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Towards Building Web Based Augmented Reality Application for Pre-School Children

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Abstract

The goal of this work is to present a concept for web based Augmented Reality. We have many examples of Augmented Reality systems in different field from military applications to medical applications, from entertainment to manufacturing. In this paper we worked on how virtual environments can be combined with web based applications. Internet users need web sites for many reasons in daily life. On the other hand, Augmented Reality is one of the popular fields on virtual environment technologies that it would be useful to associate these two technologies. In this study JavaScript were used as main language to build Augmented Reality application supported by three different libraries each with a specific role. The libraries which are used through coding are Flartoolkit, Papervision3D, and Flex SDK. The outcome of this combined algorithms shows that the method is accomplished web based Augmented Reality for preschool children to provide educators a way to teach students with deeper, and more meaningful experiences in the academy.

Keywords: *augmented reality, virtual reality, HTTP, papervision3D, Flartoolkit*

1. Introduction

Basically the description of Augmented Reality is 3-D virtual objects are integrated into a 3-D real environment in real time. In other word it is the way of enhancement of the real world with the virtual environment [1, 2]. Augmented reality is a term used to describe a live view of a physical, real-world environment that is augmented by computer-generated input usually with graphics. Georg Klein also provides a commonly accepted definition of AR as a technology which combination of real and virtual environment, is interactive in real time, and registers the virtual 3D object with the real world [3]. The participants are totally immersed in VR environment and they are able to interact with a completely synthetic world. Paul Milgram stated that such a world may mimic the properties of some real-world environments, either existing or imaginary [4].

The particular subclass of VR related technologies that involve the merging of real and virtual worlds to generically called Mixed Reality (MR). Milgram mentioned about formulating taxonomy of the various ways in which the "virtual" and "real" aspects of MR environments can be realized. The concept of a "virtuality continuum" was illustrated as Figure 1;

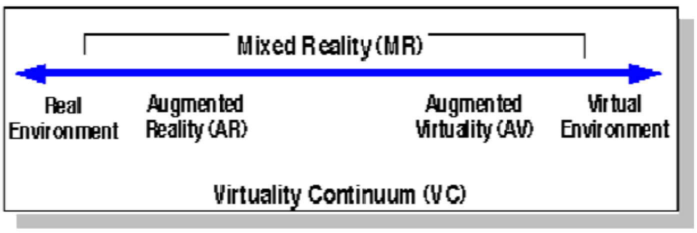

Figure 1. Milgram’s Reality-Virtuality Continuum

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Real environments are shown at one end of the continuum, and virtual environments, at the opposite direction. At the left, environments only consisting of real objects and includes for example what is observed via a conventional video display of a real-world scene. An additional example includes direct viewing of the same real scene, but not via any particular electronic display system. At the right, defines environments only consisting of virtual objects an example of which would be a computer graphic. As indicated in the figure, the most straightforward way to view a Mixed Reality environment is real world and virtual world objects are presented together within a single display, that is anywhere between the direction of the virtuality continuum.

Virtual Environment Technologies are used almost in any field such as military applications, medical applications, entertainment and manufacturing [5]. AR has been put to use in medical imaging, where doctors can access data about patients; aviation, where tools show pilots important data about the landscape they are viewing; training, in which technology provides students or technicians with necessary data about specific objects they are working with; and in museums, where artifacts can be tagged with information such as the artifact's historical context or where it was discovered. The video game industry has released primary augmented reality products for more than a decade as well. But the registration was the primary technical difficulty in AR applications that many researches were carried on to overcome efficiently [6, 7, 8, 9, 10, 11, 12].

The exact alignment of virtual images is very important when the object registered [13]. If the alignment is not proper, AR would not be convincing. For example, a real chessboard with virtual pieces a few centimeters out of alignment is useless. Similarly, if a surgeon cannot be entirely certain that the virtual tumor he or she sees inside the patient's body is exactly in the right place. When the user is stable alignment of real and virtual images come true perfectly, a system can be said to offer good static registration. When user start moving, the user should notice there is no lateness between real and virtual objects [14].

According to previous studies the display techniques can be divided three main classes: projection-based displays, handheld displays and see-through head-mounted displays. Head Mounted Displays is the most flexible and direct way to present augmentations of the environment to user. Usually for AR a camera is mounted to the head-mounted display, and a computer calculates this camera's pose [15]. But user needs to wear it continuously which might be troublesome and not comfortable after some time [16]. Also, Head Mounted Displays usually not support multiple users. Another display technique is Projector-based displays which make the augmentation visible to several users. Moreover, projector based displays have many advantages such as provide consistency of eye accommodation, reduced motion sickness, along with provide high resolution for the visualization. Somehow the project based displays also have kind of disadvantages. Usually the setups for projection-based displays are fixed [17], [18, 19, 20, 21]. Therefore this way is cause lack of movement. A single projector usually is set up for a single user and it causes self-occlusion. Lastly the handheld technique is the other display technique that they can be embedded into mobile devices but they don't support mobile computing which installed to the system [22]. The main limitation of handheld displays is the tracking. Most handheld displays use ARToolKit or tracking with markers [23, 24]. Anyway handheld displays can be more flexible and support mobile AR applications [25]. Example of marker based AR as shown in Figure 2.

Figure 2. ARToolKit Marker based AR

Unfortunately, we still have problem with real-time visual tracking. Elements in the image must be correspondence when pose extracting from a video frame. It requires software to make correspondences between elements in the image and locate the 3D object in the real world, and building these correspondences in live video streams is challenging [26]. This problem has been solved by artificial markers which are placed in the scene. Placing marker in the scene works very well for prototype applications in prepared environments, but is not totally accepted. It is not about aesthetic considerations, the placement may not be practical when dealing with large environments as well [27]. Therefore some studies focuses on marker less tracking which uses only features already available in the scene [28].

However in this paper we are interested in how virtual environments can be combined with web based applications, with the ultimate goal of supporting ordinary users in their interactions with AR. Internet users need web sites for many reasons to search or share information and for communication or entertainment purpose. On the other hand, Augmented Reality is one of the popular fields on Virtual Environment Technologies. This paper is addressed the combination of these two technologies which mean to deliver the augmented reality via web based application.

2. Research Method

This section is the description of the methodology that used in this paper for development of web based augmented reality application. This work is contained a small game which expose interaction between user and this augmented reality application. The program asks user the name of animal which is displayed as 3D object model on scene. Since the application has developed for pre-school children, parents required to involve this game in order to guide them as demonstrated in Figure 3.

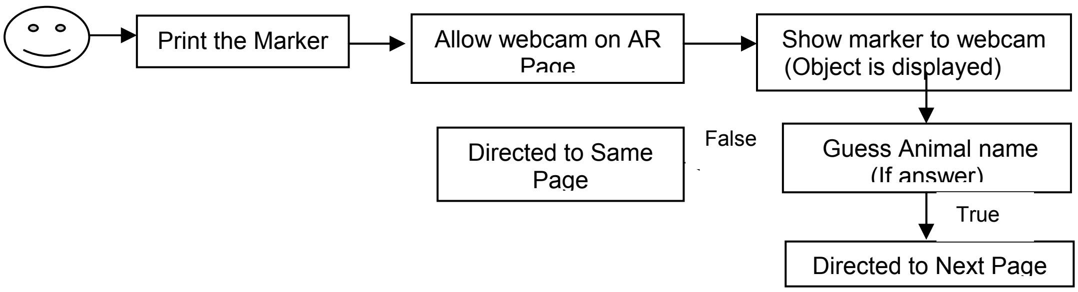

Figure 3. Web based AR Diagram

For this study the framework is divided into two main phases which is designing phase and implementation phase. Designing phase is involved three steps that will be explained in next section. Second phase is the implementation of web based Augmented Reality. This phase is involved coding to create a web based augmented reality application using Flartoolkit, Papervison3D libraries, and Flex SDK.

2.1. Designing Phase

Designing phase has three components which are designing user interface, designing 3D model and creating the marker as shown Figure 4.

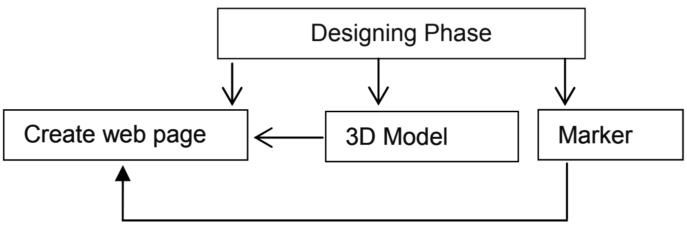

Figure 4. Web AR Application Designing Phase Diagram

2.1.1. Creating Webpage Interface

This new web site enables children to visit this virtual zoo and interact with 3D animal models in real world. Basically it was designed as simple web page which user can reach desired data simply and efficiently. Although user can access everything about web site from the index page, lately this links are not activated. To create the main page, CSS and HTML were used. Basically main menu navigated to home, animal, education, AR demo and contact. The Augmented Reality has placed at the bottom as well that the link 'LET'S ENJOY TOGETHER' will redirect them to AR application as shown in Figure 5.

Figure 5. Online Zoo Main Page

2.1.2. Creating 3D Objects

For this work 3D models has been designed for pre-school children to give them richer and excited understanding about animal's world. Eight different kind of animal augmented in this study. These animal models are cow, frog, flamingo, zebra, elephant, turtle, hippo, and giraffe were used. Papervision3D library is required Collada format 3D models. Collada models can be created and exported using many popular 3D modeling tools, including the open Blender3D. For this project Google SketchUp used for creating and editing the 3D object. Skectup is 3D modeling program marketed by Google and designed for architectural, civil, and mechanical engineers as well as filmmakers, game developers, and related professions. 3D object format required to be Collada .dae file extension for this project.

2.1.3. Generating Marker

Marker graphic image can be designed with any graphics drawing program. To design a graphic, fit the desired shape within a white square that is centered within a larger black square. FLAR Marker Generator (AIR, 322K) or ARToolKit online MarkerGenerator' required generating the pattern file. When the printed marker image shown to camera we notice that application tries to draw a shape around the square box, then we press 'Get Pattern' which shown with yellow lines below picture and named as 'FLARPattern.pat'. As demonstrated Figure in 6, the marker is obtained in this way.

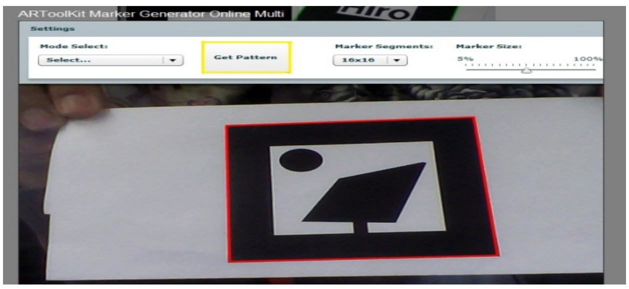

Figure 6. Online ARtoolkit Marker Generator

2.2. Implementation and Coding

This phase covers coding part in order to create web based AR. First of all we need a special compiler in order to build our augmented reality. In this study Adobe Flash CS used as compiler of the project. The libraries which used through coding are Flartoolkit, Papervision3D, Flex SDK. As pre-processing, it is necessary to prepare the libraries and new project file. A document class is needed to be created in Flash CS within new project file. It is compulsory to create separate folders inside the project folder for libraries and for camera parameters. And finally 3D Collada model file added into main project file.

2.2.1. Simple Algorithm for Web Bases AR

The document class is where all of the project's code is written. The following Figure demonstrates the algorithm simply. As it can be clearly seen, much of the work of FLAR and Papervision3D for the project is hidden within the imported libraries.

```
Start;
    1.  Import the Flash SDK, FLARToolkit, Papervision3D
    2.  Declare Class Properties (WebCam, Marker Detection, PaperVision3D)
    3.  Constructor ENTER_FRAME event built is the loop will be called
        repeatedly as long as the application is running.
    4.  Methods for class functions for setup and marker detection
End;
```

Figure 7. Algorithm for Web based Augmented Reality

All variables are declared within the Class Properties section. Most of this section is pretty standard, except the Pattern and Params property declaration which is showing the Flex Embed metatag as shown in Figure 8. Embed tag enables a property to be initialized with a value loaded from an external file. The bytes for the loaded file are baked into the SWFfile.

```
[Embed(source="./assets/FLAR/FLARPattern.pat",
     mimeType="application/octet-stream")]
     private var Pattern      : Class;

[Embed(source="./assets/FLAR/FLARCameraParameters.dat",
     mimeType="application/octet-stream")]
     private var Params : Class;
```

Figure 8. Coding for Flex Embed Meta Tag

Constructor section is function which runs when the class is created. The function's name must match the class name. In the following steps, set up code will be placed here. In this work, code is placed to set up the camera, FLARToolkit, Papervision3D and to prepare a repeating loop to handle marker detection as demonstrated in Figure 9.

```
public function AugmentedReality ()
               {
                       prepareWebCam();
                       prepareMarkerDetection();
                       preparePaperVision3D();
                       addEventListener(Event.ENTER_FRAME,
loopToDetectMarkerAndUpdate3D);
               }
```

Figure 9. Coding for Class Constructor Stage

Lastly papervision3D code library is used for handle the importing positioning, and rendering of the 3D model. FLARToolKit uses Papervision3D for 3D visualization. Here Colloada 3D model parameter is added as shown in Figure 10.

```
Private var COLLADA_3D_MODEL : String ="kaplumbaga.dae";
```

Figure 10. Setting 3D Model

Papervision3D is library written in ActionScript that allow developing 3D models in Flash. Papervision3D enables developers to create exciting and interactive 3D models. There are many options that can be created by using Papervision3D such as simple banners, games. Since it runs in Flash, you can easily place it on the web, or make it accessible as installable AR application [29].

3. Results and Analysis

The project is developed as online zoo which contains web based augmented reality for educational purpose. Before it starts users are advised to print out the graphic marker which provided in main page. Once users start the game, the application displays message which asks user to allow web camera to continue. After camera open, user shows the marker to the the webcam. Figure 7 demonstrates the result for first object model. The wide black square in marker is for determination to denote successful initial marker detection.

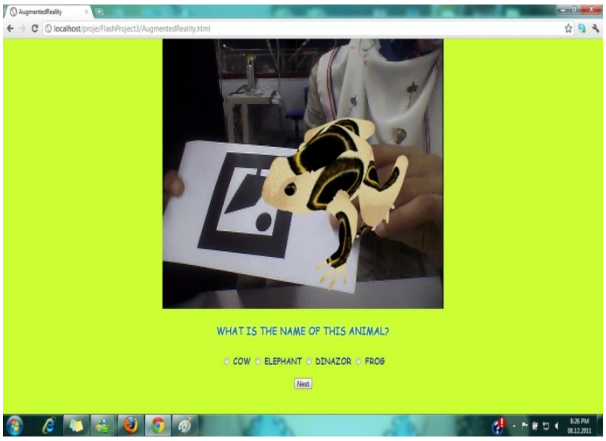

Figure 7. 3D Frog Model

The project can now read in the surrounding environment, visually scan and detect relevant objects. It works best to have a simple background of a solid wall in the application because complex scenes may confuse the detection scheme. The application superimposes the 3D model onto the user's physical space. The model now rotates and scales as the user moves the marker. The game will continue as long as user enters the right answer. If the user enters wrong answer, it will redirect to the same page to try again. There are eight different 3D models in this game.

3. System Testing and Analyze

Analyzing of the system started with trying on subjects. They are evaluated and measured by determining the advantages and disadvantages of using the system. The target population for this research was people lives in UTM Skudai, Malaysia. In this research, the sample would be total of 15 respondents. Using a set of questionnaires is the most prominent methods to gather the demanded information. A set of specifically customized questionnaire was developed to accommodate this research.

Section A is related to demographic information while Section B is related to level of user satisfaction. Section B questionnaire was designed for parents to investigate usage of web based augmented reality application is how useful for their children. Respondents were required to tick (√) the answer where it whether they strongly agree, agree, undecided, disagree or strongly disagree with each statement.

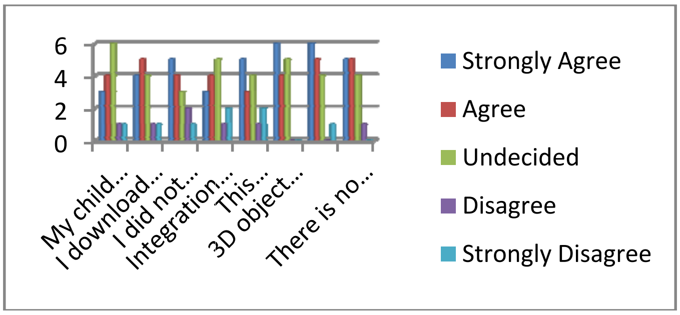

Figure 8. User Satisfaction

Based on moderate value of mean is 2.65 to 2.86 which mean total of respondents have moderate level of satisfaction as demonstrate Figure 8.

4. Conclusion

Based on the explanation on the methodology and implementation, the method is accomplished web based AR. We found out the most appropriative way to produce an educational augmented reality application for pre-school children. The project came up with a solution to teach children animals name with instructive and fancy way. There are several ways to improve the current application. It is problem that sometimes 3D object cannot display texture since the current application created does only static model of animal. Basically augmented reality web based application required specific library supports Papervision3D. Papervision3D requires 3D model in the Collada format only. To make more realistic 3D models, other rendering tools can be used such as VRay, LightUp, Shaderlight, IRender. In addition this project does not provide animated 3D model. For future work developers can model the 3D object with physical movement simulation of object.

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