TOWARDS A MOBILE AUGMENTED REALITY PROTOTYPE FOR CORPORATE TRAINING: A NEW PERSPECTIVE

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ABSTRACT

The potentials of the use of AR are showing up in a variety of ways can be used to create unique learning experiences. Recently, the advancement and popularity of handheld devices has enabled researchers to implement more effective learning methods. in educational as well as in corporate settings, from primary through to adult education. The industrial interest for such a technology is high, and in recent years, many attempts to use AR as a support for maintenance and repair processes.
In this paper, we present an ongoing research, concerning the application of Augmented Reality technology to e-learning system for corporate training purposes. More specifically, our research goal is to figure out if corporate training would get a valuable help from the implementation of AR in training programs, seeking to explore the advantages of the use of this emerging technology in maintenance contexts' needs. In particular, the research team starts from the evaluation of a previous research "Towards a mobile AR prototype for corporate training" (Marengo, Pagano, & Ladisa, 2017) and aims to go over some hurdles and criticism we highlighted during the research. The original purpose consisted in developing an Augmented Reality Web App for maintenance and repair training purposes. Going further, we noticed some critical aspects of the study, which could affect negatively the final goal of the research. The new aim is to introduce a complete new approach starting from a methodological and finishing to a technical point of view.
In this paper, we present those reinvented approaches highlighting the design and the development phases applied to achieve our goal. The last phase of our research work presented is the development of a prototype ready for further application and testing. This represent just the beginning step of our ongoing research project.

KEYWORDS

Augmented Reality, e-Learning, Mobile Learning, Corporate Training

1. INTRODUCTION

In the last few years, companies spending on corporate training grew year after year. Specifically, companies spend more money in e-learning training, always looking for more engaging and motivating experience for the employees. In fact, workers' productivity has been revolutionized by the increasing use of mobile devices on the job. This revolution leads companies in exploring how to use new technologies to increase "immersive" learning experiences for workers.

In this context, Augmented Reality (AR) represents nowadays one of the most impactful technologies on learning and training. As it is becoming more and more accessible and popular in the e-learning world, companies are attracted from the potentialities of Augmented Reality on training processes. Big companies are investing in this direction, too (Masoni, et al., 2017). Previous researches and case studies demonstrated how the use of Augmented Reality as a training system might enhance practical skills and learning processes, improving education/training outcomes (Chu, Hwang, Tsai, & Tseng, 2010; Yang, 2006; Tang, Owen, Biocca, & Mou, 2003; Hung, Hwang, Lin, Wu, & Su, 2013; Chiang, Yang, & Hwang, 2014).

In view of the above, a few months ago we started a research project concerning the development of a mobile AR prototype for corporate training (Marengo, Pagano, & Ladisa, 2017). It consisted in developing an Augmented Reality Web App for maintenance and repair training purposes, which would be useful to aid workers in the execution of some procedural tasks. While the research was going on, we found some criticism that in practical could affect negatively the results expected. Therefore, we decided to review and change the original project.

In this paper we describe our research on AR for corporate training, its origins and the change of direction in the middle of its development. We will also discuss the new perspective we have adopted to overcome the weaknesses of our previous work.

2. THE PREVIOUS RESEARCH: AN OVERVIEW

Augmented Reality is a technology that allows virtual information to be overlaid onto a live direct or indirect real-world environment in real time (Azouma R. , 1997). Our previous research is based on Augmented Reality technology, which is considered a very promising application of an emerging technology in many settings, including corporate training. We focus on the advantages of AR as directly linked to physical objects/devices of the training context, where some additional information is overlaid onto a real-world context, with the specific aim to apply it on training contexts.

The main aim of the research is to figure out if corporate training would get a valuable help from the implementation of AR in training programs, seeking to explore the advantages of the use of this new technology as a support for training on the job in maintenance contexts' needs. For this purpose, a few months ago we started the development of an Augmented Reality Web App for maintenance and repair training purposes through Wikitude, a tool providing SDKs for AR development.

In order to achieve our goal, we engaged a worldwide elevators company: Sematic-Wittur, which volunteer participated to some phases of the research. After the development of the Web App, hands-on and evaluating test sessions would have involved a focus group of the company. Future work consisted into analyzing the efficacy of AR in corporate training in comparison with the evaluation of other training methods in the same field.

Since AR has been recognized as being an interesting support in the industry for maintenance applications, assembly, and repair tasks (Azouma R. , 2016; Masoni, et al., 2017; Webel, et al., 2011; Shanmugam & Paul Robert , 2015), we expected that maintenance and repair tasks could benefit from the implementation of AR in training programs and users could take great advantage by using this new technology while performing job tasks. More details about the methodology of the project are explained in the following paragraph.

2.1 Methodology

Due to the complexity of the project, the original research consisted of three different phases:

- Phase 1: development of an Augmented Reality Web App;
- Phase 2: testing phase. Hands-on sessions and evaluation survey;
- Phase 3: analysis of the results.

The first phase concerned the development of an Augmented Reality Web App for maintenance and repair purposes. The Web App should have been mobile-based in order to be suitable for mobile devices (tablets or smartphones).

In the light of this, we had previously analyzed and compared a range of different SDKs, in order to choose the one which would have fitted better for the purposes of our project. Our choice has fallen upon the SDK Wikitude, which is an all-in-one augmented reality SDK, combining 3D Tracking technology (SLAM), Image Recognition and Tracking, as well as Geo-location AR for apps (The world's leading AR SDK). It offers markerless AR experiences, high qualitative features and an integration with Titanium (a mobile application development framework); moreover, Wikitude is community supported. The Testing phase (Phase 2) and the Analysis of the results (Phase 3) would have represented a valuable combination to assess the validity of the research and the evaluation of our research project in terms of efficacy and consistency.

3. IMPLEMENTATION OF THE FIRST PROTOTYPE AND GOING THROUGH NEW PERSPECTIVE

Recently, the advancement and popularity of handheld devices and sensing technologies has enabled researchers to implement more effective learning methods (Ogata, Li, Hou, Uosaki, El-Bishouty, & Yano, 2011). More specifically, Augmented Reality (AR) technology for maintenance aims to improve human performances and to speed up processes by providing relevant information in a highly contextual way. The kind of information to be displayed in AR permits an efficient maintenance task that accelerates the technicians' acquisition of new skill on maintenance procedures (Radkowski, Herrema, & Oliver, 2015; Cárdenas & Dutra, 2016; Elia, Gnoni, & Lanzillotto, 2016; Re, Oliver, & Bordegoni).

As explained in the previous paragraph, the first step of our original research consisted in the development of a web app for maintenance and repair tasks through the AR tool Wikitude. Before we get started the development process of the App, we made a last assessment of the potentialities of the project, making a deeper study of the target (i.e. workers) and its features. This study assessed that such a Tool could not be useful for elevator installers and repairer for several reasons:

- Mobile devices should be held with at least one hand;
- While installing/repairing elevators, workers need both hands to work;
- If they were using our web app, at least two workers would be engaged while repairing/installing onsite.

As can be seen from the points explained above, we faced some difficulties about the implementation of the App into the job process, just before starting the development. The only way to fix this hurdles were:

- Maintaining the purposes of the research and adopting hands-free technologies (i.e. Augmented Reality (AR) headset);
- Changing the purposes of the research, basing the new study entirely on mobile technology.

Firstly, we decided to change the perspective of our research, focusing the purpose of our project on training of new workers for onboarding processes. This change of direction allowed us to consider Virtual Reality Technology as one possible option, since it supports simulations of corporate settings in a virtual environment.

In regard of this, Gavish et al (2015) evaluated the efficiency and effectiveness of four training groups for industrial maintenance procedural skills. Results demonstrated no significant differences in the final performance between the VR and AR. Although this study did not directly compare the AR and the VR platform because the two platforms were different in several functions, they valued studies that compare the effects of VR and AR platforms that were in similar design (Liou, Yang, Chen, & Tarng, 2017).

However, even if VR can be considered as a more mature technology in learning contexts (Wu, Lee, Chang, & Liang, 2013), Augmented Reality provides the best scenario suited for our training goals, which is not possible with other media. Since we meant to develop an innovative prototype for corporate training, AR technology was considered the best solution for several reasons:

- Costs of development;
- Duration of development;
- The prototypal nature of our project.

From a technical point of view, we decided to evaluate the best AR software development kit (SDK) regarding the aim of our project and the company's needs. For this reason, we choose Blippar, an Augmented Reality development tool. More details are explained in the following paragraphs.

4. THE NEW RESEARCH PROJECT

Although AR has already shown promise in some corporate contexts, this immersive technology should be considered thoughtfully to ensure it adds value to the existing workflows. In regard of this, the development of an AR system involves the attentive choice of a hardware, a development software and a visualisation method (Palmarini, Erkoyuncu, & Roy, 2016). Moreover, staff should be well equipped, some hardware components have been improved (i.e. batteries), but there are still many open issues and challenges related the hardware of the technology, the content of the application and the education of the industrial market.

In the light of this, for company-specific reasons we choose to change the purpose of our AR App, shifting the focus away from repairer onto newly hired repairer. Moreover, technical aspects have been reviewed and redefined. The following paragraph will explain the details of the App development.

4.1 The Development of the App

With the changing of the purposes of the research (Paragraph 3) we have looked for a different framework or SDK to develop our project. We have chosen Blippar for several reasons, such as:

- faster development: Blippar has an app on the main app stores (also used by companies to AR marketing campaigns) that already has a powerful images and object recognition engine, so we can focus on the augmented reality experience (e.g. the image or 3D models animated on the screen, the user interface, the contents of the course), and delegate the image recognition process to Blippar;
- faster code maintenance: as explained above, the app is already on the Main app repository. By doing this, we don't need to constantly release, concerning the recognition and tracking engine. Consequently, we can focus on the course design and the user experience;
- faster prototyping: with the Blippbuilder (a drag and drop development tool) we can quickly develop a prototype in order to test the user interaction in relation to the contents of the course.

We adopted the AR technology to lead the user of a given e-learning course from the frame of the mechanical object to the learning object on the LMS Platform in an engaging and easy way through mobile devices (i.e. smartphone, tablet). By doing this, our App will:

- Frame the mechanical object;
- Detect the image with the device camera and recognize the marker;
- Display multimedia contents on the device screen (like text or video/audio contents);
- Display a button that will lead the user to the pertinent learning object

The purposed system is a mobile Augmented Reality system and a marker-based one. The choice of the marker image is a crucial part in the development process. A marker should have the following features:

- A jpeg image with RGB color space and without extra channels or paths. High resolution image are not required for the image tracking and recognition, and a too heavy image will only slow down data exchange with Blippar server;
- high contrast image with as many sharp crisp edges and corners as possible;
- a size measured in n*100 pixels.

In view of the above, we conducted some tests to choose the image better responding to the identification of the system. After evaluating several images, we choose to test the app using the logos of Osel Srl (Figure 1 and Figure 2). The test was conducted using an Android device. It revealed that the logo in the Figure 1 was identified faster than the logo in Figure 2 from different orientation and positions of the camera. This may depend on the complexity and the definition of the image. In fact, Figure 2 consists of the logo and some text, which could negatively affect the performance of image-recognition.

Figure 1. Logo Osel S.r.l.

Figure 2. Logo Osel S.r.l.

The next step to be taken is to develop the mobile AR App, basing on the above observations. Before getting started with the App, we designed the "Blipp", basing on the structure represented in Figure 3. As shown, the "Scene" is the root node containing various other types of nodes. The Model node is the root of visible entities within a blipp, that in our case consists of Sprite which is used for 2D images. The other nodes within the scene, such as Light, Material, Space and Texture have functional purpose but won't be defined because useful to 3D images. Anim could be subsequently defined.

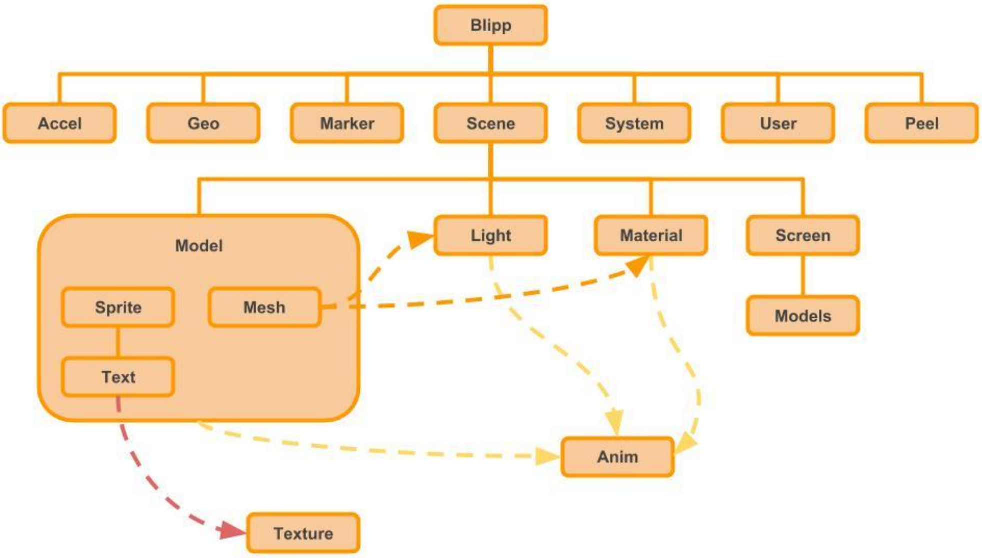

Figure 3. Diagram Showing the Relationship between the Nodes of a Single Blip

We've set the values of the Marker properties on the dimension the uploaded files and the values of the Sprite, which will cover the marker on the display:

VAR MarkerWidth ⟵ GET WidthOfMarker
VAR MarkerHeight ⟵ GET HeightOfMarker
VAR SceneSprite ⟵ SpritePath, SpriteName, SpriteTranslation, SpriteScale

The purpose of the function GET is to fetch the marker width and height from the marker file previously uploaded on the Blippar server and assign it to "MarkerWidth" and "MarkerHeight". The variable SceneSprite stores all the data of flat plane (e.g an image) that will overlap the marker during the tracking; the Blippar image recognition engine will continuously track the marker with the camera and keep the flat plane stuck on it.

IF onTouch = TRUE

THEN
OpenCourse

The User might tap the object/image displayed on the device and be led directly to course on the LMS Platform. We can add a floating frame with a brief definition or a video depending on the content of the learning object. As explained in the previous paragraph, the User might Interact with the object/image displayed on the device and be led directly to course on the LMS Platform.

5. CONCLUSION

The three characteristics of AR, combining real and virtual objects incorporated into reality, providing collaboration between real and virtual objects, and real-time interaction between real and virtual objects (Chiang, Yang, & Hwang, 2014) can empower experience-based learning and learning outcomes. More specifically, Augmented Reality as a support for maintenance AR can help to reduce time and errors of maintenance tasks (Fiorentino, Uva, Gattullo, Debernardis & Monno, 2014).

In this paper, we analyzed our previous research about the development of an AR App for corporate training in maintenance and repair, and tried to overcome the hurdles we found in the course of the research development. Basing on what highlighted in the evaluating phase described above, in our ongoing research we are developing an Augmented Reality App for training newly hired repairer and we are planning the evaluation steps.

As in the original research project, future work includes developing phase, hands-on and evaluating test sessions, aiming to evaluate the impact of our project on the training program of Sematic-Wittur on both a quantitative and qualitative point of view. Furthermore, once the results will be collected, our research will go one step further by analyzing the efficacy of AR in corporate training in comparison with the effectiveness of other training methods (such as traditional training and e-learning) in the same field.

Whereas the purposed paper presents an ongoing research, the achievement of our expected results will depend on the further steps of the study. Therefore, when the project will be finished, data will be analyzed and compared with our expectations.

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