ARPostIts: Mobile Application for Agile Software Engineering using Augmented Reality

Dhiana Deva
and Thaiana Lima
Polytechnic School
Federal University of Rio de Janeiro (UFRJ)
Rio de Janeiro, Brazil
Email: {dhiana.deva, thaianamaria}@poli.ufrj.br

Cláudia Werner
and Claudia Rodrigues
Systems Engineering and Computer Science Program
COPPE/UFRJ
Rio de Janeiro, Brazil
Email: {werner, susie}@cos.ufrj.br

***Abstract*—This paper presents the case of ARPostIts, a mobile application that uses Augmented Reality in the context of Agile Software Development. ARPostIts supports daily stand-up meetings. It expands the information of a given item (physically represented by Post-its at agile task boards) with a virtual progress bar. These virtual objects change size and color according to the progress and status of the item.**

***Keywords*—Augmented Reality; Software Engineering; Mobile devices; Agile development; Frame Makers**

I. Introduction

Software Engineering (SE) is defined as a series of methods, tools and procedures that allows software development in a sustainable way [1].Observing those defining elements, SE has changed in the past decades towards new methods, perspectives and technologies, due to the growing complexity and requirements of software products.

Currently, software technologies and systems still represent a challenge for anyone who creates software based in computers [1]. The rapid changes in software projects and infrastructure, such as massive distribution, mobile computing and evolving Web objects, represent some of the challenges the 21st century presents [2].

Despite the information technology changes happen very fast, the developers and their organizations often take some time to update their methods and tools. Then, another technology emerges in the market and so the process starts all over again. Technologies such as mobile devices, advances in computer graphics, evolution on the processing power, battery and connectivity create new demands and possibilities for software applications.

In this context, it is possible to notice that the way SE is used can also be altered. The impacts of such modifications need to be studied so the development and design of software products can be optimized in order to minimize the damages in time, price, rework and other traditional problems in this field of study.

The goal for this work is to raise attention to ARPostIts, an innovative application where new technologies are applied at SE, particularly to the agile development methods.

The remaining of the paper is presented as follow: Section II introduces the Augmented Reality (AR) technology; Section III integrates SE and AR indicating some related works; Section IV briefly explains the agile method and its use of Post-It notes; Section V describes the ARPostIts application; Section VI discusses the experience of users on applying it, and Section VII presents some final considerations

II. Augmented Reality

Many emerging technologies that modified software requirements and developing methods are the ones that combine mobility, connectivity and graphics evolution. This is due to advances in knowledge about computer systems, graphics and processing power, which are some of the main reasons we currently have so many tools for complementing our real world with virtual objects.

The goal of Augmented Reality (AR) is to deliver a scenario where the real world is enriched with virtual items (usually 2D or 3D computer generated elements) rather than being replaced [3].Also, it needs to be a real time system that allows interaction between the user and the virtual objects. Therefore, we can represent and interact better with systems that could be otherwise difficult to visualize [4].For example, for a regular person, the car engine is something too complex to interact with, even if the goal is to execute a simple task. With AR we can enhance only the part we have to use, with a virtual line or any other object. In this way, the real world is altered with virtual elements in order to make it easier to be understood.

AR is now used for several goals, such as simulation, training, tracking, teaching and learning processes and many others. In a classroom, AR can be a powerful tool to envision 3D objects rather than visualize 2D figures in books.

AR technology is already available in daily activities of people with a simple smartphone, tablet or other computer device. The applications, initially developed for studies and academics, became tools for medicine, teaching, games and even military use.

III. Software Engineering and Augmented Reality

AR makes it possible to include information in the real world using additional dimensions and, therefore, enhances the users perception without modifying the physical environment. AR applications change basic notions of what a software product can do and on which devices it can run. Those types of applications need to be developed fast, otherwise they will become obsolete before reaching a mature state.

AR use in SE is not explored as it could be. By executing an ad-hoc search through literature, we could find some works such as VisAr3D [5], an application that uses AR to support the teaching process of the Software Architecture (SA) concept. The public of VisAr3D are students of a SA discipline, so that they are well prepared to the market. This application motivates students to participate in more complex projects, decreasing the gap between theory and practice. The environment is explored in 3D by the student. Figure 1 shows the prototype screen capture for VisAr3D, representing a diagram with 3D elements. Figure 1 shows the prototype screen capture for VisAr3D, representing a diagram with 3D elements.

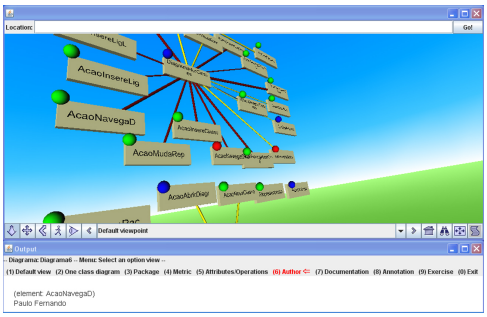

Fig. 1: VisAr3D prototype screen

SkyscrapAR [6] is another example that uses AR as a visualization technique for software evolution. Software classes and packages in a particular project revision can be observed in a 3D perspective. Buildings are a metaphor for constructing a city graphic as illustrated in Figure 2.

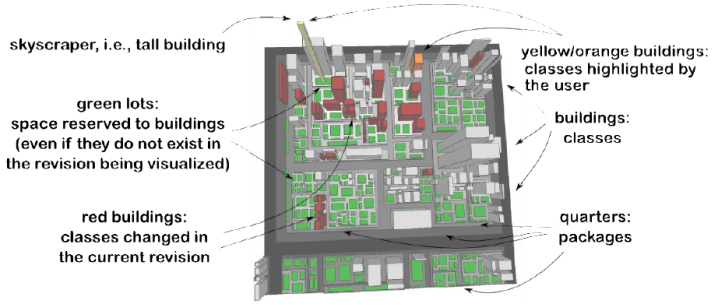

Fig. 2: Example of project visualized as a city [6]

These works address the architecture of software systems. Our contribution uses AR technologies for the management of software development processes

IV. Agile Software Development

Agile software development values individual and interactions more than processes and tools [7]. In this context, the use of Post-it Notes at Task Boards, also called Information Radiators, is very popular in the agile community. Agile task boards are created for the team and by the team, adapted according to its needs. Project management tools have built-in abstractions that force the team to be adapted to the tool, and not the inverse. For example, Mingle[1] uses cards to refer to the items being developed by the team. In contrast, the central elements of Pivotal Tracker[2] are stories. These concepts are similar, but when a tool is chosen, the team has to work according to its foundations and stick to it throughout the project lifetime.

A study [8] shows that paper-based task board outperforms its software-based pendant in terms of accessibility, motivation, haptic quality, costs, availability, overhead and communication. A software-based task board outperforms its paper-based pendant in terms of flexibility, integration, archiving and distance.

Visual pollution may be a disadvantage for paper-based task boards. When the team wants to give visibility to more information about an item, it may pile up multiple Post-its upon one another. Figure 3 shows an example of a polluted task board where the communication is undermined. A video[3] was recorded to illustrate extreme cases of these situations.

Fig. 3: Example of a polluted area of an agile task board

Another well-known agile practice is the stand-up meeting, such as the Daily Scrum [9].This is held every working day at the same time and place for no more than fifteen minutes. Every member of the development team must attend it.

The goal is to give visibility to the progress of the items being developed. This allows daily inspection and adaptation opportunities during the iteration. Since they are only fifteen minutes long, they must be effective. The team members stand-up to keep the meeting short.

These are not status report meetings where the developers show the work they have done. The items represent the most important part of the meeting. Keeping them on the focus is an important practice.

[1]Mingle website. Available in http://www.thoughtworks.com/mingle.
[2]Pivotal Tracker website. Available in http://www.pivotaltracker.com/.
[3]Visual pollution with Post-it notes https://www.youtube.com/watch?v=VVSMlZFBCOY

V. ARPostIts

ARPostIts is a mobile application to help agile software development teams overcome the limitations of paper-based task boards. Using AR, virtual elements related to a Post-it can be displayed. This is done by printing an encoded frame on Post-it notes and tracking them using computer vision-based image recognition.

ARPostIts was developed as a final project for the Augmented and Virtual Reality discipline at the Computer Engineering graduation course of UFRJ. In this context, there were limited resources to run a formal evaluation of the application.

The idea behind ARPostIts was conceived exploring how AR could be applied to the agile SE context, where Post-it notes represent items to be developed by the team. Currently, the application displays a virtual progress bar aligned to the bottom of each Post-it. Its color represents the current status of the item. In the future, ARPostIts can support other types of virtual elements.

Figure 4 illustrates a Post-it note with an encoded frame. Only the frame is used for image tracking. People can write anything inside it.

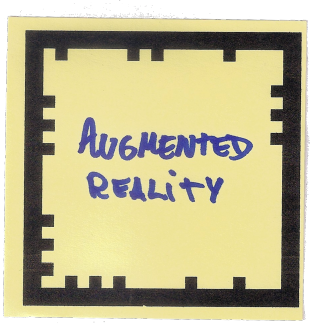

Fig. 4: Post-it with encoded frame

When the user starts the application, the splash screen accesses the cloud and updates the information about the projects, items and tasks. Then, the user is prompted to input the identification number of the project he wants to access. The application displays the device's camera image and renders the virtual progress bars with lengths and colors according to the data associated to each Post-it. The application's usage has been recorded in a video[4].

ARPostIts consists of two applications: an Android mobile application and a cloud based web system with a RESTful API.

The mobile application is built with Vuforia[5] platform. Vuforia image tracking algorithms are very robust. This platform supports encoded frame markers and provides 512 different codes. These markers can be printed on regular Post-it notes with the aid of the template available along with the source code. The Developer Portal has in-depth documentation and a variety of sample applications. Also, it has a growing community of active developers

Figure 5 shows the main screen of the mobile application.

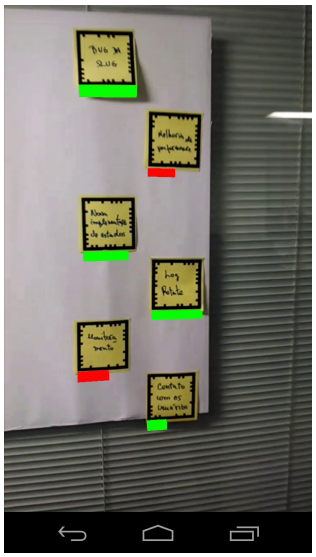

Fig. 5: Android mobile application AR screen

The cloud based administration web interface[6] is hosted at Heroku[7] and was developed using Django[8] framework. This web system supports User authentication, User accounts management, Projects management, Items management and Tasks management. In this administration interface, users can link the actual items of a given project with its corresponding encoded post-its.

All code developed for the solution is open-source and available at GitHub [9] [10].

VI. User Experience

Marker-based AR is known to rely on environmental factors such as illumination. It is usually recommended attaching the AR marker at a flat surface such as a piece of cardboard.

The malleability of Post-it notes initially represented a risk for the markers recognition. Therefore, we have tested the application response for different types of Post-it sizes and colors, rooms lighting and Post-it distortion.

The tests showed that the most familiar color, Canary Yellow, has adequate contrast for the application. Even when the Post-it note has small distortions due to heavy manipulation. But ARPostIts could not track markers printed at Neon Pink color.

[4] ARPostIts video showing its usage at an agile consulting firm. Available in https://www.youtube.com/watch?v=ek7FqlI_qXc

[5] Qualcomm Vuforia Developer Portal. Available in https://developer.vuforia.com/

[6] Administrative web application of ARPostIts. Available in http://arpostits.herokuapp.com/admin/

[7] Heroku: Cloud Platform as a Service. Available in https://www.heroku.com/

[8] Django: High-level Python web framework. Available in https://www.djangoproject.com/

[9] Code repository for the mobile application of ARPostIts. Available in http://github.com/dhiana/ARPostIts

[10] Code repository for the administrative application of ARPostIts Available in http://github.com/dhiana/arpostits_api

By using the typical 3 x 3 in Post-it model, the application provides good tracking at close distances such as the common alignment of the team around a task board on stand-up meetings.Also, corporate offices usually have adequate lights and stable wi-fi signal. These factors are important for a good user experience with ARPostIts.

A. Applications

ARPostIts has been used for product and project management activities at Concrete Solutions[11]. It expands the visibility of items progress on agile task boards. Figure 6 shows a task board using encoded Post-its.

Fig. 6: Organized task board using ARPostIts

Such task boards are mostly inspired by the KanBan [10] tool, which is the first pillar of the Toyota production system. This suggests that ARPostIts can also be used for production tracking at industries aligned with the lean manufacturing practices. The use of AR can be an invaluable technique in SE education. It has potential to enhance traditional learning methods by fostering a more engaging participation of students. ARPostIts can also help agile SE education by setting up project templates for illustrating typical scenarios during the agile life cycle of software projects.

Personal task management also benefits from the ease of visual communication of ARPostIts. This expands the potential reach of the application.

VII. Final considerations

This paper presented ARPostIts, an innovative mobile application using augmented reality for agile software development. It provides an intermediate solution between paper-based and software-based task boards, an approach that haven't been explored as it could be. With this, it is suggested that it balances their advantages and disadvantages.

No formal experiment was performed yet. However, the application is currently on active use by a small team of four developers at Concrete Solutions. The feedback gathered suggests that ARPostIts helps keeping efficient stand-up meetings with organized, updated and clean information radiators. Also, the use of AR contributes for more energetic and engaged team members during the meetings. A formal experiment is a goal for future work.

Another practical aspect is that the frame recognition is little intrusive for teams that use physical task boards. Teams with already established virtual task board tools are harder to accept new tools. This can be overcome by integrating it with the most popular virtual task boards and project management tools.

Currently, a virtual list of tasks related to an item is being developed. The application will display the tasks associated with a given item (represented by the Post-it in focus), according to the information stored on the cloud service, a tap on the touch screen will trigger that feature.

The need for updating the progress of the items before the stand-up meeting is the most notable downside. Web-sockets and mobile push technology can be used for on-the-fly updates of user interactions with the virtual progress bar changing its value and color.

Also, publishing the application to Google Play app store and gathering usage metrics is another important milestone.

Finally, ARPostIts, as well as similar works, shows that SE can also benefit from high-level AR software platforms. Such platforms are mostly used at games studios and publicity agencies for retail and branding mobile applications, but can be exploited for SE methods and tools.

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