A Web3D Authoring Tool for Augmented Reality Mobile Applications

Abstract

This paper presents a Web3D based authoring framework for designing and creating Augmented Reality (AR) applications for mobile devices without the need of plugins. The framework is accessible from a web authoring tool that allows the configuration of a 3D scene in the real world scenario. Without the needing of any particular knowledge on Augmented Reality, a 3D model can be easily placed in the scene using a reference image of the real world. All the information is stored into the cloud so it is immediately accessible by the mobile AR application. The proposed integration of Web3D in AR graphic user interfaces provides a powerful solution for covering the existing gap in plugin-free authoring tools.

CR Categories: I.3.8 [Computer Graphics]: Applications—; I.4.8 [Image Processing and Computer Vision]: Scene Analysis—Tracking

Keywords: web3d, augmented reality, authoring tool, texture tracking

1 Introduction

In recent years Augmented Reality applications have become very popular for mobile devices. The development of new and faster processors made possible to implement AR applications capable of real-time performace on smart phones. These new AR applications made great impact on mobile users. The key of this success is that AR mixes an attractive 3D animation appearance with a powerful informative complement to the real world, resulting on an easy to watch and an amazing interface.

At the beginning very simple fiducials where used for tracking and therefore applications were less attractive. Black and white squared markers looked intrusive in real world environments, so researchers focused on markerless tracking. The use of better techniques and algorithms made possible to track planar textures under cluttered environments, and even faces and other body parts. This derived in the creation of more useful and amazing applications for consumers. Anyway, creating an AR application has always been a difficult task, and a deep knowledge on the topic was required.

Authoring tools have been the common way to make the creation of applications easier, giving high level tools that allow users to avoid dealing with more complex programming issues, and let them focus on the creative part of the application. The advantage of authoring tools is that no specific knowledge on the technologies used is required. In the case of Augmented Reality this is a huge relief due to the advanced underlying algorithms. The main benefits of using an authoring tool are the saving of time and resources.

Some works have tried to develop Authoring Tools on this field, achieving good results and attractive user interfaces. Nevertheless, none of them succeeded in the creation of a plugin-free web interface for viewing the 3D content and designing the scene. Instead, all the proposed authoring tools are solutions that require the installation of software in the user's computer.

With the recent standardization of Web3D technologies a high quality and handy way of displaying and creating 3D scenes has born. With only a web browser and a graphic card it is possible to create complex 3D environments, and navigate in real-time through them. Also with the standardization of 3D formats like X3D or Collada many compatibility problems were solved. Plenty of shared 3D models can be downloaded from the web, which saves a lot of time and effort. Despite these interesting properties, to the best of our knowledge there are no references to any solution that combines an AR authoring tool with a Web3D plugin-free interface. In spite of this fact, Web3D technologies seem to be the ideal solution for a better user experience in designing AR scenes. They are standard, plugin-free and compatible with most browsers.

We propose an AR authoring framework that allows the easy creation of AR mobile applications with the help of a Web3D application to configure the virtual scene. The user can load the 3D objects and place them into the scene, using a representation of the real world as a reference. This reference can also be created with the authoring tool from an image with texture. This way the author can get a 3D vision of how the application will augment the real world when launched on the mobile device. Once the 3D scene is configured, it is stored into a database ready for being downloaded by the mobile application. An AR SDK implemented for the mobile device performs the tracking of the specified texture and renders the 3D scene according to the author's design. This way, Web3D technologies give a simple solution for a remote web authoring tool.

The remainder of this document explains the framework and its modules for creating AR markers, 3D scenes and mobile applications. Also the Web3D authoring tool prototype is thoroughly analyzed and the procedure for using it is described. Finally, last section summarizes the conclusions and introduces the main future improvements on the authoring tool.

2 Related Work

There have been many approaches to the problem of easy creating AR applications through the use of authoring tools. Some of them are targeted to developers and programmers, like the pioneer open-source library ARToolkit [Hirokazu 2002], which provides AR tracking based on very simple fiducials. A wide range of AR applications use ARToolkit library. The more recent Vuforia SDK [Vuforia 2011] provides an advanced library for tracking any texture marker, although it does not provide tools for creating the virtual environment. Metaio [Metaio 2006] is another AR engine that inserts almost any 3D content into the real world. It can perform tracking of images, objects and even environments. Although both are very robust and provide high quality results they demand deep knowledge on AR and programming from users.

As opposed to the mentioned libraries, other authoring tools try to hide the low level programming tasks from the graphic user interface. For example, Amire [Grimm et al. 2002] is a framework for mixed reality that attempted to set the basis for the new authoring methodologies. Its visual interface allows to quickly creating AR applications without requiring specific knowledge about programming. Other similar tools are ComposAR [Seichter et al. 2008], although it also adds a scripting interface, and the simple and open source ATOMIC [Atomic 2008] authoring tool. However, these approaches are too basic and not valid for complex applications.

Other authoring tools are focused on specific applications to make the final result more useful and attractive. For example, a progress in AR authoring tools was made by Ming-Jen Wang et al. [Wang et al. 2010] with a simple interface for examination applications that allows finger-based interaction and decision nodes. The user

interacts with the augmented scene by finger clicking yes or no. Also the work of Jesus Gimeno et al. [J. Gimeno 2010] introduces an interesting editor of the virtual content based on real world photos. The user places the virtual objects according to the photos and ARToolkit markers are automatically generated. The system can handle occlusions with the help of a kinect sensor. Although these solutions provide interesting visual interfaces and results, they still require the use of specific software and its installation, which limits the accessibility to the tool.

An interesting innovation on authoring interfaces was made by Liarokapis et al. [Liarokapis et al. 2004], adding the first version of Web3D technologies to their editor. They had an early vision of the potential power of these emerging technologies due to their web based operating nature. The proposed system uses a web based editor for the 3D content, and a viewer for the AR scene. Anyway their approach needed the use of plugins for embedding VRML into the web browser, and their system was designed for a limited tabletop environment.

Nowadays Web3D technologies have evolved, becoming standalone and allowing the editing of 3D content from a web, without depending on plugins. In order to fill this gap in AR authoring tools, our proposal takes advantage of Web3D to create a web authoring tool for designing the augmented scene. The scene can be configured using a view of the real world that shows how the AR application will work like. Finally we make use of our AR SDK to render the scene in mobile devices just like the author designed it. This solution provides a powerful tool with a real time rendering of the scene in Web3D, accessible from any browser without needing to install additional software.

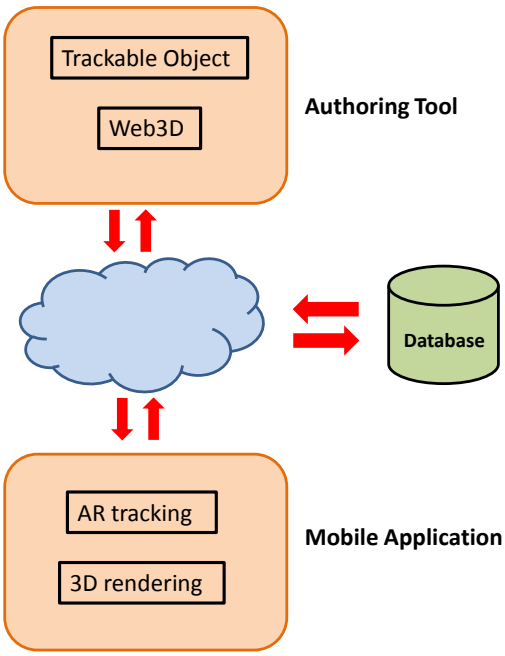

Figure 1: *Authoring Framework modules.*

3 AR Authoring Framework overview

The authoring framework consists of different modules that provide different functionalities to the whole system. The design of the modules is focused on making them independent and multiplatform. The main goal is to provide a 3D web authoring tool running "on the cloud" so the users can access remotely from a web browser. The most relevant modules are the server for the AR engine and remote data storage, the web authoring tool, and the mobile client application. In Figure 1 there is a schema that illustrates the modules and their functionalities.

The server stores all the trackable objects created, the 3D models, and the configured AR scenes. There is also an AR engine running on the server, accessible from the authoring tool to help in the creation of AR trackable objects. This engine detects natural feature points on an image using a pyramidal FAST [Rosten and Drummond 2005] algortihm, and extracts the descriptors of the features using FREAK [Alahi et al. 2012]. Those extracted feature points and descriptors are what we call a trackable object, as they are the tools that the mobile application will later use for real-time matching of the image.

The web authoring tool is a graphic user interface accessible through a web browser. On the one hand it shows the available trackable objects on the server. Those trackable objects are the representation of the real world and the reference for configuring the 3D scene. More trackable objects can be created by browsing images with texture from the user's computer. The authoring tool will make use of the remote AR engine to create the trackables and store them to the database. On the other hand there is a 3D viewer based on Web3D technologies for configuring the virtual scene. When clicking a trackable object the 3D viewer is activated and the user will see the trackable object in a 3D environment, representing the real world. The authoring tool can import 3D models and place them in relation to the real world. Once the 3D scene is configured it can be saved and stored.

Finally, the mobile client application runs in a tablet. It is a standalone application that uses an AR SDK and a 3D engine. This application connects to the server and asks for the required AR scene. Once the user selects which trackable object will be used, the application connects to the server, downloads the 3D scene associated to that trackable object, and starts the real-time tracking. If the object appears in the vision field of the camera the AR engine performs the detection of natural features and the matching of detected points. Then the position and orientation of the camera are extracted with a homography calculation. Finally, the 3D scene is rendered according to the previous design in the web authoring tool. In the next section the web authoring tool and the detailed creation of an AR application are explained.

4 Web3D Authoring Tool

As explained in the previous section, the main goal of the authoring tool is to create an AR mobile application. For this purpose there are two main steps: setting the information about the real world environment and creating the virtual scene.

The authoring tool provides a graphic interface (Figure 2) for creating trackable objects. A trackable object is a common way in AR to reference the real world.

For example, if we want to perform a 3D render over a particular wall we can use a frontal picture of the wall as a texture marker to build the 3D scene. The picture of the real wall is a representation of the AR environment where the scene will take place. Another way of referencing the environment is to place non-intrusive textures in the scene, like a picture on a table or a page of a book. The user can browse a picture from the computer and load it to server where

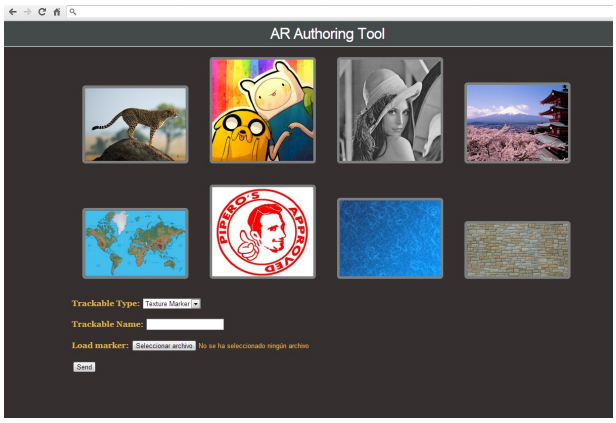

Figure 2: *User interface for creating trackable objects.*

the AR engine will create the trackable object. The next step is to select a particular texture marker to design the 3D scene.

The 3D editor (Figure 3) is based on a Web3D application that shows the current scene, a loader of 3D Collada models, and some sliders for moving the objects in the scene. The operation of the web is based on a HTML5 and CSS layout and a PHP + JavaScript main core that handles connections and Web3D features. The Web3D engine is purely written in JavaScript using WebGL as the rendering technology. As HTML, CSS, PHP and JavaScript are multiplatform they provide a general and easy solution for integrating Web3D with any browser that supports it. The PHP code handles the logic under the HTML interface, like loading objects and sending forms. By using Ajax sentences, the PHP can communicate with the Web3D JavaScript for modifying the scene.

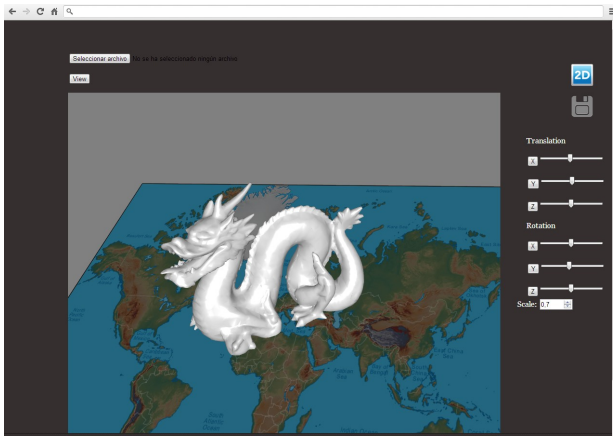

Figure 3: *3D Editor page.*

4.1 Implementation

First the trackable object selected by the user is downloaded from the server and passed to the Web3D engine, which renders it in the 3D editor window. When a Collada 3D model is selected in the interface, it is copied to the server and the URL is passed to the engine. The Web3D engine will load the scene again but this time with the 3D object placed in the center of the trackable object.

The user can control the position and orientation of the loaded virtual object with the sliders. As the trackable object is the representation of the real world scenario, it is easy to figure out how the 3D model will look like in the real world. When the object is placed at the desired position, the final transform matrix is stored in a database, as well as the relation marker-3DModel. Figure 4 illustrates the workflow.

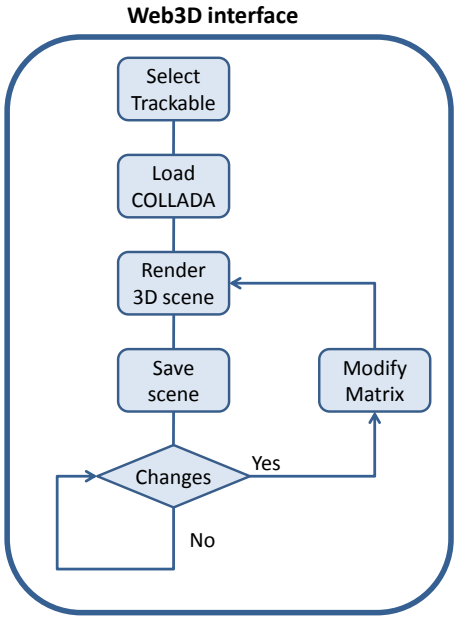

Figure 4: *Flowchart of Web3D editor procedure.*

At the end, in the remote server there is a trackable object and a 3D scene associated, ready for being displayed at the tablet application. The stored scene can be modified from the authoring tool at any time. Also the markers and 3D models created may be reused.

Figure 5 shows a picture of the tablet application rendering the 3D scene. In this example a physical map of the world is used as a texture marker. A simplified Collada model of the Stanford Dragon is loaded in the 3D editor. The dragon is placed in the desired position respect to the map. Finally the tablet application downloads the 3D scene and after detecting the map it renders the dragon as designed in the Web3D editor.

5 Conclusions and future work

We have presented a prototype for easy designing AR mobile applications through a Web3D graphic interface. Without installing any software in the computer, an user can browse the Authoring Tool and quickly create an AR application without the need of programming or having any AR skills. Immediately after the application is created, another remote user can launch it in a tablet.

The use of Web3D for authoring tools in AR provides a standard solution for graphic interfaces, compatible with web browsers that support Web3D, like Firefox and Chrome. This allows the use of this tool from any computer, and even from a tablet with WebGL compatible browsers.

Currently the prototype is very simple and only one collada scene can be loaded at a time. Also the actions for configuring the scene

Figure 5: *Picture of the tablet application rendering the designed 3D scene.*

are very limited, as only translation, rotation and scale operations are allowed.

In future versions of the prototype the authoring tool will incorporate controls for advanced positioning of 3D models, handling occlusions and virtual-real shadowing, with a SLAM module for 3D reconstruction of the environment. It will also incorporate a flowchart editor for defining logical sequences of actions and complex interactive augmented scenes. This way, it will be possible to create storytelling applications or augmented reality courses for e-learning, for example.

Another future improvement is to change the way of storing the scene configuration. Currently, the transformation matrix is being stored into a Mysql database and the mobile application performs a query for getting it. However a better way of storing the scene would be to save the changes made at the 3D editor into a unique Collada file.

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