A Pattern-based Approach to Support the Design of Multi-Platform User Interfaces of Information Systems

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ABSTRACT

This PhD thesis is focused on a pattern approach for designing multi-platform user interfaces. The pattern approach is applied on the complete user interface (UI) development process. UI patterns can be used to improve the usability and cycle-life development. To achieve a good quality of software development, UI patterns related to ergonomic context can be used in unification of models to support the UI development process.

UI Patterns of the OO-Method are introduced in the whole model driven process of UI in order to obtain different UIs in the Final User Interface (FUI) level including specific platforms. In using different patterns on other devices, the thesis analyses the derivation of up-to-date UIs with the application of the built ergonomic guide and extended patterns. A comparative study of these different FUIs built in different contexts is necessary to show how difficult it is to adapt the different patterns on variety platforms.

Author Keywords

Patterns; Multi-Platform; User Interfaces.

General Terms

Human Factors; Design; Experimentation; Evaluation.

ACM Classification Keywords

D2.2 [**Software Engineering**]: Design Tools and Techniques – *Modules and interfaces; user interfaces.* H5.2 [**Information interfaces and presentation**]: User Interfaces – *graphical user interfaces, user interface management system (UIMS).*

INTRODUCTION

User interfaces (UIs) with good usability must be developed to accommodate different types of users and devices in changing environments [6]. Patterns are a solution to common problems in a specified design context [10,15,16]. Indeed, patterns provide an advanced concept of reuse and a more aggregated perspective in the UI process [7]. UI pattern sets up the best design practices from distilled experience from real life [14]. Previous works used patterns in the UI development process [13] but are not focused on multi-platform and ergonomic contexts. The objective of this PhD Thesis is to develop a framework that considers in a general and systematic way the UI pattern development cycle. For this purpose, a certain level of abstraction with respect to code is desired, such as in Cameleon Framework (Figure 1) or in OMG's framework (CIM, PIM, PSM) for developing multi-target UIs [4].

General patterns with ergonomic guidelines on multi-platform context are introduced in a XML-compliant format. These guidelines are stored in a specific database and compose the ergonomic guide. They comprise two abstraction levels: a generic one (adapted on multi-platform) and a specific one (based on specific platform). Our objective is also to extend the ergonomic guide and its application in developing more different FUIs, based on the code level in Model-Driven Engineering (MDE), on a variety of devices. Therefore, this thesis also extends the conceptual model of patterns.

In generating different FUIs based on the UI pattern approach, this thesis aims at demonstrating the performances of the ergonomic guide related to multi-platform-based patterns with different users and the extension of the usability UI patterns related to information systems (ISs).

Section 2 of this paper presents the motivations; Section 3 describes the related works; Section 4 explains the contributions of this research and Section 5 describes the conclusion.

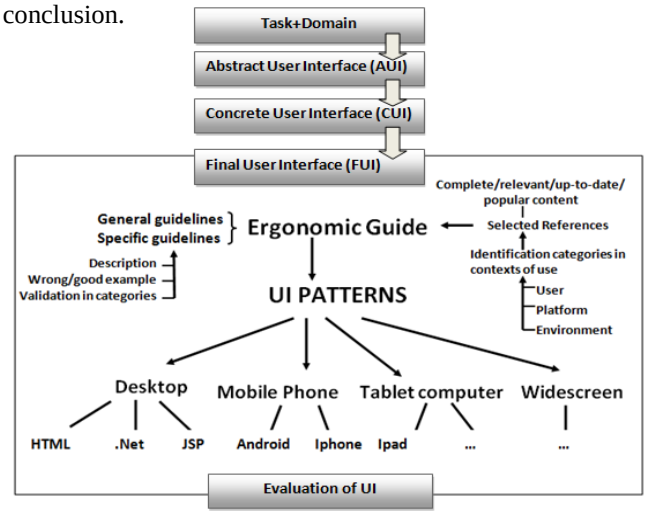

Figure 1: UI patterns in the whole UI process

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MAIN MOTIVATIONS

A huge variety of platforms are currently available. The average time spent on them rises constantly. Time spent in designing UI (on average, 48% of the coding efforts are spent in interactive human-computer application and the average time spent on different phases of design and construction is estimated between 40% and 50% [2]) represents a large part in the development cycle of an application, particularly in terms of pure development and maintenance, even for application of a "traditional" single target platform.

Objectives of the interface development based on models allow to:

1. extend development environments ;
2. design contexts and the implementation of software, to improve the portability and adaptation of interfaces;
3. have a solid development cycle;
4. integrate the development of usability studies (to promote the usability of interfaces for their users and to have a performance measure of the software quality [6]);
5. specify the UI at a high level of abstraction independently of the implementation.

RELATED WORK

The first part of the thesis consists of being aware of the problem context, understanding the current highest level of development of techniques, scientific fields about the designing of UI based on pattern approach.

The emergence of new devices and services brings a new dynamic in UI development. The multitude of interaction devices has created a diversification of environment interactions and an increase of multi-profile. Furthermore, the information is extremely dynamic. Therefore, UIs have to adapt to the variation of context (users U, platforms P, and environment E). Patterns are a solution to common problems in a specified design context [10,16]. Using a pattern approach allows to design UIs by a set of models (the UI model-based development) [7] and to provide knowledge on different fields. For instance, "Using patterns to clearly and succinctly describe particular workplaces, in order to understand possible impacts of new technologies [12]."

[17] described a developed method for implementing GUI based on generative patterns . This method used the Pattern Language Markup Language (PLML) applied to support designing patterns. UI patterns extended from PLML had been represented in an UML diagram class (Figure 2). This representation implies UI patterns in a method involved models found in UI development life cycle (based on the Cameleon Framework [4]). The multi-platform and ergonomic context is limited in this content.

In [14], code generators based on usability patterns are the results of the JUST-UI concept. This approach considers the conceptual model in the Object Oriented Method, OO-Method.

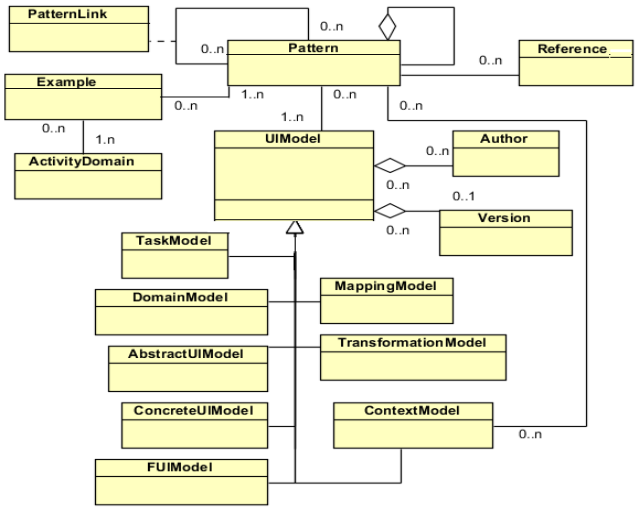

Figure 2: UI patterns extended from PLML represented in UML

The conceptual model is structured in four elements: Object Model, Dynamic Model, Functional Model and Presentation Model. This fourth component specifies the issue on how the users interact with the system. In the Presentation Model, the set of conceptual patterns are called interaction units. In addition to the execution of a service and to the manipulation of an (or a set of) object(s), these interaction units provide frequent scenarios in which we can find an interaction between the user and the system without an up-to-date ergonomic rules on variety contexts (U, P, E).

Another tool that supports the application of patterns during the IS development is demonstrated by [8]. In this work, task models with patterns and pattern-supported model transformations are described. Although, patterns are used to transform models in an interactive way, it is limited to implementation to one single platform.

To know current ergonomic context, selected guidelines were integrated using a specific template in a database integrated, DESTINE, a software-based ergonomic evaluation of websites. The approach used in this software is a language called XML-enabled GDL (Guideline Definition Language) [11]. This software evaluates web site in ergonomic conform. It adopts a methodology for evaluating the inter-usability that allows therefore to ensure the usefulness and usability of products for the benefit of simultaneous users and organizations.

COMPUTATIONAL FRAMEWORK

Shortcoming and Requirements

The literature reviews are limited for some reasons:

1. **Specialization of research**. The current works about patterns are constrained to one or some levels of the UI process and do not consider the integration of UI patterns in the entire process. Most of pattern works derivate only from the task model.
2. **Lack of conjunction and consistency.** Content information is described in model fragments.

Moreover, some links between other levels of the UI Process are missing.

3. **Lack of structure.** Current pattern catalogues are not correctly structured. They do not cover the whole domain of dependent and independent modeling and design problems.
4. **Limitation of technological space.** Some works consider only of UI patterns in only one platform.
5. **Lack of ergonomic approach.** Tools to support pattern assisted design and development exist but the ergonomic aspects should be detailed in an enough expressive way to give rise at applicability.
6. **Limitation of the context.** The context (U, P, E) is necessary to take all problems into consideration.
7. **Lack of evaluation of the pattern performance. "**Most of pattern languages/libraries have not been proved if their solutions are suitable to address the identified problems."[3]

In order to address these shortcomings, improvements are required:

1. Integration of UI patterns in the whole UI development process
2. Consolidation of methods and techniques
3. Appropriate organizational structures
4. The overall coverage of available technological space
5. Designing UI pattern within ergonomic context
6. Context-awareness to design patterns
7. Validation of UI patterns with an up-to-date ergonomic guide

The result of [3] explains how current tools on patterns are easily accessible to the developers but new evaluation methods are needed to prove the usability of patterns. This evaluation is one objective of the thesis. Indeed, in the comparative study, all extracted FUIs from patterns and ergonomic guides designing from each level of UI process based on UI descriptive language are compared. According to [1], languages based on models offer new opportunities for the validation of rules of ergonomics, as they include information not present in the final structure of UI.

INNOVATIVE APPROACH AND RELEVANCE OF TOPIC

The contribution of this thesis to its research field consists of an improvement in the IS life-cycle. The usability patterns are used to have an attractive view to end-user platforms as well as an ergonomic aspect. The objective is to have a validated model based on various quality factors (e.g., QUIMERA [9]) and resources and to optimize the schedule of developers and project managers. Therefore, the project enables the improvement of research management in IS to prevent changes, management errors and quality management of UI on different platforms and to improve time and effort of designers and developers on the life-cycle development of software.

METHODOLOGY

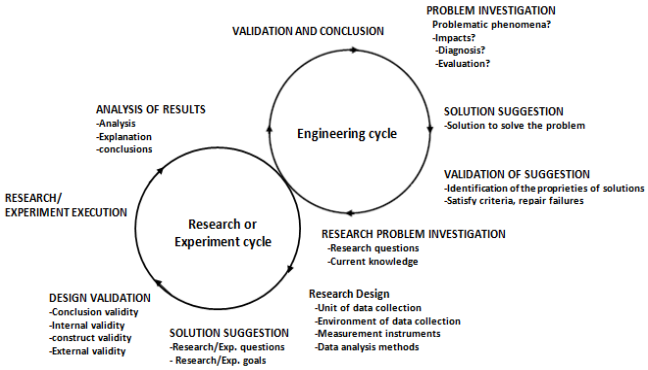

Figure 3: Engineering Methodology adapted to this thesis

The research design used in this work is based on the popular "Requirements Engineering Research Methodology" from [18]. The methodology of this thesis uses two cycles. The first one specifies the main purpose and uses a cyclic way, the engineering process, to fix objectives, to investigate, to provide feedback and continuous evaluation. The second one is more focused on the research/experiment process.

In the Engineering cycle, after the identification of the problem and the suggestion of a general solution, the investigation part consists of the identification of state of the art information, current methods and techniques of patterns in UI design and ergonomic guidelines. Relevant information on ergonomic guidelines is inserted in a specific database and constitutes the ergonomic guide, DESTINE [11]. This last element and information of patterns are necessary to develop UI patterns of the OO-Method in the whole UI process (see on Figure 1). For instance, the thesis evaluates a master/detail pattern described in Just-UI concept. On the first time, this pattern implements task and domain model merged with the patterns of [5] corresponded to problems. Then, different frameworks of patterns from AUI are created. Each AUI framework designs a CUI based on specific platform (for example, one CUI on Desktop computer and another one on Mobile Phone). Then, the Patterns based on the ergonomic guide are applied in FUI. In the FUI level, we can find several usability guidelines in the ergonomic guide aiming at helping developers to develop user interfaces with good usability and to adapt it into an explicit context.

Currently, several studies suggest a list of guidelines which may be incomplete due to a lack of illustrations, definitions, simplicity, structure or because the guidelines are not adapted to the current situation of the new devices. The ergonomic guide, inserted in a specific database, is built in order to avoid these scenarios and to provide a support to facilitate the development of interface on multi-platforms.

The properties of FUIs involved different platforms and range of possibilities still need to be validated. For example, the current technology enables the problem to be solved. The application of researches with experiments will

be measured and compared with the initial suggestion of the problem, a feedback about all the engineering process will be defined at the end. The conclusion will be the identification of the pursued objectives, contribution, limitation, and future activities.

The experiment cycle begins with current works on technics and the appropriate design of experimentations. Experimentation based on the qualitative research measures the efficient of ergonomic guide and the most popular patterns by end users. The evaluation process, by using a quantitave methodology, makes sure that the building framework is in line with the UI regarding usability patterns for multi-platform interfaces.

CONCLUSION

The history of pattern applications and language is limited by its lack of up-to-date ergonomic approach and its context (U, P, E). This proposal represents UI patterns of the OO-method, supported by an up-to-date ergonomic approach involved in the UI design process based on a uniform modeling language. This language building on XML-compliant format supports the transition between different models such as task, domain, AUI, CUI, FUI, context model and mappings between them. User requirements are involved in each stages of the project in order to maximize ergonomic context and consistency. The usability of an interface determines the performance of the user. Evaluations and study cases are planned in order to depict the performance (the strength of evidence) of UI patterns contained in a variety of FUI prototypes adapted to different contexts. An evaluation of the ergonomic guide involved in the UI pattern design is also planned in the performance study.

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