PILOT TESTS OF AUGMENTED REALITIES IN SCIENCE DISPLAYS AND DESIGN PRESENTATIONS[1]

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ABSTRACT: *Augmented Reality (AR) enriches the education environment by adding spatially aligned virtual objects (3D models, 2D textures, textual annotations, etc.) by means of special display technologies .This research was a pilot test within a longer research project aimed at investigating and evaluating the relevance of realism elements in 3d AR education technologies in science centers and design presentations. The main advantages of using virtual objects are that they can be animated, they are interactive and can respond to the user's actions and are not constrained by the costs and practical or physical limitations of real objects. These factors make AR a powerful educational tool. In this research, AR Planets and AR Dinosaur in National Science Center Malaysia were developed as a testbed. A pilot study - to gauge the public reaction to the technology - was developed involving the augmenting of earth globe and a dinosaur. Researchers found out that both adult and children reactions were enthusiastic, changing a dry subject such as science to an exciting activity. A survey was undertaken to gauge the reactions and significance to aspects of realism in AR. User studies were done using field studies to study the effectiveness of realism in AR application in real scenarios. The participants were asked to evaluate two different approaches of application to experience the Augmented 3d science content with heavy realism content and less realism content. After a couple of minutes exploring the content with recorded video, they filled in the questionnaire which assessed their experience towards the application. The importance to the realism elements recorded with the feedback and attitude by the users such as their satisfaction and feel real to the AR content and the feeling of connection to the content elements .The evaluation found out that 98% of the participants believe the AR content with heavy realism elements is superior to compare with AR content with less realism elements in science center. This research will give a better guidance to education centers on user expectations and responses towards such an application including the importance and significance on using realism in Augmented Reality application.*

KEYWORDS: *Augmented reality, education, science, design, presentation, science center, planet, dinosaur*

1. INTRODUCTION

This paper presents two prototype developments – Dinosaur AR for National Science Center, Malaysia and 3D Interior building AR for ALM Builders Company. We investigated methods to have an optimized realistic animated AR content for interior building design presentation that commonly involve details 3D drawing With these methods allow the AR content augmented or pop up from marker tracking paper with more immersive. The result of the study indicated that this development can provide a quality approach in AR evaluation, more 'presence' information for attraction and hence will give the real experience and knowledge to the users. Having the benefits of this development will facilitate and expedite the construction process simulation as well as heavy 3D AR development cost for the AR science display and AR presentation in augmented reality.

Evaluation and pilot tests regarding the introduction of mobile guides in the museum setting is a concrete issue that has hopefully and unlike other areas in human interaction has been accredited sufficient interest and important among related scientific community (Kelly,2002). The design, implementation and maintenance of an augmented realities display and presentation for science need to be systematically and creatively designed based on the result of pilot test and surveys.

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2. AUGMENTED REALITY IN SCIENCE AND EDUCATION

There are 2 types of AR application for science and education content: 1) location-aware; and 2) vision-based. Location-aware AR presents digital media to learners as they move through a physical area with a GPS-enabled smart phone or similar mobile device The media (i.e., text, graphics, audio, video, 3D models) augment the physical environment with narrative, navigation, and/or academic information relevant to the location. In contrast, vision-based AR presents digital media to learners after they point the camera in their mobile device at an object**.**

The potential power of AR as a learning tool is its ability "to enable students to see the world around them in new ways and engage with realistic issues in a context with which the students are already connected" (Klopfer & Sheldon, 2010, p. 86). These two types of AR influence several smart phone capabilities (i.e., GPS, camera, object recognition and tracking) to create "immersive" learning experiences within the physical environment, providing educators with a novel and potentially transformative tool for teaching and learning (Azuma, Baillot, Behringer, Feiner, Julier, & MacIntyre, 2001; Dede, 2009; Johnson, Smith, Willis, Levine, & Haywood, 2011).

Fig. 1: Crowd enjoying the AR Dinosaur content in National Science Center

Studies have shown that the element of presence and immersion in a digital and real environment can enhance education in at least three ways: by allowing multiple perspectives, situated learning, and transfer.

Moreover, these two forms of AR both leverage the affordance of context sensitivity, which enables the mobile device to "know" where it is in the physical world and to present digital content to the user that is relevant to that location (Klopfer, Squire, & Chapter 67: Augmented reality Jenkins, 2002). For example, using the medium of sensorily immersive virtual reality, Project ScienceSpace contrasted egocentric rather than exocentric frames of reference (Salzman, Dede, Loftin, & Chen, 2009).

3. RELATED WORK

3.1 Science Center To Go (Scetgo)

The "Science Center To Go" (SCeTGo) approach aims at the presentation of such AR technology initiative in science teaching both in formal & informal educational environments that facilitates lifelong learning by offering to learners the opportunity to gain exposure to everyday science in a way that is appropriate to the individual level of understanding.

SCeTGo's approach is based on an educational kit that is delivered in the form of a small suit- case and contains a tablet, a web camera, a series of 3-D printed miniatures and a user guide. This hardware combined in various arrangements can form in total five mini- exhibits that illustrate various physical phenomena linked to secondary school curricular: sound wave propagation, rigid body (double cone) motion on an inclined plane, wing dynamics, wave-particle duality and gas particles' velocity distribution. Learners can interact dynamically with the miniature exhibits and by using AR enrich their optical view with information relevant to

the physical content shown. Some of the examples of the content include explanation of why do planes fly and why does the siren sound of a fire truck is different when it approaches a n observer than when it moves away from him. (Angelos Lazoudis, The science center to go project, EDEN - 2011 Open Classroom Conference)

3.2 Science Stories" Augmented Reality Science Museum Tour App

Fig. 2: James May "Science Stories" augmented reality Science Museum tour app (HANDS-ON: James May "Science Stories" augmented reality science museum tour app.
- http://www.techdigest.tv/2012/04/hands-on_james.html)

3.3 AR London Museum

Another AR application that relate with science center is Science Stories AR London Science Museum tour app. Using smartphone and tablet, user can click on a marker at selected plinths (refer figure 3), a 3D walking talking rendering of James May appears magically on screen to talk to the user through the objects, how they work and their place in history. The talking and walking fully in 3D object which user can move around freely as long as the plinth trigger marking stays in view of the camera sensor. The app also has an “At Home” mode to let user access the avatar of James May commentary outside of the museum.

Street Museum is an augmented reality iPhone app created by the Museum of London that allows you to browse historical photographs in various parts of the city. The app leads you to various locations around London using either the map or GPS. Once you’re there, click the “3D View” button, and the app will recognize the location and overlay the historical photograph over the live video feed of the real world, giving you a brief glimpse into how the past looked. The application uses LAYAR based apps to create a layer of image based on geo location marker.

Fig. 3: Using smartphone to run Augmented Reality App for London Street Museum (http://attention2ads.com/post/2797866923/taking-arts-to-the-streeds-the-street-museum-app-from)

3.4 Augmented Reality (AR) Magnet

Augmented Reality (AR) Magnet displayed in the Fleet's exhibit gallery was intended to visualize how the magnetic field works. The new AR application exhibit, the first of its kind in a Balboa Park museum, serves as a

pilot project to investigate the usefulness of mobile apps as teaching tools to enhance hands-on exhibits in informal science educational institutes like the Reuben H. Fleet Science Center. The app has been custom built using Qualcomm's AR technology, for the Fleet as part of an interactive exhibit on magnets and magnetism.

Fig. 4: The magnetic field visualized using Augmented Reality application (http://www.youtube.com/watch?v=GiJjTdoWZFs)

4. METHODOLOGY

This paper was aimed at investigating evaluate the relevance of using Augmented Reality in science display and design presentation in the optimized 3d animated content. User studies are done using field studies to study the effectiveness of this application in real scenarios. The participants will be experience the AR Dinosaur in National Science center. After a couple of minutes of exploring the content with recorded video, they will fill in the questionnaire on their experience towards the system. The importance to the presence elements will be recorded with the feedback and the attitude of the users such as their satisfaction and feel real to the 3d AR content, the feeling of connection to the content elements and how comfortable the system are . The participants will evaluate whether they deem the presence content as suitable for museum and improvement for the current content and whether they would be willing to pay a higher entrance fee, and whether they prefer to go to the science display booth to experience the new technology with heavy presence elements. All items will be answered on the questionnaire.

5. USER TASK ANALYSIS

The aim of task analysis in this paper is to classify a complete description of tasks and actions required to use an application system development as well as other resources necessary for the user and the system to cooperatively perform tasks (Hix & Hartson, 1993). Generic user requirements were identified during our preliminary study in order to perform the analysis using face-to-face interviews with science visitors (Murni et al., 2009) and a series of roundtable discussions with content expert.

National Science Center has granted a space to locate a booth to do pilot test of Augmented Reality Science Display during their Science Festival 2012. A simple booth has been designed with LED 40 inch, webcam and CPU experimenting Dinosaur content for various respondents.

Following are notable findings from this preliminary study:

The demographic information of 100 respondents shows computer competency of majority respondents is intermediate (66% valid percent), novice (24%), expert (6 %), and not exposed (4 %). However, majority (94%) are not exposed to Augmented Reality while 6% familiar with the term Augmented Reality.

There are 100 participants: 56 male, 44 female, and majority (64%) of them are below 20 years old involved in this study. It is observed that teenagers and kids were enthusiastic to explore the 3D AR application rather than adults. In most cases, when they were accompanied by parents, their parents normally asked the children to participate while the parents observed or guided them in nearby area.

6. USABILITY EVALUATION

Table 2 describes the results gathered using usability questionnaire. Respondents were satisfied that overall our AR Dinosaur application provides sense of presence (86%). This application also provides satisfactory learning experience (91) and satisfactory overall usability (89).

Table 2: Usability evaluation

Item	Evaluation	Percentage (Agree)
1	I felt a sense of being immersed in the augmented environment	77
2	I did not need to feel immersed in the virtual environment to complete my task	23
3	I got a sense of presence (i.e. communicate with dinosaur)	85
4	The quality of 3D content reduced my feeling of presence	43
5	The display resolution reduced my sense of presence	46
6	I felt isolated and not part of the virtual environment	13
7	I had a good sense of scale in the virtual environment	74
8	I thought the system provides a good learning experience	8
9	The system improves my learning capability	72
10	I can easily recognize elements/content shown in this application	100
11	I would be comfortable using this system for long periods	88
12	I did not have a clear idea of how to perform a particular task	6
13	I found it difficult to learn how to use the system	2
14	I felt in control of the system	72
15	The system did not work as expected	11
16	I found it difficult to work with the system	24
17	I enjoyed working with the system	94

6.1 AR Science Display Crowds:

The AR Dinosaur received extremely high numbers of visitors and crowd visited the booth and experienced the contents. In total, the booth received at least '3424' numbers of visits during the events and each of visits spent at least '4 minutes' to play with the AR contents.

Table 3: AR booth; visits & time consumed with AR application statistics

Date/Day	Visits (No.)	Time Consumed (Min.)
11/12/12 Tuesday	719	2876
12/12/12 Wednesday	473	1892
13/12/12 Thursday	457	1828
14/12/12 Friday	414	1656
15/12/12 Saturday	628	2512
16/12/12 Sunday	733	2932
Total	3424	13696

6.1.1 Attractions

The animated AR dinosaur became one of the reasons for visitors to stop by and look at the AR Application. The visitors fascinated with the 3D dinosaur that looks like standing together with them in the LED tv screen. The webcam also attracted most kids as they can see themselves in the screen while playing with the content. The kids tend to stay longer in front of the screen as they like to explore more on the AR earth and dinosaur beside the camera on the top of screen can exactly view their faces together with AR model. The camera position also suit with kid's height.

The adult visitors also attract with the AR model by the kids reaction towards it on screen and join together to snap some pictures. Besides, some of the visitors amazingly enhanced the interactivity of AR application with people by taking picture of marker with their own smartphone, tablet and make the AR model appears on their phone/tablet screen. The string attached to marker board help visitors to get the proper length to view the AR model, besides preventing the board from been taken away.

The markers that have been designed also suit with kids and adults hand thus give them better and proper position to hold. The utmost important reason for high numbers of crowd was because the booth location at the center area thanks to PSN. The best thing about AR booth was when parents can capture photos of their kids holding a dinosaur and earth and to be shared with others.

6.1.2 Issues

Most of the time, the lighting factor became one of the reasons for AR model not to appear properly. Although the location was perfect to attract people, but the lighting inside the hall was not consistent. It created confusion to the camera and need to be adjusted from time to time.

The camera position is not suitable with adults' height. The adult visitor still can view the AR model with kid's height focus camera, but most of them tend to duck down to let their faces also appeared on the screen together with AR model.

The marker board on the floor always been stomped by visitors as they think it is one of the required action to make the AR dinosaur appear. Need to put direction together on the floor afterward. Some kids really put emotions on the content and as a result they tried to hold and punch the dinosaur at the screen and webcam.

6.1.3 Future Plans for Improvement.

More screen need to be added. With only one screen definitely cannot entertain all the crowd that combined kids, teenagers, and adults that usually come in a form of student groups and families.

A holder stand needs to be prepared afterward for marker board, as it is more proper than just using a chair to display the marker board.

The limit line for viewing should be put on the floor to avoid the AR model disappeared due to marker out of camera focus, besides avoiding the kids to slam on the screen again.

Need to put direction together on the floor afterward.

Need to buy better software that has better marker detection although the lighting is not consistent. The current software can still be used for experiments, demo and presentation.

By participated in Science Festival 2012 organized by National Science Center, a lot of strengths and weaknesses can be reviewed to improve the AR content. The AR Dinosaur application also manages to attract crowds and get highly positive feedbacks from them. From the festival, much potential can be seen for AR science display in the future.

In general, visitors would like to have some interactive exhibits in the science center in order to learn and experience science and education content. Those in family trips would be relieved to see their children enjoy the 3D AR content by experiencing and experimenting things by their own. This contributes to the design requirements of the AR application.

6.2 3D AR Interior Building Content

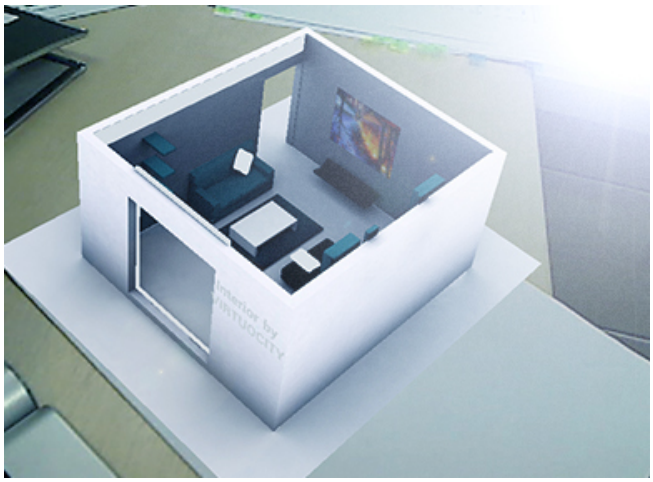

Fig. 5: 3D AR interior building content presented to ALM Builders.

To get perspective of AR content using design presentation, an application has been presented to a company named ALM Builders. ALM Builders is an architect company, seek a new style of presentation for their new marketing strategy. Series of discussion has been conducted with the members of company and an AR application has been designed to build a 3D interior building content. This AR content will replace their old way of presenting new building to customer. A realistic and animated AR prototype was presented to the expert of ALM Builders and the expert made comments during the presentation. Finally, a set of requirements was established where among others: the AR application should be able to cater more customers and visitors at their booth. The booth design and the content also will replace their small scale building mockup and can be placed anywhere and anytime they want .The AR content also should be intuitive and easy to use by the general public; and it can support social interaction that may initiate conversation among family members or groups.

6.2.1 Expert Review

Expert review and feedback of the application was really good and positive. At the early stage, the expert list out requirements to build the AR application content. The requirements are:

1) Easy to transfer from any location

2) Can easily attract visitors and customers

3) Low cost

4) Easy maintenance

Based on these requirements, the AR prototype develops by using high detail 3d content of an interior building model. The 3d model exported to AR application with some animation features to impress the visitors.

6.2.2 Feedback and Recommendations

During the first expert review, the AR interior building prototype as shown in Figure 4 was presented in front of an architect group. One of the architects questioned the inconsistency to control the prototype as it depends on the lighting condition. Therefore, the prototype hardware and software need to be improved to make sure that they manage to control the experience the prototype seamlessly. Aside from that, all architects in the group agree that the prototype meets the entire requirement given.

7. PROCEDURE

During the presentation, at least three evaluators were there, one was to respond to respondents‟ enquiries and another was to mark time stamps and did the video recording, and both observed the respondents and gathered other qualitative data such as respondents‟ expressions and conversations if they did the session in pairs or in groups. In most cases, respondents were free to play with the AR content and complete predesigned tasks themselves. Evaluators would help them only upon request and at critical incidents that halted respondents to complete their tasks

8. PICTURES DURING PILOT TEST

These are several other pictures that have been captured during the pilot test.


A.R. DINOSAUR
A.R. EARTH
EARTH

9. DISCUSSION

The key aim of this study was to investigate the important elements of presence in Augmented Reality, similar to the study by Lombard and Ditton (1997) whether presence in media is necessarily a good thing or not as significant as expected, especially in science displays and design presentations. Based on the deliberations above clearly the objectives have been achieved to focus on the technical challenges and requirements, particularly on the presence elements for AR visualization to represent education and building content for science displays and design presentation. The aim to introduce a new method of optimizing and to add realism elements to the content within innovative uses of Augmented Reality also attained. Having the benefits from this development will facilitate and expedite the construction process simulation as well as heavy 3D AR development costs for the science displays and design presentation.

As a conclusion, the pilot test on evaluating presence in Augmented Reality for cultural heritage help us answer some of the important questions raised by cultural heritage researcher and technology developers. Can presence improve Augmented Reality content for science displays and design presentations significantly? Or is it just an add-on to the content? Is presence efficient for all project types? Can a content developer easily implement presence in their application and is it worth the cost and the budget? Will presence bring fun and attract people with education and building content? And will presence give impact to the future generation? Overall the survey found a significant number of percentages of satisfactory overall usability by 89% respondents proved that by applying presence elements in Augmented Reality for science displays and design presentation was significant and provided more benefits and fun experience to the users and visitors.

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