Smart RE: Using Smart Devices to Support Face-to-Face Meetings

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***Abstract*—Communication barriers in Requirements Engineering (RE) are various, including different levels of experience, different backgrounds, cultures, and personalities of stakeholders. Such barriers can lead to communication gaps and project failures. This paper introduces the Smart RE framework, an approach to reduce communication gaps in RE by using the advantages of personal smart devices, which are very popular nowadays. As RE communication often occurs in regular face-to-face meetings, which commonly involve presentations and discussions, the framework captures the meeting context on the stakeholder's smart devices and provides personalized additional information such as explanations of the discussed terms.**

I. Motivation

The main objective of Requirements Engineering (RE) is to identify, negotiate, document, and manage unambiguous requirements throughout the project and beyond [17]. The more clear and understandable to all stakeholders the project goals, requirements, and tasks are, the faster and more efficient they can be achieved. One of the main challenges for RE is thus to facilitate the communication between stakeholders and develop a common understanding of the project and the requirements.

An old well-known story illustrates potential communication issues in RE. A group of blind men touched an elephant and told the others about "what an elephant is". Each man touched a different part of that big animal, and hence came with a completely different explanation. In RE the situation is similar when stakeholders try to define and communicate important requirements as they see and understand them.

To resolve such communication issues in RE, it is common to use meetings, presentations, and discussions. Meeting participants often come from different domains, which might lead to different understandings and associations even for simple terminology questions. For instance, we experienced in several projects long meta-discussions due to the misunderstanding of general terms such as "requirement" or "feature". A linguist understands a *feature* as a semantic, grammatical, or phonological structure. The media expert understands a piece of writing that covers a selected issue in-depth. The software developer sees a feature as a user-perceived functionality of the product. Finally, the data scientist interprets this term as a measurable property that can, e.g., be used as input for a machine learning algorithm.

In addition to the ambiguity of the natural language and the different meanings of terms in different domains, misunderstandings arise also due to the different levels of education, global and domain-specific knowledge, or personal experience [2]. Misunderstandings can also arise due to the different level of information of the project members. Missing or outdated information on project progress, requirements changes, planed goals, relevant tasks, and responsibilities might lead to an increased amount of miscommunication and therefore a risk of project failure [13].

This paper introduces the Smart RE framework as a one possible approach to reduce misunderstandings and communication issues in RE face-to-face meetings. The framework provides a context-sensitive and personalized support to the meeting participants on their smart devices such as smartphones, smart glasses, or smart watches. Showing additional relevant information during a meeting can improve the understanding and reduce the interruptions for clarifications and meta-discussions. Figure 1 shows an example of such a support on a Google Glass.

We describe the framework concepts and main components along with a visionary scenario in Section II. Then, in Section III we report on a preliminary evaluation of the Smart RE prototype implementation for Google Glass and briefly discuss the main challenges and open questions. Finally, we summarize the related work in Section IV and conclude the paper in Section V.

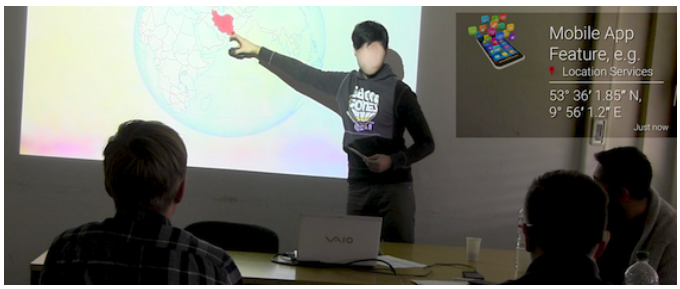

Fig. 1. Smart RE prototype for Google Glass during an evaluation session.

II. Smart Requirements Engineering Framework

Smart RE is an extensible software framework for an ad-hoc, personalized information capturing and visualization during RE meetings. It can be seen as bridge between a personal smart device and the project and requirements repositories, since it matches personal information and knowledge with the project and domain knowledge. Additional functionality of the framework includes bookmarking, commenting, and directly capturing and changing of information. In the following we describe a visionary scenario and introduce the main components of the framework.

A. Visionary Scenario

A developer presents the new feature, which has just been implemented. The product owner is unsure to which requirement this feature is related, *why* it is needed. The developer expected this question and has thus linked the corresponding slide in the presentation with the related project resources and rationale. The product owner's personal smart device observes the link and provides a notification of additional information to the product owner. This way, she can get the list of relevant resources without interrupting the presentation. If desired, she can navigate to the information needed and read, bookmark, or comment it.

The new implemented feature works well but should be improved for the future release. For instance, the data used in this feature must encrypted. The developer suggests a broad list of different encryption methods. Some of these are well-known to the project manager and some are not. Before he disrupts the discussion between developers, architects, and security experts, he looks at his smart device. Smart RE knows which of the discussed security methods are known by the manager and thus shows only the information of his interest. The Smart RE app lists the predicted encryption methods and links them to entries in project glossary, wiki, or websites.

The development team suggests the action items and deadlines for delivering the improvement. They use conventional project abbreviations and acronyms such as "WP5" for "work package 5". The acronyms are linked to the titles, descriptions, and other metadata. Each meeting participant can see the additional information on his own smart device individually and bookmark, read, or check it after the meeting.

B. Framework Components

Smart RE supports stakeholders with the requirements elicitation, negotiation, and planning tasks during face-to-face meetings by monitoring the meeting context, predicting the information needs of each stakeholder [13], and visualizing the information on the stakeholder's smart device. The framework can learn from previous observations about information needs and from similar meetings situations to predict the relationship between the current context and the relevant project information that should be shown and to whom [8], [11].

The framework consists of a Server, a Device App, and a Desktop App, as shown in Figure 2.

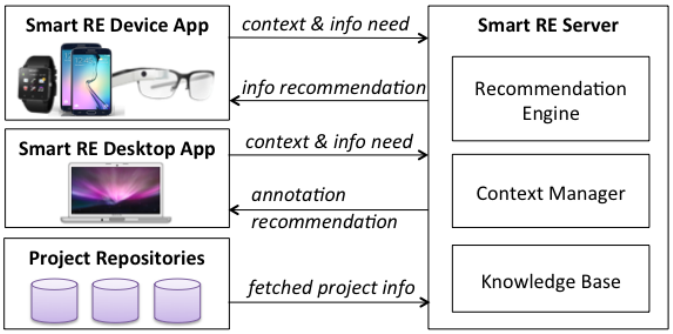

Fig. 2. Overview of the Smart RE framework components.

The *Smart RE Server* collects, processes, and compares the context information and the stakeholders' information needs [13] in the context manager. The knowledge base consists of an index and an ontology of the project and the domain where the concepts and the relationships are continuously maintained by mining the project and requirements repositories. The knowledge base also transforms the data requests to appropriate format and fetches the related information from the project repositories. Finally, the recommendation engine proactively delivers the additional personalized information to the stakeholders during the meeting or when preparing it.

The *Smart RE Desktop App* supports stakeholders when creating meeting artifacts, such as presentations, meeting agendas, or demos. This app identifies project relevant or ambiguous terms in the meeting artifacts and recommends linking additional information as annotations. This can be done either by analyzing projects artifacts and glossaries [8] on the server's knowledge base or by querying dictionaries and shared knowledge bases such as Wikipedia. For instance, querying Wikipedia for the term "feature" will return several explanations depending on the domain. Finally, the interaction history of the stakeholders when creating the meeting artifacts as well as other stakeholders who are participating in the meeting can reveal their potential information needs [11].

The *Smart RE Device App* running on the smart devices of the meeting participants monitors the meeting progress and the stakeholder's context. The progress can be determined based on the presentation content (e.g., current slide or current item in the agenda) or based on anchors and events broadcasted by the presenter's tool. More advanced approaches such as scene and voice recognition can also be used. The Smart RE apps also gathers the personal context of the stakeholder by using the physical and logical sensors on the smart devices such as motion detectors or proximity sensors, e.g., to find out where and with whom the stakeholder is meeting and detect the current situation such as talking, listening, wondering, chatting, or taking notes... The app identifies the context and the information needs and sends this to the server, which provides additional information for the stakeholders to supply the information needs.

The Smart RE framework provides communication interfaces to the Smart RE applications running on different types

of personal smart devices and to the project repositories such as requirements and project managements tools.

III. Preliminary Evaluation and Challenges

For a first proof-of-concept we implemented a smart glass application for the Google Glass which we called InterAct Glassware. During a meeting, the InterAct Glassware notifies the participants with the availability of addition information to the past and current presentation slides. The app allows participants to access and navigate this information which has been selected and linked to each slide by the presenter when preparing the presentation.

We ran a preliminary evaluation with 16 students (who have basic software engineering and project management knowledge) and with two professionals. Each evaluation session consisted of two presentations (5-7 minutes each) and a discussion. One presenter, two meeting participants, and one observer participated in each session, as depicted in Figure 1. The participants tried both situations: with InterAct Glassware and without. At the end, the participants answered a prepared questionnaire about their overall impression and the advantages and disadvantages of using the InterAct Glassware.

Overall the evaluation showed that the basic idea of providing additional context-aware information during face-to-face meetings was well perceived and worked well regardless of the different restrictions and difficulties. According to the self-assessment of the participants their knowledge and comprehension of the topics increased when using Smart RE.

In the following we summarize our observations, made during the implementation and the preliminary evaluation.

A. Device Restrictions

One major challenge that we encountered is to deal with the hardware and software restrictions of the smart devices. The restrictions of the Google Glass and its APIs introduced additional complexity to the Smart RE app and for implementing the framework concepts. For instance, we were not able to use the Google Glass in an offline mode without storing the stakeholders' data on the Google server, which leads to major privacy and information security concerns. Also the information flow between the smart devices, the project repositories, and the Smart RE components might be restricted, which might itself restricts implementing the features of Smart RE such as a conditional notification. The complexity of handling the restrictions increases when supporting multiple heterogeneous devices of different vendors and technologies.

B. Usability

The hardware and software restrictions caused additional usability issues which are anyway present due to the limited display sizes and interaction options of smart devices as well as the very limited cognitive ability of the stakeholders, who are rather focusing on the meeting. It is unclear what are the ideal formats and methods for delivering and visualizing the additional information to the stakeholders in the meetings.

Finally, the user experience with new devices such as smart glasses is naturally a major issue. In spite of the short tutorial on the interaction concepts with the InterAct Glassware for each evaluation participant, most participants reported inconvenience with the usage of the InterAct Glassware. This was mainly caused by the unfamiliarity with Google Glass and its new interaction forms. Most people get discomfort and headache when using Google Glass at first time [18]. Using a smart watch or a conventional smartphone might be a better alternative to deal with this issue. In any case, we think that the use of the stakeholder's *personal* smart device is crucial for the acceptance and success of Smart RE.

C. Interruptions and Cognitive Overflow

The interruption and cognitive overflow [10] which might be introduced by Smart RE lead to the following question: How can we handle the information flow without loosing or interrupting the attention of the meeting participants?

This means that additional information should be selected and visualized very carefully especially with respect to the human cognition and perception of saturation boundaries. Techniques for controlling and focusing the user attention to the currently relevant information according to the new technology of smart devices should be further explored.

D. Privacy of Stakeholders

One major challenge of Smart RE is to tackle the privacy concerns of stakeholders, who might be employees of a company. Continuously observing them can be easily misused and might impact their work behavior.

Moreover, involved stakeholders will probably be using their smart devices for both private and professional activities. The more context data is collected, the more the integrity of their privacy will be threatened, in particular when using smart glasses [7] and smart watches [1]. One solution approach is to separate between the professional and private work sessions and to allow stakeholders to mute or switch off Smart RE apps at anytime as proposed in MUSES (http://musesproject.eu).

IV. Related Work

We focus our related work discussion on the synergies between virtual reality and requirements engineering, stakeholder assistance in requirements engineering, as well as context-awareness in requirements elicitation.

A. Virtual Reality and RE

Santos et al. [15] discussed the application of RE methods for virtual reality systems and the application of virtual reality systems for RE. The authors observed a lack in both directions and therefore a low impact of the synergy between RE and virtual reality in practice. Elliott et al. [4] discussed the application of virtual reality in software engineering, focusing on development and program comprehension scenarios. The authors identified the discussion and collaboration in code review tasks as a main potential application. This is similar to our focus on the face-to-face meeting but with different

collaboration artifacts. While Elliott et al. focus on code we focus on requirements knowledge, such as terminology, priorities, preferences, and rationale. Creighton et al. [3] suggested a technique to analyze video sequences, extract scenarios, and relate them to process models of software development artifacts. This technique focuses on capturing and documenting requirements rather than reducing communication gaps between stakeholders during RE meetings.

B. Stakeholder Assistance in Requirements Engineering

In the last years, several researchers suggested using recommendation systems to support stakeholders when working on requirements. Felfernig et al. [5] and Hariri et al. [6] summarized the field, including the techniques, applications, and challenges. Perhaps the most related work to ours is of Knauss et al. [8], who introduced an approach for recommending glossary terms based on the frequency of term occurrences within requirements documents. Lutz et al. [9] presented CREWSpace, a tool for conducting Computer-Assisted Class Responsibility Collaborator (CRC) sessions in RE. The tool allows users to simultaneously interact through Android-enabled mobile devices with the same model displayed on a shared screen. While conceptually similar to Smart RE, CREWSpace focuses on CRC sessions and UML models. The corresponding Android app provides special collaboration features.

C. Context Aware User Requirements Elicitation

Maalej et al. [12] suggested a continuous feedback model with the following steps: prospective observation of the users, assisted feedback, community sharing, and back-feedback. Maalej and Pagano [14] introduced a framework to increase the socialness of software by involving users and users communities in software systems and engineering processes. The framework asks users for proactive feedback and collects their usage context to understand their requirements and needs. Seyff et al. developed and evaluated *iRequire* [16], a tool that enables users to capture their needs, the associated contextual information, and (personal) rationale during their daily tasks, e.g. while waiting for the bus or while using a specific app. While Smart RE agrees with these approaches that requirements should be augmented with contextual data, we rather focus on discussing and negotiating the requirements than on in-situ elicitation of user needs and requirements with the context. Therefore, Smart RE observes the stakeholders and project participants rather than the end users.

V. Conclusion

The preliminary evaluation Smart RE showed that the idea of context-aware and personalized support during face-to-face, rather formal meeting sessions works well. While we think that the idea is powerful, many research questions still remain open: e.g. about the cognitive ability of the stakeholders and the selection of the "really" needed information.

The next steps towards a Smart Requirements Engineering include improving and evaluating the prototype, developing apps for other devices, and running a quantitative and qualitative evaluation of the framework in real project settings.

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