An Approach for the Elicitation of Usability Requirements in the Development of Web Applications

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Abstract. Non-functional requirements specify software restrictions and how well the software shall perform its functions. In Web applications, usability requirements are the most important type of non-functional requirements because they determine the acceptability of such applications. Nevertheless, usability requirements are usually forgotten or unconsidered, which increases the cost of their development and the cost of fixing usability problems. This paper presents the research agenda for the development of a set of technologies for the elicitation and specification of usability requirements for Web applications. We will propose and develop a set of techniques and a tool support that will allow software engineers to produce descriptive requirements specifications. Such specifications will guide the development team through the implementation of Web applications meeting usability principals. Finally, to verify the feasibility of the techniques and tool; identify improvement opportunities; and safely apply the technologies in the industry, we will evaluate the technologies through empirical studies.

Keywords: Usability; Requirements Specification and Elicitation Technologies; Web Applications

1 Introduction

Requirements elicitation is one of the most important phases of the software development process since it is when the software functional and non-functional requirements are identified and defined. When poorly performed it can lead to software failure or increases in time and cost of the development process. Non-functional requirements play a fundamental role in the software because they specify software restrictions and how well the software shall perform its function. Furthermore, non-functional requirements try to address aspects that affect software quality such as: usability, maintainability, performance, security, and flexibility.

Usability has been pointed as the most important type of non-functional requirement for guaranteeing software quality [1]. Usability is the absence of obstacles that

stop the users from carrying out their tasks in the system with efficiency, effectiveness, and satisfaction [2]. In Web applications, usability requirements are even more important because in this type of applications, the user interface plays a central role and determines their acceptability and success. In this sense, usability requirements for Web application describe needs in the outlined system, such as the ability to prevent errors and reduce mental workload, in order to enhance its quality.

In our previous research [1], we identified that despite the importance of including usability requirements, their evaluation was mostly performed in later stages of the development process (more specifically during the testing and implantation activities). The main reason for this lack of attention to usability requirements is that the technologies (techniques, processes or tools) that have been proposed to address them are usually applied late in the development, where it is too expensive to develop usability requirements or fix usability problems. Moreover, we identified that there were only a few methods that could be used in the elicitation and analysis of usability requirements [3]. It is important to guarantee the usability of the software in its earlier stages since correcting usability problems after writing the source code can be much more costly than if it was done at the beginning.

In this research, we aim to provide a solution for the late identification of usability requirements in Web projects. We are proposing an approach that will integrate several technologies to understand the users' needs and identify usability requirements in the beginning of the development process. First, we will propose a set of techniques for the elicitation of usability requirements that will allow software engineers to produce descriptive requirements specifications such as: textual specifications, mockups specifications and navigational models. Such specifications will guide the development team through the implementation of Web applications meeting usability principals. Then, we will develop a tool support for the identification and validation of usability requirements, and a monitoring system to examine how users perform tasks in low fidelity prototypes in order to identify further usability requirements.

2   Objectives of the Research

The main goal of this research is to propose an approach composed of a set of technologies for software requirements specification to allow the identification of usability requirements of Web applications. By developing usability requirements along with functional requirements, we intend to improve the quality of Web applications in terms of usability.

In this research, we intend to use mockups which are a software model that makes use of images to show how the software would look like once its source code is written [2]. By using mockups along with descriptive textual specifications and navigation models, we intend to identify possible user interaction problems with the software, and to integrate usability requirements in the development of Web applications. We also aim to reduce the cost of integrating Human Computer Interaction Practices to Software Engineering practices by identifying and developing usability requirements early in the development process of Web applications.

There are several software available in the market for the creation of mockups (e.g. Balsamiq Mockups[1], Mockingbird[2] and Pencil Project[3]). These software can be used to design mockups and link them so that the software development team can come up with interactive mockups and wireframes that can be used for sharing with clients, reviewing workflow, and streamlining user experience. Nevertheless, to the best of our knowledge, we are not aware of any prototype creation software that is able to support the identification of usability requirements and the verification of usability attributes in the mockups, which is essential in order to guarantee the quality of Web applications in their early stages [3]. In this context, our secondary goal is to develop a tool support for the elicitation process of usability requirements.

Our tool will provide several functionalities in order to support the use of our approach by software engineers. First, we will support requirements specification techniques that consider usability requirements along with functional requirements. Then, we will allow software engineers to create requirements specifications such as: (a) a specification using mockups with a hand-drawn look to describe the user interface of the Web application and its usability requirements; (b) a textual specification with thorough descriptions of the requirements of the Web application; and (c) navigational models containing the overall design of the interaction among the different pages within the Web application. The tool will also allow software engineers to perform usability inspections so that they can identify usability problems or further usability requirements. Furthermore, the tool will support the validation of these requirements with users. Finally, we will integrate a user monitoring system in order to analyze the real interaction between users. This last functionality will allow software engineers to identify further usability requirements regarding the navigational models in order to improve the navigability, interactivity and design of Web applications.

3   Methodology and Scientific contributions

To achieve and evaluate the previously proposed research goals we will follow a research methodology based on empirical studies (refer to Figure 1). The analysis of the results from the empirical studies will be used to answer research questions evaluating if the proposed technologies present difficulties that could affect their use. We present here the steps of the methodology and our expected contributions.

First, we will perform a secondary study, through a systematic literature review, to understand the current state of the field of Web usability requirements. We will perform this literature review in digital libraries to identify related research on elicitation techniques that considers usability requirements. Therefore, after applying a research string in the digital libraries, we will select papers addressing the specification of usability requirements in Web applications. Each returned paper will be evaluated through inclusion criteria, such as the quality of the journal or conference in which it was published or the degree of description of the proposed technologies for require-

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[1] http://www.balsamiq.com/

[2] https://gomockingbird.com/

[3] http://www.evolus.vn/Pencil/Home.html

ments specification and elicitation. Then, the accepted papers according to the inclusion criteria will be fully reviewed, and the identified technologies will be categorized according to the type of document they generate and in which phases of the requirements engineering process they can be applied. The results from the systematic literature review will be used to propose a set of techniques for usability requirements specification that will be used to create requirements specifications considering usability.

We will also develop a tool support in order to assist software engineers using the specification techniques. Also, such tool we will provide questionnaires, checklists, and any other artifacts that might be used during the requirements specification activities. The tool will support five main activities (*Functionalities to be Developed* activity in Figure 1): (a) requirements specification documentation, (b) usability evaluation, (c) requirements validation, (d) user monitoring, and (e) report creation. In the requirements specification documentation phase, we will support the creation of specifications such as descriptive specifications using mockups and navigational models. Then, software engineers will be able to carry out usability inspections using the tool to identify any problems and guaranteeing that the final software product will meet usability requirements. Also, during the requirements validation, the software development team will show the interaction design to the end users of the application enabling the validation of usability requirements and correction of misunderstandings. Afterwards, to understand how users will really use the software, we will allow monitoring their interaction with the mockups. We will automatically check and verify the number of clicks that would be needed in order to perform a task in the Web application and which design elements catch the user attention. Software engineers can analyze this information to make suggestions and improvements in the user interface. Finally, we intend to automate the creation of different types of reports: (a) validation reports: containing correct, unspecified, misunderstood, or incomplete functional or usability requirements; (b) usability inspection reports: containing the identified usability problems and suggested modifications; and (c) user monitoring reports: containing the comparison of the real use of the application with the interaction models, and further improvement opportunities or identified usability requirements.

We intend to carry out three empirical studies aiming at evaluating the feasibility and suitability of the proposed technologies for the elicitation of usability requirements. Initially, we will evaluate the set of elicitation technologies by comparing them with other technologies that have been proposed for similar purposes (*Feasibility Study* activity in Figure 1). Thus, we will perform quantitative analyses and measure the accuracy (percentage of correct usability requirements), effectiveness (percentage of elicited usability requirements), and efficiency (speed when performing the elicitation) of our approach. Also, the qualitative results from observational (*Observational Study* activity in Figure 1) and industrial case (*Industrial Case Study* activity in Figure 1) studies will be used to improve the performance of our approach in order to be used in the software industry. Finally, we will also use the qualitative data obtained from the opinions and behavior from the subjects participating in the studies to evaluate: (a) if the proposed approach meets the needs of software engineers and if they can follow it accordingly; and (b) how much do the proposed technologies interfere in the development of a real Web application.
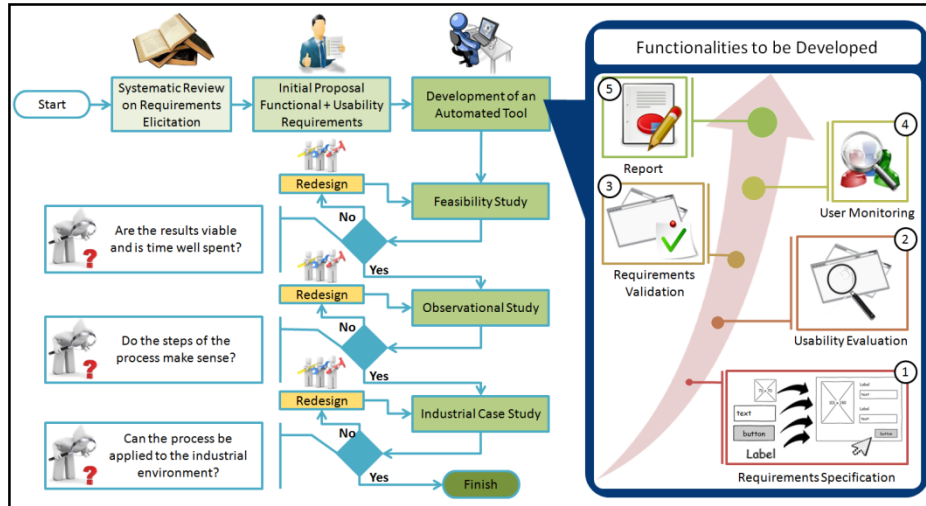
Fig. 1. Research methodology for the elicitation of usability requirements.

4 Conclusions

Our results in [1] and [3] suggested that despite the effort in including or evaluating usability requirements in the development of Web applications, few technologies provide assistance in assuring usability in the beginning of the development. To address this gap, we propose an approach composed of a set of technologies for the inclusion of usability requirements during the design of Web applications mockups.

We will use the research methodology presented in this paper as a plan for the development of the set of proposed technologies for the inclusion of usability requirements. By proposing and supporting requirements specification techniques that consider usability requirements, generating descriptive specifications and models, evaluating the usability in the requirements specification documents, and monitoring user behavior, we intend to improve the usability of Web applications in its early stages, reducing the cost of correcting usability issues later on in the development process.

We hope that the proposed technologies assist software engineers in improving the quality of Web applications in terms of usability, particularly in: (a) diminishing the percentage of dropout in Web applications, (b) diminishing the time of performing tasks, (c) increasing usage and user satisfaction, and (d) diminishing usability errors that prevent users from carrying out their tasks.

5 Ongoing and Future Work

The starting point of this research is the evolution of our previous work [1], the Mockup Design Usability Evaluation (Mockup DUE) tool, which allows the inspec-

tion and validation of Web applications mockups. The Mockup DUE tool currently supports: (a) the inspection of Web applications mockups and (b) the visualization/interaction and validation of mockups with clients.

Figure 2 shows screens of the current version of the Mockup DUE tool. First, we can load and map mockups to simulate interaction (see first half of Figure 2 on the left). Element 1 shows the different functionalities available in this stage: (a) add mockup, (b) add links, and (c) preview. The user uploads image files of mockups which are shown as miniatures (see Element 2). In Element 3 users can view the selected mockups in real scale and add links to connect them. Also, by using the "preview" functionality it is possible to simulate interaction by clicking in the created links. After that, it is possible to use the Mockup DUE tool to identify usability issues (see second half of Figure 2 on the right). Currently the tool allows users to (see Element 4): (a) point errors, (b) add notes, and (c) create reports. In Element 5 the tool shows the supported usability inspection techniques. The inspectors can use the set of verification items or heuristics from the available technique to point usability problems or add notes in the selected mockups (which are shown in Element 6).
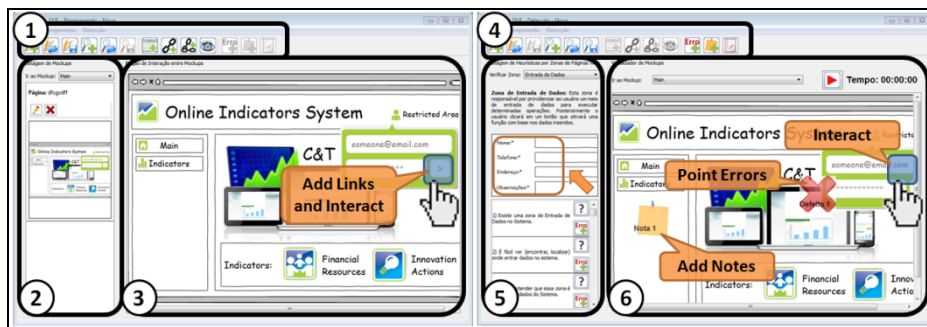

Fig. 2. Current version of the Mockup DUE tool – Mapping mockups and inspection.

We are currently evaluating the Mockup DUE tool in terms of ease of use and user satisfaction. After using the results from this evaluation to improve the tool, we will follow the methodology in Figure 1 to integrate the proposed functionalities that will support the elicitation of usability requirements along with functional requirements.

6   References

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