

FORMALIZATION OF MEDICAL
INFORMATICS WITH
UML AND Z SPECIFICATIONS

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MASTER OF SCIENCE
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**FORMALIZATION OF MEDICAL INFORMATICS
WITH UML AND Z SPECIFICATIONS**

MAGESWARI RAJOO

**Thesis Submitted in Fulfilment of the Requirement for the
Degree of Master of Science in the Faculty of Science and Technology
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DEDICATIONS

Abstract of thesis presented to the Senate of Kolej Universiti Sains dan Teknologi
Malaysia in fulfillment of the requirement for the degree of Master of Science

To my two little kids, Skandakumera Selvaraj and Ainthini Selvaraj, you both are
always my inspiration.

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MAGESWARI RAJOO

September 2003

Chairperson	Professor Md. Yazid bin Mohd Suswan, PhD
Member	Noraida Binti Hj. Ali, MSc Anir Ngah, MSc
Faculty	Science and Technology

UML is a standard graphical modeling language; it presents a set of notation for visualizing, specifying, constructing, and documenting a software-intensive system. But UML is not a formal language; it is composed by graphical notation and natural language. To improve software reliability and reusability, the use of formal specification is necessary. A method is *formal* if it has a sound mathematical basis, typically provided by a mathematical modeling language. A formal method can help establish the correctness of a system design before the implementation stage. Therefore, formalizing UML into formal specification will assist in the development and verification of system requirements. The focus of this research is on formalizing UML diagrams into Z specification by using a set of mapping rules. A number of various different mapping rules for the translation purposes of UML models into Z specification were created and applied.

Abstract of thesis presented to the Senate of Kolej Universiti Sains dan Teknologi Malaysia in fulfillment of the requirement for the degree of Master of Science

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UML is a standard graphical modeling language; it presents a set of notation for visualizing, specifying, constructing, and documenting a software-intensive system. But UML is not a formal language; it is composed by graphical notation and natural language. To improve software reliability and reusability, the use of formal specification tools are evaluated in the process to carry out specification of applications accurately. With this research, it is hoped that more projects on formalization of Medical Informatics using UML or any other OO modeling languages into formal methods such as Object-Z or B will be initiated.

UML into formal specification will assist in the development and verification of system requirements. The focus of this research is on formalizing UML diagrams into Z specification by using a set of mapping rules. A number of various different mapping rules for the translation purposes of UML models into Z specification were created and applied.

Case studies on Medical Informatics (Radiology Imaging Database system and Dialysis Machine system) are chosen for this research. The ultimate goals of medical informatics are to streamline the processes of patient care, to provide clinicians with accurate data in a timely manner, improve the quality of care, and to reduce costs, which is in line with the Malaysian Health Ministry's vision.

This research is believed to be a topic on its own in the field of formalization of UML with Z specification because the case studies are of medical related. In this research, the formalization concept of UML into formal method using Z specification is elaborated in detail. Case studies on medical informatics are presented, analyzed and designed using the formalization of UML technique. Finally, two different verification methods, functional model of the entire system and Z/EVES' theorem prover are used, to validate and verify the formal specification of UML models. This can lead to early detection of errors and inconsistencies in the software development process. Meanwhile, some UML tools are evaluated in the process, to carry out specification of applications accurately. With this research, it is hoped that more projects on formalization of Medical Informatics using UML or any other OO modeling language into formal methods such as Object-Z or B will be initiated.

Abstrak tesis yang dikemukakan kepada Senat Kolej Universiti Sains dan Teknologi Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

FORMALISASI UNTUK INFORMATIK PERUBATAN DENGAN MENGUNAKAN UML DAN SPESIFIKASI Z

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UML adalah satu piawai bagi bahasa grafik model; iaitu mewakili set notasi untuk visual, spesifikasi, pembinaan dan dokumentasi sistem perisian. Tetapi UML bukanlah bahasa formal; ia mengandungi notasi grafik dan bahasa semulajadi. Untuk memperbaiki kekesanan dengan penggunaan balik perisian, spesifikasi formal diperlukan. Sesuatu kaedah adalah formal jika ia mengandungi asas matematik yang kukuh, biasanya dilengkapi dalam bahasa pemodelan matematik. Kaedah formal dapat membantu dalam pembuktian implimentasi sistem. Dengan memformalkan UML kepada spesifikasi formal, ia dapat membantu dalam pembentukan dan verifikasi keperluan sistem sebelum rekabentuk sistem. Fokus penyelidikan ini adalah untuk memformalkan gambar rajah UML kepada spesifikasi Z dengan menggunakan peraturan pemetaan.

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Dalam penyelidikan ini, konsep pengformalan UML kepada kaedah formal menggunakan spesifikasi Z dibincang dengan lebih mendalam. Kajian kes dalam bidang Informasi Perubatan dibentangkan, dianalisaikan dan direkabentuk menggunakan konsep pengformalan UML ini. Akhirnya, dua kaedah termasuk kaedah Z/EVES's theorem prover telah digunakan untuk mengesahkan spesifikasi formal untuk model-model UML. Ini akan membolehkan pengesanan kesilapan dan ketidaksejajaran dalam proses pembentukan perisian. Dengan penyelidikan ini, diharapkan lebih banyak projek untuk memformalkan Informatik Perubatan dengan menggunakan bahasa pemodelan OO yang lain dan kaedah formal seperti Object-Z atau B boleh dibangunkan.