VR Multiple Channel Authoring with Immersive Display

Mohamed Farouk, Mohamed Ismail, Karam Mustafa
Center for Documentation of Cultural and Natural Heritage (CULTNAT),
Bibliotheca Alexandrina,
Giza, Egypt

***Abstract*—The virtual reality and real time 3D technology in addition to many other display technologies are getting more and more into our life nowadays. The spread of smart portable devices is changing our style of life, day after day with very rapid advance in technology and capabilities. It is very common now to have VR application either for standalone U; desktop, Web, mobile apps, or even special immersive systems like cave, simulators etc. The usual practice especially for immersive display systems is that a separate application being developed for that specific platform. Accordingly, a lot of repeated work has to be done. In this paper we are going to illustrate our experience in the development of Virtual Reality applications, with the methodology of developing a single application for multiple platforms with slight modifications. Then a Unity 3D plug-in developed to convert any VR application developed using Unity 3D to our immersive display system Culturama, is presented.**

***Index Terms*—Virtual reality, 3D technology, real time 3D, immersive display**

I. Background

The Egyptian Center for Documentation of Cultural and Natural Heritage (CULTNAT) is one of the research centers of Bibliotheca Alexandrina. Its main mandate is to digitally document and disseminate - using latest technologies, the different aspect of Egyptian cultural and natural heritage. In 2003, CULTNAT developed its own display system Culturama, a huge immersive panoramic interactive display using regular equipment (Fig. 1). Culturama was patented in 2007. In 2010, CULTNAT developed the second generation of Culturama (Fig. 2) that is fully based on real time 3D graphics profiting from the advance of the GPUs, unlike the first version which is fully based on 2D graphics. [1]

Currently, the real time 3D applications are widely used on the internet and mobile devices. Each one of these output channels (desktop, internet, and mobile devices) has its own application development considerations. Many of current real time authoring tools and game engines has the feature of authoring the applications for Desktop, Internet or mobile devices.[2,3] In this paper we will add an immersive display systems having Culturama as an example

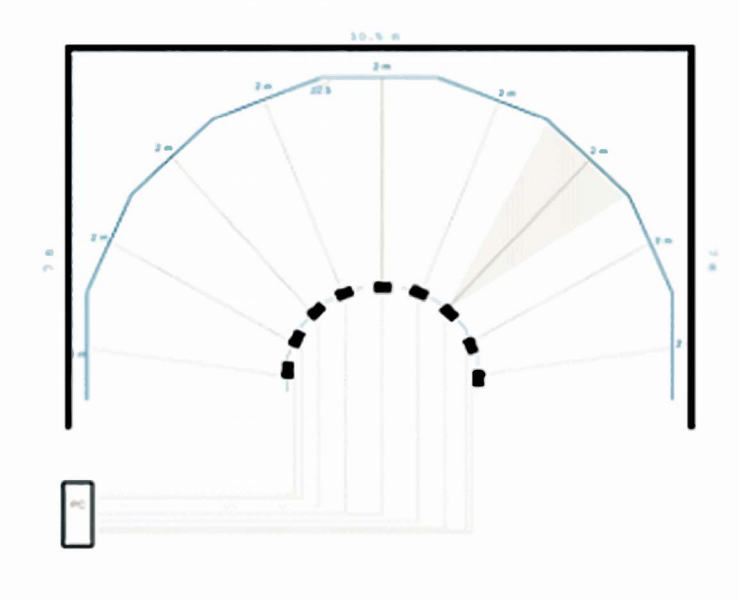

Fig. 1a. Culturama

Fig. 1b. Culturama

978-1-5090-0048-7/15/$31.00 ©2015 IEEE

II. CULTURAMA SECOND GENERATION

Since all of the regular authoring channels (desktop, internet, and mobile devices) are well known, explaining some characteristics of Culturama 2nd generation, Culturama II will follow. The screen is composed of 9 seem-less flat projection screens arranged in curved shape. The size of the projection screens and the curve angle are arbitrary to fit in all installation situations, as both versions of Culturama systems are designed to be portable fit to be displayed in certain events or exhibitions. It is worth mentioning that Culturama first generation was exhibited in more than 35 cities all around the world till now. The curved screen of Culturama II has exactly the same structure as the curved screen of the first generation. This enables the display of both versions at the same location. On the other hand, the hardware structure of the second generation is different. The projection of Culturama II is designed to have each three screens being projected upon using one full HD projector. Thus, the system uses three projectors to display the full panoramic display instead of nine of the first generation. A reverse distortion is being implemented by software to have a rectified final projection on the curved display. Another feature that is important to mention to better understand our solution in this paper is that, in the 3D engine the scene is being rendered using nine cameras arranged in a curve similar to the physical screens curve. This will provide a proper viewing angle for each screen.

Fig. 2. Culturama II

III. MULTIPLE AUTHORING CHANNELS FRAMEWORK

As we are dealing with 3D environment, the 3D assets are the main input to any VR application. Consequently, the work flow consideration and restrictions should start at the 3D model design and simplification level. In our case, we had Unity 3D as an authoring tool. We will refer from now on to the work using Unity 3D which was selected as it is one of the most commonly used tools nowadays specially in the domain of Cultural Heritage. Nevertheless, most of the work done using it can be implemented for other tools. [4,5]

The first step done was to develop a list of considerations and conditions to be fulfilled by the 3D models in order to develop a multi authoring channels application. The list was developed by studying already existing projects developed using Unity 3D and converting them to other channels and noting the changes that have to be performed. For example, having already developed desktop VR application and converting it to mobile device application. During this process we got some errors or low performance issues that had to be modified either on the 3D model level (either mesh or texture) or in other times at the application level. Another aspect of difference is related to plugins and shaders used, as not all of them supports or function well with all channels. This conversion experiment has been performed using many applications from and to different channels. At the end of these extensive experiments, we came up with a full list or guide for the developers including all issues that can be faced later at the authoring stage for different channels. The final step was the validation of this guide by using it to develop two applications from scratch and authoring them to each of the four channels.

IV. CONVERSION TO AN IMMERSIVE DISPLAY

One of our main authoring channels is Culturama second generation, as in the first version, we had the problem of a special development for Culturama. So, we developed a special plug-in for Unity 3D in order to facilitate the conversation process of any Unity 3D application to work on Culturama immersive system. This work has been done within the framework of V-musT "Virtual Museum Transnational Network project. [6] The plug-in is designed to make the conversion process almost automatic. The plug-in has three main sections:

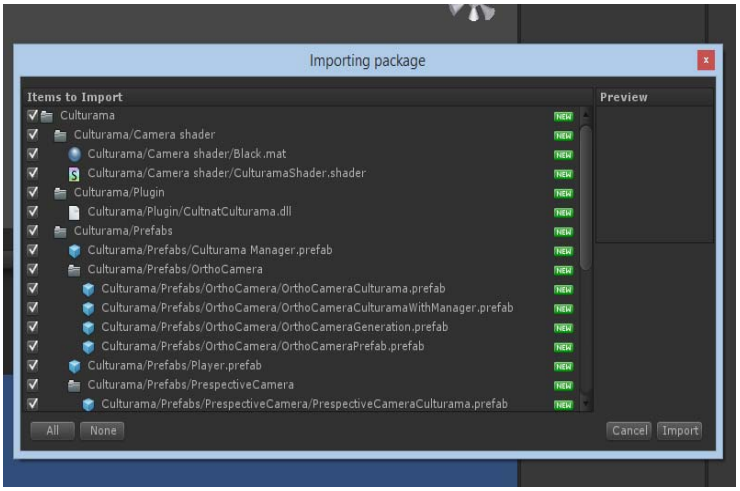

Fig. 3 Culturama plug-in

V. A. CAMERA SECTION

This to add to any project, the panoramic camera composed of nine Unity cameras to be compatible with the projection screens physical setup. Setting all necessary camera properties, angles of the curve, field of view, LOD,

etc. In addition to making available all functions needed for the cameras. (Fig.4)

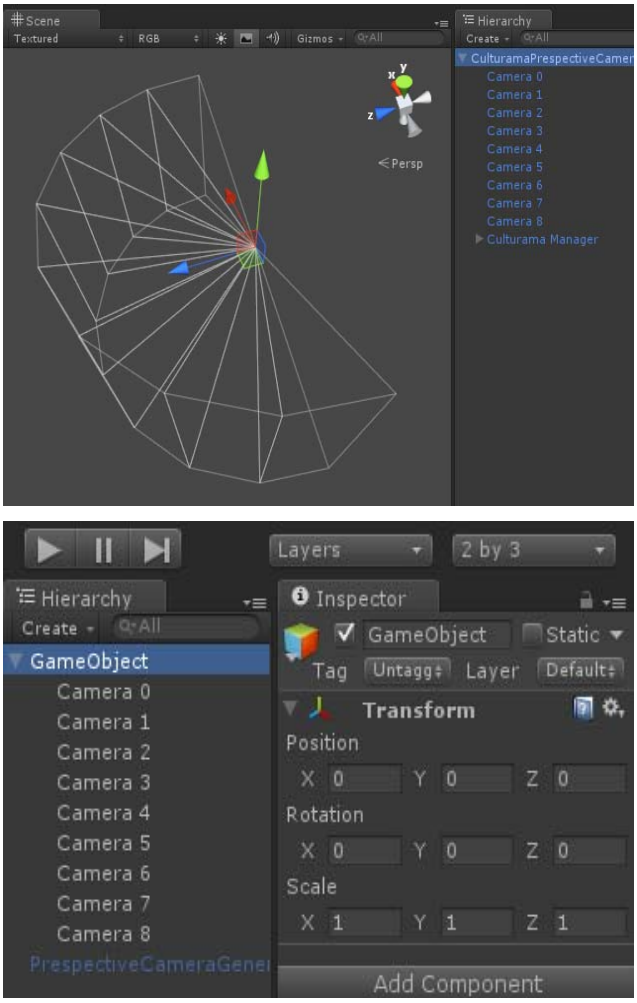

Fig. 4. Camera creation and settings

VI. B. NAVIGATION AND INTERACTIVITY

This section is concerned firstly with the conversion of the interactivity behavior of objects in the scene. One of the challenges faced at this conversion is mouse interactivity and how to determine which object the mouse ray hits. Regular applications are using one camera; thus the mouse ray is always calculated relative to the sole scene camera. In our case, there are nine cameras in the scene. To overcome this issue, two steps through the plugin are needed. The first is to remap the cursor over the nine cameras to have continuous mouse over the entire panoramic screen. So the plugin translates the global mouse pointer position provided by the operating system to local coordinates relative to each camera. The local camera coordinates are then used to render the mouse pointer in the correct location, and also to determine the clicked object when the mouse is clicked. This is done by mapping the mouse ray to camera including the cursor, then using the local camera coordinates.

Secondly, the developer selects the objects in the scene that have mouse interaction scripts. The plugin will then propagate this codes and list of objects to be active in the nine cameras.

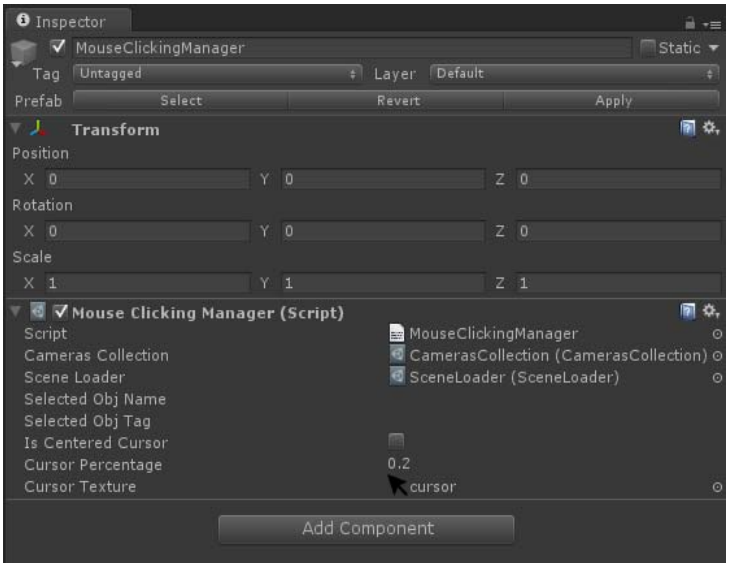

Fig. 5. House pointer settings.

C. DISPLAY CUSTOMIZATION AND ADJUSTMENT

This section enables the developer to adjust the reverse distortion to have a well rectified final projection. This function has two stages of adjustment. The first is the development level, in which the developer sets the size of the nine physical projection screens, the angle between them and the position of the three projectors relative to the screens. The second stage is at the runtime to fine-tune the projection and reverse distortion in the real time. At this stage the plug-in enables the control of each of the nine screens each on its own. For each of the nine screens, we can separately fine tune each corner position, each screen width, angle of each camera, etc. Therefore, any imperfections of the physical screen setup can be adjusted and rectified. This step is extremely important as any small mismatch in the viewing angles between the physical screens and camera position and angle will result in unrealistic view of the environment, especially with movement of the camera. This can result in an inconvenient user experience with the system. In addition, this display customization methodology enables us to display on the large variety of screen shapes. As long as we build the screen using adjacent flat segments.

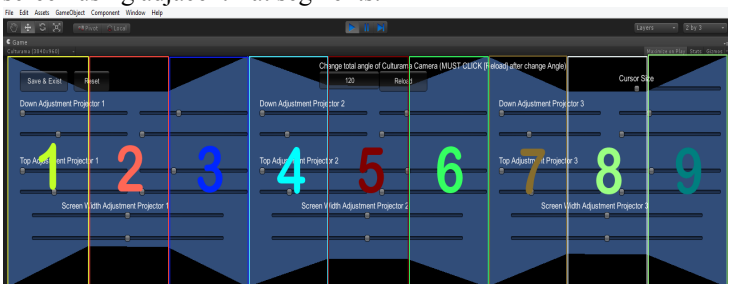

Fig. 6. Display customized adjustment.

VII. CONCLUSION AND FUTURE WORK

To conclude, we presented in this paper concept and requirements for Multiple Channel VR Development where you can develop once and deliver the application to different devices. We compiled a guide for developing it starting from the 3D modeling level. Finally, the proof of concept on two applications that worked fine on desktop, Web, mobile devices and the Culturama immersive system was presented. All work done Using Unity 3D.

Our future work will be concentrated on extending the VR Multiple channel authoring to also include immersive displays using any screen shape. The current the work presented here is focused on screens composed of adjacent flat segments. A projection on any organic shape for example planetarium dome is our next step. In addition, as we have new display technologies and devices being introduced in the market frequently, these technologies will also be examined to include them in our list of authoring channels.

REFERENCES

http://[1] F. Saleh, M. Farouk, "Cultural Interactive Panorama (CULTURAMA," ICHIM 2004, September 2004, in press.

[2] Lavin-Mera, P., Torrente, J., Moreno-Ger, P., Vallejo-Pinto, J. & Fernández-Manjón, B. (2009). Mobile Game Development for Multiple Devices in Education. International Journal of Emerging Technologies in Learning (iJET), 4(2009), 19-26. Kassel, Germany: International Association of Online Engineering.

[3] Koutsoudis, A. (2012). Bringing cultural heritage 3D content to the web using the X3DOM framework.

[4] AGUGIARO, G., REMONDINO, F., GIRARDI, G., von SCHWERIN, J., RICHARDS-RISSETTO, H., & DE AMICIS, R. (2011). QUERYARCH3D: QUERYING AND VISUALISING 3D MODELS OF A MAYA ARCHAEOLOGICAL SITE IN A WEB-BASED INTERFACE. Geoinformatics FCE CTU Journal, 6, 10-17.

[5] Unity3D, http://unity3d.com (last access 1-3-2015).

[6] http://v-must.net (last access 5-5-2015).