diubah atau dinaiktaraf sebagai contoh adalah corak. Corak memberikan penyelesaian yang efektif bagi penyelesaian masalah yang berulang serta membolehkan jurutera perisian menggunakan semula kaedah ini bagi menyelesaikan masalah lain. Dengan mengaplikasikan penggunaan corak keatas pembangunan perisian ERT, kerumitan prosesnya dapat dikurangkan selain menggalakkan penggunaan semula corak. Di dalam projek ini, gabungan *Rapid Object Process for Embedded System (ROPES)* dan *Pattern-oriented Analysis and Design (POAD)* metodologi telah dibangunkan. Untuk menjadikan gabungan kedua-dua metodologi ini lebih kukuh dan mengikut peraturan pembangunan perisian berasaskan corak, gabungan metamodel telah dihasilkan. Matlamat utamanya adalah untuk memastikan rekabentuk perisian ERT mengikut corak. Selain itu, pembangunan proses perisian juga telah dibangunkan. Untuk memastikan gabungan metamodel tepat, proses teori graf bersama *Meta-Object Facility (MOF)* telah dilakukan. Hasil keputusan keatas pelaksanaan gabungan metamodel dan proses pembangunan perisian menunjukkan kerumitan pembangunan perisian ERT telah dikurangkan dan penggunaan semula corak keatas rekabentuk perisian telah ditingkatkan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION OF THESIS STATUS	
	SUPERVISOR DECLARATION	
	TITLE PAGE	i
	STUDENT DECLARATION	ii
	ACKNOWLEDGEMENT	iii
	ABSTRACT	iv
	TABLE OF CONTENT	vi
	LIST OF TABLE	xi
	LIST OF FIGURE	xii
	LIST OF ABBREVIATION	xv
	LIST OF APPENDIX	xvi
1	PROJECT OVERVIEW	
	1.1 Introduction	1
	1.2 Problem Background	4
	1.3 Problem Statement	6
	1.4 Project Aim	7
	1.5 Objectives	7
	1.6 Scopes	8
	1.7 Significance of the project	8

1.8	Thesis Outline	9
2	LITERATURE REVIEW	
2.1	Introduction	10
2.2	Component Based Software Engineering (CBSE)	11
2.2.1	Software Component Model	11
2.3	Component Oriented Development	13
2.4	Pattern Oriented Development	16
2.4.1	Software Pattern	17
2.4.1.1	Analysis Pattern	18
2.4.1.2	Design Pattern	19
2.4.1.3	Programming Pattern	19
2.4.2	Pattern Oriented Methodology	20
2.4.2.1	Pattern Oriented Analysis and Design (POAD)	21
2.4.2.2	Pattern Driven Modelling and Analysis (PDMA)	25
2.4.2.3	Metamodel POAD+PECOS	26
2.4.2.4	Design Pattern + CBSD	28
2.4.2.5	Comparative Evaluation	29
2.5	Embedded Real Time (ERT) System	30
2.5.1	ERT System Methodology	31
2.5.1.1	ROPES	32
2.5.1.2	OCTOPUS/UML	34
2.5.1.3	COMET	36
2.5.1.4	MARMOT	38
2.5.1.5	DESS	40
2.5.1.6	Comparative Evaluation	43
2.6	Discussion	45

3	RESEARCH METHODOLOGY	
3.1	Introduction	47
3.2	The Software Engineering Research	48
3.3	Research Framework and Process	49
3.3.1	Problem Formulation	51
3.3.2	Literature Review	51
3.3.3	Integrated Metamodel POAD and ROPES	52
3.3.4	Define and Design Software Process	53
3.4	Feedback Control System (FCS)	54
3.5	Summary	56
4	INTEGRATED ROPES AND POAD METAMODEL	
4.1	Introduction	57
4.2	Metamodel	58
4.2.1	UML Specification	59
4.3	POAD Metamodel	60
4.4	ROPES Metamodel	63
4.5	Integrated POAD and ROPES Metamodel	66
4.5.1	Mapping POAD to ROPES	66
4.5.1.1	Mapping POAD Metamodel to ROPES Metamodel	67
4.5.1.2	Validation of the Integrated ROPES and POAD Metamodel	72
4.5.1.3	Mapping ROPES Process to POAD Process	77
4.5.1.4	Initial Result of POAD + ROPES Development Process	79
4.5.2	Summary	82
5	THE INTEGRATED ROPES AND POAD SOFTWARE PROCESS	

5.1	Introduction	84
5.2	Software Process Engineering Process (SPEM)	85
5.3	The Process Model	86
5.3.1	Method Content	88
5.3.1.1	Role Definition	89
5.3.1.2	Work Product Definition	91
5.3.1.3	Task Definition	93
5.3.2	Process Content	94
5.3.2.1	Analysis Process	97
5.3.2.2	Design Process	102
5.4	Discussion On The Proposed Software Process	107
5.5	Comparative Evaluation on Pattern Oriented Development	108

6 ANALYSIS AND DESIGN OF FEEDBACK CONTROL SYSTEM

6.1	Introduction	111
6.2	Analysis Phase	111
6.2.1	Requirement Analysis	112
6.2.1.1	Main Use Case	113
6.2.1.2	Use Case Behaviour	114
6.2.1.3	Use Case Text	114
6.2.1.4	Sequence Diagram	117
6.2.1.5	Statechart	118
6.2.1.6	Pattern Selection	120
6.2.2	System Analysis	122
6.2.3	Object Analysis	123
6.2.3.1	Object Structural	124
6.2.3.2	Object Behaviour	126
6.2.4	Analysis Result Summary	128
6.3	Design Phase	129

6.3.1	Architectural Design	129
6.3.1.1	Component View	130
6.3.1.2	Deployment View	131
6.3.1.3	Pattern Level Diagram	132
6.3.1.4	Pattern Level with Interface Diagram	134
6.3.2	Mechanistic Design	135
6.3.2.1	Design Pattern Internal Class	135
6.3.2.2	Refined Class Diagram	138
6.3.2.3	Sequence Diagram	141
6.3.2.4	Statechart Diagram	142
6.3.3	Detailed Design	145
6.3.4	Design Result Summary	146
6.4	Summary and Discussion	147
7	DISCUSSION AND FUTURE WORK	
7.1	Introduction	149
7.2	Summary	150
7.3	Project Contribution	151
7.4	Future Work	152
	REFERENCES	154
	Appendix A	158-176