

Challenges in Requirements Engineering for Mobile Applications for Disabled –Autism

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Abstract—Autism Spectrum Disorder (ASD) is a brain development disorder caused due to abnormal functioning of brain impacting development activities. Different traditional techniques and methods have been used to communicate with ASD person. Researchers and developers have come up with different innovative ideas to aid ASD patients to communicate with others. As ASD people do not communicate properly so requirement engineers face challenges while gathering requirements from them. This paper focuses on the challenges faced during the requirement elicitation process. As challenges are discussed we have proposed a solution to overcome these problems.

Index Terms—autism, mobile computing, requirements engineering, software engineering, special needs, smartphone

I. INTRODUCTION

Autism is a spectrum disorder dealing with wide range of developmental disorders. Autism spectrum disorder (ASD) is a cognitive disorder of social interaction, impaired communication and creative impairments, repetitive and restricted interests and sensory sensitivities also known as pervasive development disorder [1]. ASD is a set of disorders including Rett syndrome, autistic disorder, pervasive development disorder, and childhood disintegrative disorder and Asperger syndrome [2].

Autism paired symptoms are difficulty in communication, social skill and reaction to the world around them [3]. These symptoms of ASD appear during early child mental developmental years between 2 to 3 years of age [4]. Communication problem deals with

- Not talking or less talking,
- Loss of known vocabulary,
- Essential needs and wants not expressed properly,
- Not answering question properly,
- Poor vocabulary development and repeating what is said

Problems with social skills may include:

- Poor eye contact with people or objects,
- Poor participating skill,
- Overly focused with objects or subjects,

- No or less friends,
 - Weeping, giggling, becoming angry or laughing for unknown reasons or at wrong times,
 - Disliking being hug or touched.
- Third basic symptom for autism is reacting to world around them. This may include sub-symptoms such as:
- Self-stimulated problems,
 - Paying no attention to objects or people,
 - Not encouraging routine changes,
 - Using objects in an unusual way,
 - Not fearing real dangers and,
 - Sensitive to light, touch or sounds.

The reason for autism is not quite known, however according to “Ref. [5]” it may be caused by i) genetic problems or syndromes ii) severe infections that affect brain, or iii) exposure to toxins during pregnancy. A research shows that autism is common among boys with the ratio of 1 in 100 to 1 in 320 in girls [6][7].

Autism Spectrum Disorder persons apart from social, behavioral or communication problems sometimes excel in mathematics, art, music and visual skills [4]. Parents and teachers use different modes for communication with an ASD person. These include play-boards, clay modeling, drawing activities and musical means for communication. Person with ASD appears to have difficulties in learning and education so different technologies are used for this purpose.

Rapid development in the field of smart phones i.e. androids and iPhone encourages researchers and developers to help autistic people by developing applications to aid them. This paper focuses on the challenges being faced during the elicitation process for developing mobile applications for people suffering from autism. As the autistic people suffer from communication problems so they cannot express what they really want. In this study problems faced by autistic people are discussed and a solution is proposed in the end after analysis.

The paper consists of following sections i) introduction ii) literature review iii) challenges iv) proposed solution and v) conclusion.

II. RELATED WORK

Miguel *et. al.* [8] study the applicability of three Requirement Engineering (RE) techniques (Use Cases [9],

Viewpoints [10], and Goal-Oriented [11]) for the specification of collaborative systems and paying special attention to the awareness requirements. In order to carry out their study, they specify some awareness requirements of a real system (Google Docs) [12].

The RETTM is a selection methodology - an approach to appraise the applicability of Requirements Engineering (RE) methods and tools for use in time-to-market (TTM) projects [13]. By examining RE methods and tools in three fundamental ways, schedule time can be reduced as i) schedule time over entire project ii) Joint Application Development (JAD) and iii) Quality Function Deployment (QFD). A subjective analysis method is used to help requirement engineer in making educated decision about the RE methods.

The Mobile Scenario Presenter (MSP) is a prototype, a PDA (Personal Digital Assistant)-based tool that supports scenario-based requirements discovery [14] [15]. A mobile scenario tool is developed to discover requirements directly in the user's work context. The results show that MSP support workplace requirements discovery and their documentation, even though RE mobile tools face a lot of challenges.

Seyff et.al [16] examine usefulness of different usage scenarios on requirement discovery in two different projects. The first project, they selected, is a new aircraft management system at UK airport and the second one is a work-based learning tool for consortium organizations. Different scenario tools are used to walkthrough scenarios both in facilitated workshops and in stakeholders' workplaces. In the paper results are revealed in both qualitative and quantitative way suggesting differences in requirements having effects on models of scenario-based requirement discovery and design of scenario tools.

Geisser et.al [17] focus on the distributed software engineering tasks. Requirement elicitation phase is a critical one therefore needs tool support for distributed teams. Traditional methods of requirement engineering support collocated scenarios. The paper presents a cost-effective, adaptable and evaluation concept for requirement engineering in distributed environment. They develop a tool "TraVis" for visualizing and analyzing requirements in distributed settings. The experimented design explains and discusses many aspects of data collection. The data analysis phase covers a statistical analysis of the quantitatively measured data.

III. CHALLENGES IN MOBILE BUSINESS APPLICATIONS

It has become the norm for businesses to have a mobile application with increasing demand day by day. The operational practicality of such an application often poses a question, which generally serves more as a status symbol.

In the fulfillment of this demand, a perilous path is trading, which begins at the customers' needs and ends at the developers' idea of what they think the customers want. As with all domains of software development, convergence of these views is the only key to success.

While this problem does exist in conventional systems, it gets worse when it comes to mobile development due to the following reasons:

- Like most new media tools, Mobile Apps are a "new thing" which despite the whole-hearted adoption by the market, do not come with a guarantee of a thorough understanding on the customers' part of the design constraints and possibilities of a mobile phone platform.
- Apps are the latest trend picked up by businesses to showcase their status value [18].

The main challenges that the mobile application development community is facing in their efforts to ensure that the views of customers and developers converge include, but are not limited to, the following factors:

A. Target Group

For the study at hand, the target group is the autistic children themselves. Deciding whom to use in your target group is a problematic task when the application is being developed is for mass-market-driven products. This problem has been relatively made easier for us, however, as we know whom our target audience is. Our main quandary concerns extraction of requisite information from them to enable the development of a best-suited app for them. Autism can be seen as a communications disability of sorts. When the developmental process starts, efforts are made to gather as much background information as possible, to ascertain the needs of customers as closely as possible. If such measures are employed right from the beginning, less costly alterations will be required later on. This is essential! No doubt, planning for future conflicts is definitely a plus and is always done, as conflicts are bound to occur when you are developing a system which is going to serve a wide range of persons with varying expectations. Another primary cause of conflicts is that no two autistics are the same. There is a small overlapping area between generic and customized settings that cover those needs, which all autistics have and a few other features that will make each one of them feel like this app was designed specifically to fit his/her needs.

B. Unearth Suitable Requirements

Judgment can best be passed on whether a system's goal matches the developer's requirements if the goals and the requirements are clearly laid out. Since extraction of complete information is tricky when it comes to autistic children, rigorous research is required to fill in the blanks. With these children, it is already a tough job explaining the technicalities of the job and they in turn have difficulty articulating their exact needs. In any case, new product development is particularly difficult because the product must present innovative features to attract the attention of autistic children.

Time-to-market is another pressure evident when developing these kinds of products [13]. This is not much of a problem when we are talking about a single customer or a niche market. For such a wide audience, though, time is of the essence. Market dynamics are always at play and

it is crucial that a product is brought out on its specified date. The choice lies between delivering on time and jostling with your competitors to win the favor of your customers by convincing them you have the best to offer compared to the rest.

C. Prioritizing of Stakeholders

When developers first sit down to understand the proposed requirements for an app, they have to exercise great care to separate those items which may seem redundant and clearly outline the functions of the remaining to present a clear picture. Somehow there has to be a prioritization of stakeholders, which contains – but is not limited to – the company with the idea, the developers, the autistic children, and their guardians – who will act as the main source of requirements gathering. The interests of each shall vary and affect the system accordingly, which may require negotiations to resolve. This is generally the case with non-functional requirements, where difficult agreements often need to be made among requirements related to cost, flexibility, performance etc. It is imperative to effectively resolve all issues in order to satisfy the stakeholders.

D. Dealing with Conflicts

The necessity of avoiding conflicts is already dwelled upon in the previous passage. Effective communication, sound decision-making and personal flexibility – all combine to adequately manage conflicts. In an ordinary scenario, if ever there is a falling out pertaining requirements among the stakeholders due to ambiguity within a requirement or conflict amongst them, it is a good practice to schedule a meeting with the customer, discuss all the issues and try sorting them out. If conflicts still persist then it is the best option to let the customer have the final say. The same practice cannot be applied in this situation; however, as no two autistics are the same. It will be left upon the stakeholders' intuition and perspectives based on their experience with the autistics, to come to a conclusion.

E. Is the Requirement Fulfilled?

The big day arrives and it is finally time to test the product out. A new dilemma faces the developer, which was actually there right from the beginning: How to ensure that the system works, as it should? Of course, at this point in time we have more or less all the information necessary to build our system. The only thing left to be done is to make sure that the system is either working the way we want it to or not.

IV. PROPOSED SOLUTION

In line with the predicaments faced by the requirements engineer in gathering requirements for applications for autistics, we are proposing a solution called Autistic Users Requirements Engineering (AURE).

The agenda of AURE consists of:

1. Aggressive recruitment efforts, as the autistics are usually not very confident and lack motivation to be a part of such initiatives,

2. Oral communication is inherently ineffective in case of autistics. Hence, data collection techniques that the use of visual aids as a mode of communication is recommended,
3. As autistics have short concentration spans, it is necessary to accommodate working memory limitations of the participants along with dependence on visual aids, instead of oral communication,

The procedure for the AURE method has its roots in the basic requirements engineering process. The following stages have been designed to meet the agenda of AURE mentioned above.

Pre-Study: This phase is determining the attributes of the participants and the purview of the research. The participants should possess the ability to respond spontaneously and promptly. This will facilitate communication with autistics. Filter the participants for required traits, such as “lead user” characteristic [19] [20]. Make use of visual aids in interview sessions as a chance to gather stimuli by questioning the tentative participants for innovative ideas [20].

Needs elicitation: Employ the laddering method to gather data from participants in private visual aids based interviews [20]. Do not shower the participant with loads of questions as autistics have limited concentration spans. This will confuse them and they might lose the willingness to be the part of the session.

Needs evaluation phase: Make visual cards of all the ideas proposed by the participants. Then the participants will be encouraged to explore further potential avenues in feature development using their own proposed ideas.

Model aggregation phase: Create thematic maps using the themes formulated from the ladder interview statistics. “Value maps” are generated for every theme [21] while categorization is carried out for singular statement in the statistics as characteristics, consequences and criteria items. Organize these value maps to indicate subthemes and collection of characteristics, outcomes and criteria, encompassing the themes.

Model evaluation phase: Make visual cards containing a brief themes' description. Then ask the participants to arrange these visual cards in descending order of importance of each theme.

Select most important features: In order to accommodate various features that appeal to a user's imagination, pictorial scenarios encompassing brief description of attributes and their consequences are developed. Each scenario usually comprises of two or more features based on theme complexity.

Give reasons for preference: For the features determined in the previous phase, inquire the participants about the reasons for the selections and document the feedback. This post-analysis response mechanism will serve as a fruitful evaluation or validation of the analysis phase.

Presentation phase: Formulate a detailed business report for the client. The document should include an elaborate description of all the features of the most-valued applications along with the data collected, analysis,

and precise user comments related to the application. Furthermore, the report should also contain the consequences the applications address.

Final Validation: This is the last phase of AURE. It involves scrutinizing all the data, documents and/or presentations generated during the specification sub-phase and ensuring their relevance and validity. This validation should have all the stakeholders involved. Since, the autistics are the major stakeholders; the validation should be carried out using visual aids.

V. CONCLUSION AND FUTURE WORK

Although work has been done for blind users in the past, the domain of autism is relatively newer as far as requirements engineering is concerned. This paper identifies the challenges faced by the autistic community and contains AURE (Autistics Users Requirements Engineering), a methodology for gathering requirements from autistics users. AURE has three objectives that include, aggressive participant recruitment, data gathering with the help of visual aids, and accommodation to working memory limitations among participants. AURE in the future can be used for gathering requirements from patients suffering from different diseases.

The future work will include testing and verifying the proposed solution for different scenarios with children suffering from mild to severe levels of autism. This technique can be verified using different phases of software development life cycle from design, implementation and testing.

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