ENHANCEMENT OF UML-BASED WEB ENGINEERING FOR METAMODELS: HOMEPAGE DEVELOPMENT CASE STUDY

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ENHANCEMENT OF UML-BASED WEB ENGINEERING FOR METAMODELS: HOMEPAGE DEVELOPMENT CASESTUDY

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A dissertation submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science (Computer Science)

Faculty of Computing
University Technology Malaysia

JUNE 2013

ACKNOWLEDGEMENT

First of all, I would like to warmly express my utmost gratitude to Allah S.W.T for His blessing and given strength during the completion of this research.

I would also like to sincerely thank my supervisor **Assoc. Prof. Dr. Dayang Norhayati Binti Abang Jawawi,** for her continuous motivation, advices, encouragement and support from the beginning to the end of my studies, till I was able to develop a deep understanding of the research topic.

Finally my special thanks to my parent for their love and care especially my beloved wife Hwda and my Son Nima, for their support and cheering me up at those difficult time.

ABSTRACT

Web Engineering is the application of systematic, disciplined and quantifiable approaches to the cost-effective development and evolution of high-quality solutions in the web-based applications. *UML-Based Web Engineering* (UWE) is one of the approaches of web engineering, which provides a standard and systematic approach for the development of Web applications. UWE metamodel is a design considered as the conservative extension of the UML metamodel. In this thesis we used UWE metamodels to develop web homepages, the problem is current UWE cannot support homepage contents directly because UWE metamodels are not enough elements for supporting homepages. The goal of this research is enhancement UWE metamodels to high usability UWE in homepage development. There are two steps in this development process. In the first step, we compared UWE with *Object Oriented Hyperlink* (OOH) and *Web Modeling Language* (WebML) to show the strengths and weaknesses of UWE in the development of homepages. In the second step, extended UWE metamodel was proposed eleven elements (six elements for navigation model and five elements for presentation model) to solve these weaknesses to fully support the homepage development process. For the enhanced UWE metamodel, we defined the eleven elements to support the design of homepages, it is fully integrates the UWE metamodel and provides an *XML Metadata Interchange* (XMI) extension. The construction process of Web applications is supported by incorporating the semi-automatic UWE development steps and the *Object Constraint Language* (OCL) of the UWE. Finally we compared the enhanced UWE metamodel with the original UWE metamodel by using a case study, and then the result showed capabilities of the eleven elements in UWE metamodel for development website homepages, and become to increase usability UWE metamodels.

ABSTRAK

Kejuruteraan Web menggunakan pendekatan yang sistematik, berdisiplin dan boleh diukur yang dapat menyumbang kepada penjimatan kos yang efektif dan evolusi berkualiti tinggi dalam aplikasi berasaskan web. *UML-Based Web Engineering (*UWE) adalah salah satu pendekatan dalam kejuruteraan web yang menyediakan piawaian dan pendekaatan sistematik dalam pembangunan aplikasi web. UWE meta-model adalah rekaan yang dianggap sebagai lanjutan konservatif UML meta-model. Dalam tesis ini, pendekatan UWE meta-model digunakan untuk membangunkan laman web.Namum begitu, terdapat masalah berkaitan UWE sedia ada tidak mempunyai elemen yang mencukupi untuk menyokong kandungan laman web secara terus. Kajian ini bermatlamat untuk menambahbaik UWE meta model seterusnya menyelesaikan isu berkaitan pembangunan laman web. Terdapat dua langkah dalam proses pembangunan ini. Dalam langkah pertama, perbandingan UWE dengan *Object Oriented Hyperlink* (OOH) dan *Web Modelling Languange* (WebML) dibuat untuk menunjukkan kekuatan dan kelemahan UWE dalam pembangunan laman web. Manakala dalam langkah kedua, lanjutan UWE Metamodel telah dicadangkan dengan sebelas elemen (enam elemen untuk model navigasi dan lima elemen bagi model persembahan) bagi menyelesaikan kelemahan ini seterusnya menyokong sepenuhnya proses pembangunan laman Web. Untuk menambahbaik UWE Metamodel ini, sebelas elemen dikenalpasti untuk menyokong rekabentuk laman web. Ia adalah integrasikan sepenuhnya UWE Metamodel dan menyediakan *lanjutan Metadata Interchange* XML (XMI). Proses pembangunan Aplikasi Web ini menyokong dengan menggabungkan langkah-langkah semi-outomatik UWE dan *Object Constraint Language (OCL)* daripada UWE tersebut. Akhir sekali, UWE metamodel yang telah ditambabaik dibandingkan dengan UWE metamodel asal dengan menggunakan kajian kes, maka hasil menunjukkan sebelas elemen dalam UWE metamodel berkeupayaan dalam pembangunan Laman Utama bagi Laman Web dan manjadi untuk meningkatkan kebolehgunaan UWE metamodel.

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LIST OF ABBREVIATIONS

AJAX	-	Asynchronous Java Script and XML
APD	-	Abstract Presentation Diagram
ASP	-	Active Server Page
BP	-	Business Process
BPMN	-	Business Process Modelling Notation
CASA	-	Computer Aided Software Engineering
CGI	-	Common Gateway Interface
CIM	-	Common Information Model
CLD	-	Composite Layout Diagram
CMS	-	Content Management System
CRUD	-	Create Read Update Delete
CWM	-	Warehouse Metamodel
ER	-	Entity-Relationship
FUF	-	Functional Usability Features
GEF	-	General Graph editing Framework
HDM	-	Hypertext Design Model
J2EE	-	Java 2 Enterprise Edition
JSP	-	Java Server Pages
MDD	-	Model Driven Development
MOF	-	Meta Object Facility
MVC	-	Model View Controller
NAD	-	Navigation Access Diagram
NAD	-	Navigation Access Diagram
NC	-	Navigation Class
NDT	-	Navigational Development Techniques
NET	-	Network Service Providers

NF	-	Navigation Filters
NL	-	Navigation Link
NSUML	-	Novo Soft UML Library
NT	-	Navigation Target
OCL	-	Object Constraint Language
OID	-	Object IDentifier
OMG	-	Object Management Group
OOH	-	Object Oriented Hypermedia
OOHDM	-	Object Oriented Hypermedia Design Method
OOWS	-	Object Oriented Web Solution
PC	-	Program Commit
PHP	-	Personal Homepage
PIM	-	Platform Independent Model
RIA	-	Rich Internet Applications
RMM	-	Relationship Management Methodology
RUX	-	Rich User eXperience
SQL	-	Structure Query Language
UML	-	Unified Modeling Language
UTM	-	University Technology Malaysia
UWE	-	UML-Based Web Engineering
UE		Usability engineering
W2000	-	A Modeling Notation for Complex Web Applications
WAE	-	Web Application Extension
WE	-	Web Engineering
WebML	-	Web Modeling Language
WebSA	-	Web Software Architecture
WML	-	Website Meta Language
WSDM	-	Web Site Design Method
XMI	-	XML Interchange format
XML	-	eXtensible Markup Language
XSL	-	Extensible Stylesheet Language
MDE	-	Model Driven Engineering

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Web engineering is the application of a systematic and quantifiable approach to cost effective requirements analysis, design, implementation, testing, operation, and maintenance of high quality web software, In web engineering there are lots of methods to develop the web application like UWE, OOH, WebML, OOWS, OOHDM, HDM/HDM-lite, NDT, RUX, Hera, RMM, W2000, WAE/WAE2, WSDM and WebSA (Koch *et al.*, 2008).

UML-Based Web Engineering (UWE) is an advancement of software engineering for the formation of web applications. Since 1999, web application is extended constantly (Baumeister *et al.*, 1999; Koch & Kraus, 2003). UWE supports web application development and special focus on systemization (Koch & Kraus, 2002).

The parting of apprehensions defining a web system such as matter, hypertext construction, delivery, and procedures drive web modelling strategies. For modelling these varied apprehensions by a set of domain-specific model features are provided by UML-based Web Engineering (UWE) strategy. A metamodel indicates these model features and the associations between them (Koch & Kraus, 2003).

UWE metamodel is a design considered as the conservative extension of the Unified Modeling Language (UML) metamodel, in other words that the modelling elements of a UML metamodel are inherited from the UML metamodel and they are not modified by adding new features or additions to the modelling elements class. Any additional features or relationship if using metamodel to implement then they can be specified in different metamodel modelling element and then define Object Constraint Language (OCL) restrictions on additional static semantics and it is equivalent to well formatted rules in the UML specs (Kroiß & Koch, 2011).

World Wide Web (WWW) revolutionary tool was invented in 1990 by Sir Tim Berners-Lee (Berners-Lee & Fischetti, 2001). World Wide Web created a most important part in the life of mankind. Developing disciplined and systematic website is the best part of this study in a visual illustration of the development process of software which is object oriented and homepage design. This study aims to facilitate the students of web engineering and students of university in the masters and undergraduate as a point for programs education in the future. In 2010, 21.4 million websites were added (Pingdom, 2012).

To everyone that visits the site, a structurally excellent homepage will highlight an outstanding first impression. Making certain that the homepage appears like a homepage to users and has entirely the elements anticipated of a homepage is vital. A homepage should display every key choice available on the website as well as precisely convey the site's function. Usually, most of the homepages should comprise of a restricted quantity of prose matter and be seen ’above the fold’.From each page in the site, designers should offer hassle-free entrees to the homepage.As a result, the users become very acquainted to the homepage. The notion to locate a standard method for creating analysis and design models of Web systems came through UML-based Web Engineering (UWE) by the conclusion of the nineties (Baumeister et al., 1999; Wirsing, 1999). The goal, which is still shadowed, was in any case, to demarcate metamodel based mappings among present strategiesas well as to utilize a shared language. Rather than signifying concrete constituents of any current technology, UWE Presentation model features elucidate what applicability is needed at the specific point in the user interface (Kroiß & Koch, 2011).

Cultural differences observed in the background color of the homepage, that the colors of the national flags were usually used by governmental sites in all the countries they studied, with the exception of Brazil, which used a variety of bright colors. French sites heavily used blue, white, and red (the colors of the French flag) regardless of the domain, the companies and commercial websites emphasizes on the images and flashes of the new products on their homepages while academic homepages emphasizes on the links of the faculties and department and admission application (Taieb, 2011).

There are various challenges to developing a homepages such us Accessibility, Navigability, Compatibility, Readability and Usability. The Readability and Usability consists of content and design, the homepage content should be presented in such a way that provides proper information very easily or we can say that it should enhance ease of reading. Homepage readability depends on factors such as Typeface, Colours and design of homepage (Kripintiris, 2008).

Every homepage of website is evaluated by their, navigation, links and commerce, search consequences. The UML is utilized because is graphical language for documenting, constructing and specifying the artifacts of software and as well it includes metamodel, diagram types, object constraints language and notations with well formed regulations (Hennicker & Koch, 2001).

1.2 Problem Background

While most current Web Engineering methodologies model the separate aspects, content, navigation, presentation and business logic, of Web systems in separate models, integration of the different models and in particular the validation of their interaction is not yet sufficiently supported (Knapp, 2006).

Model-driven engineering (MDE) approaches aim to reduce at least some of these problems providing techniques for the construction of models and the specification of transformation rules, tool support and automatic generation of code and documentation. The method of resolution of MDE is to first build models, which are independent of the platform, transforming them in later stages to technological-dependent models, and to achieve automatic model and code generation based on transformation rules. Web engineering is a domain where model-driven approaches can be used to address evolution and adaptation of Web software to continuously emerging new platforms and changes in technologies (Koch, 2007).

UWE come up by the end of the nineties (Baumeister et al., 1999; Wirsing, 1999) with the idea to find a standard way for building analysis and design models of Web systems. The aim, which is still pursued, was to use a common language or at least to define metamodel based mappings among the existing approaches (Koch & Kraus, 2003; Escalona, 2007). Furthermore UWE is UML profitable, meaning accepts by UML in industry and science as well as its flexibility, making it possible to define so called UML profiles (Cullmann, 2010).

UWE helps the designers to build the system models which orient developers during the system implementation. UWE is still a new proposal which needs to be experimented to identify its strengths and weaknesses although UWE provides a good approach to design web systems, since it provides stereotypes and methods that allow the designer to model the specific features of systems which belong to that application domain as the navigation space and structure, UWE still needs to be improved (Carvalho & Silva, 2005).

UWE presentation model elements do not represent concrete components of any presentation technology but rather describe what functionality is required at the particular point in the user interface (Kroiß & Koch, 2011).

Modeling adaptive Web applications is a difficult and complex task. Usually, the development of general system functionality and context adaptation is

intertwined. However, adaptively is a cross-cutting concern of an adaptive Web application, and thus is naturally viewed as an aspect. Using aspect-oriented modeling techniques from the very beginning in the design of adaptive Web applications (Baumeister, 2005).

The strength of the presented Web engineering approach is given by the fact that we use exclusively the UML notation and techniques. Moreover, our specification of constraints with OCL (part of UML) allows augmenting the exactitude of the models (Koch *et al.*, 2001).

The WebML (Web Modeling Language) follows the style of both Entity-Relationship and UML offering a proprietary notation and a graphical representation using UML syntax. This approach is currently not closed and it is continuously being extended and improved. This approach is also supports tool in its development process, the tool is called WebRatio and it is being currently applied in an industrial environment. WebML is a high level modeling language (Brambilla, 2006).

Object-Oriented Hypermedia Method (OOH) method is used in the field of web engineering. This model is focused on describing Navigation at the conceptual level. This approach is supported by the tool called Visual Wade. The building of two added standpoints, corresponding to those caught in conservative, UML-adapted, theoretical modeling strategies are involved in the design procedure. They are mainly, the Navigation View, which extends a class diagram with hypermedia navigation elements, and the Presentation View, where dissimilar features concerning interface outlook and conduct are demonstrated by a series of interconnected template constructions, described in XML (Gómez, 2012).

In the last few years, models and generations of website shave been a key topic for Web Engineering. But, the utilization of the amalgamation of tools has not been a key target; a few usability advocates take advantage of models which describe the website (Atterer, 2008).

1.3 Problem Statement

There are many papers and thesis solved the problems in Web Engineering methods to development web applications, but still now the UWE cannot fully support the homepage development and cannot solved the usability in homepage design.

Homepage is the most important page on web site because clearly communicates the site's purpose, show all major options available on the page and the key to show the quality of website. Solving the usability in homepage help the homepage to elegance, clarity, easy user interface and easy to understand.

Current UWE cannot fully support the homepages directly because the UWE metamodels do not have enough elements to represent content of homepages, but UWE metamodel is a design considered as the conservative extension of the UML metamodel, also the metamodel provides a good description to development homepages.

UWE metamodel is “profileable” (Baresi*et al.*, 2002a), which indicates a probability for a UML profile to be mapped with the metamodel. Hence, to form UWE metamodels of homepage development, standard UML-CASE tools providing for UML profiles or the UML extension mechanisms, i.e. typecasts, tagged values and OCL restrictions can be utilized. To provide for the UWE method, if technically viable, these CASE-tools can be extended more.

1.4 Aim of Study

The aim of the dissertation is enhancement UWE metamodels to development of the homepages and helped designers to development homepages. The content of homepages developed continuously at this time the current UWE cannot support it, caused by define a new elements by OCL language for extension UWE metamodels for the development of homepages, finally become to increase usability design metamodels to best quality for homepages

1.5 Objectives

The objectives of this study are:

1. Study the three methods (UWE, WebML, OOH) to design homepage and comparison between it to show capability and weaknesses current UWE.
2. To enhance UWE metamodel to support homepage contents for the development homepages through define new elements by OCL.
3. Redesign case study after enhancement UWE metamodels, then compare UWE metmodel enhancement with UWE metamodel before enhancement to show enhancement result.

1.6 Scopes

Scopes of study are mentioned below:

1. Content homepage's Accomplishment the UTM's homepage like as case study.
2. Getting the UWE metamodels for improving homepage development, and using WebML and OOH to compare with it.

3. In the metamodels we focused on navigation model and presentation model, but for creating both of them also we need conceptual model.
4. Using ArgoUWE as a development tool of homepage development, also using WebRatio and VisualWade as a tool.
5. Using OCL language to define new elements for UWE metamodels, and using XMI code to representing the diagrams.

1.7 Significance of Study

To assess the endorsement of homepage website is the significance of study. This is extremely a wide part, in this area in December 2010 more than 21.4 millions websites were presented. The main significant of this dissertation is that the profile of UWE help homepage developments move to automatically through the new elements, will be used to each investigation for each model and tools that are being used after their advantages are being used for the clarification of the technical difficulties by AgroUWE and UML. Thus this research has a great involvement in development process of website homepages, use it helps to minimize the cost and maximize the development quality.

1.8 Dissertation Organization

Chapter 2 discuss the homepages, usability web design, metamodels of three methods UWE, OOH and WebML. Also three tools; ArgoUWE, WebRatio and VisualWade.

Chapter 3 the research methodology is conducted in achieving the dissertation objectives and scopes. On case study is used UTM Homepage, UWE and ArgoUWE.

Chapter 4 defines the UTM homepage as the case study and definition of the elements and attributes of the homepage, next step is design UTM homepage by using current methods UWE, OOH and WebML and comparison between then for finding weakness and strength UWE to development homepages

Chapter 5 enhancing the UWE metamodel, redesign the case study after enhancing UWE, comparison with current UWE.

Chapter 6 in this chapter discussion about usability design, challenges to design homepages, and future work about UWE for development web application.

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