Virtual Artifact: Enhancing Museum Exhibit using 3D Virtual Reality

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***Abstract*— The museum is a place to learn the progress of human civilization. Various relics of history can are there to be studied. However, some objects cannot directly have explored. This is due to the fragility of these objects. Virtual Reality 3D technology enables the presentation in virtual form and can revive these objects in virtual space. We succeeded in developing a 3D visualization using virtual environment that has several objects of cultural heritage collections. Compiled in to a mobile application, it consists of relics collections from the late Majapahit kingdom, presented in the virtual form. The collections provided by Mpu Tantular museum in Sidoarjo East ava Indonesia. The museum visitors can navigate and explore the virtual environment having heritage objects. The presentation setup by mimicking the movement floating across the virtual environment. The ability to see in all directions is possible to give freedom of observation process. The Virtual Artifact application available in google apps and installed into a smartphone equipped with a built-in gyroscope and head-mounted display goggles.**

Keywords—Virtual Artifact; Museum Exhibit; 3D Visualization; Google Apps; IoT

I. INTRODUCTION

Museum exhibit is an event where most citizen from various background came with their specifics purposes. There can be common visitors, students from elementary to high school and researcher. A new atmosphere for elementary students available to them by attending the exhibit. It can widen their point of view of cultural heritage. A sightseeing for common visitors such as tourist, and for the researchers, they tend to dig more information from the exhibit. However, human need an immersive way to learn new things from the past. A sightseeing is not enough. An interaction with objects can give unforgettable experiences. Therefor many efforts to enhance museum exhibit has done. One from many technologies to fulfill this is 3D Virtual Reality. Nowadays, it is one satisfactory solution. This can give virtual access to fragile objects of cultural heritage ancient collections(CHAC). Some earlier research managed to reconstruct the CHAC to a 3D virtual objects[1]–[3]. They were using many algorithms to recreate the objects from 2D photos into a 3D virtual objects. Those objects cannot stand alone in an empty space of virtual environment for the visitors to see. It needs some supporting story. Several researches conducted to managed to support a story for their CHAC[4]–[8]. However, in seems like an ordinary film. How about placing the visitors inside the virtual environment? A challenge questions. The recent technology supporting it. Varies from virtual and augmented reality. A virtual environment can be setup in a stereoscopic view. It gives the visitors illusion of being in the real place instead of visiting an exhibit[9], [10]. There are several kinds of application which managed to support the exhibit i.e. a sightseeing in the national park of 10th November Hero Monument in Surabaya Indonesia[11], packing an introduction of traditional stories to the younger generation using mobile application[4], an interactive digital city was also built to enhance museum exhibit[12], [13]. Another research product is a 3D environment which resembles the actual site for virtual visit. Our contribution is a combination of various research. We used the pre-reconstructed 3D virtual objects and place it in a virtual environment. Those objects setup on a specific site mimicking its original nature. The combination then compiled into a stereoscopic visualization. It will give a sense of onsite presence for the viewer. The application already published on google-play, so everyone can use it freely. This paper will discuss on how the development of this application. It will be start from the preparation of pre-reconstructed 3D virtual objects, the design of the virtual environment, objects placement, camera movements, speed of the sightseeing movements.

II. RELATED RESEARCH

A. 3D Object Reconstruction

The process of reconstructing an artifact in a new 3D Virtual form has done for years. Several techniques such as image sequencing[14], another algorithm using volume based method to reconstructed an object in 3D model[15]. An affordable technique to recreate an object in 3D virtual form also developed using an algorithm called structured form motion[16].

B. 3D Virtual Environment Develompent

After several 3D virtual objects ready from the reconstruction process, the next stage is creating the virtual environment. Some studies managed to create a small size of real environment to a small one. It needs a meticulous details to developing the miniature environment[17]. Another simpler study creates only a 2D environment using a 360-degree

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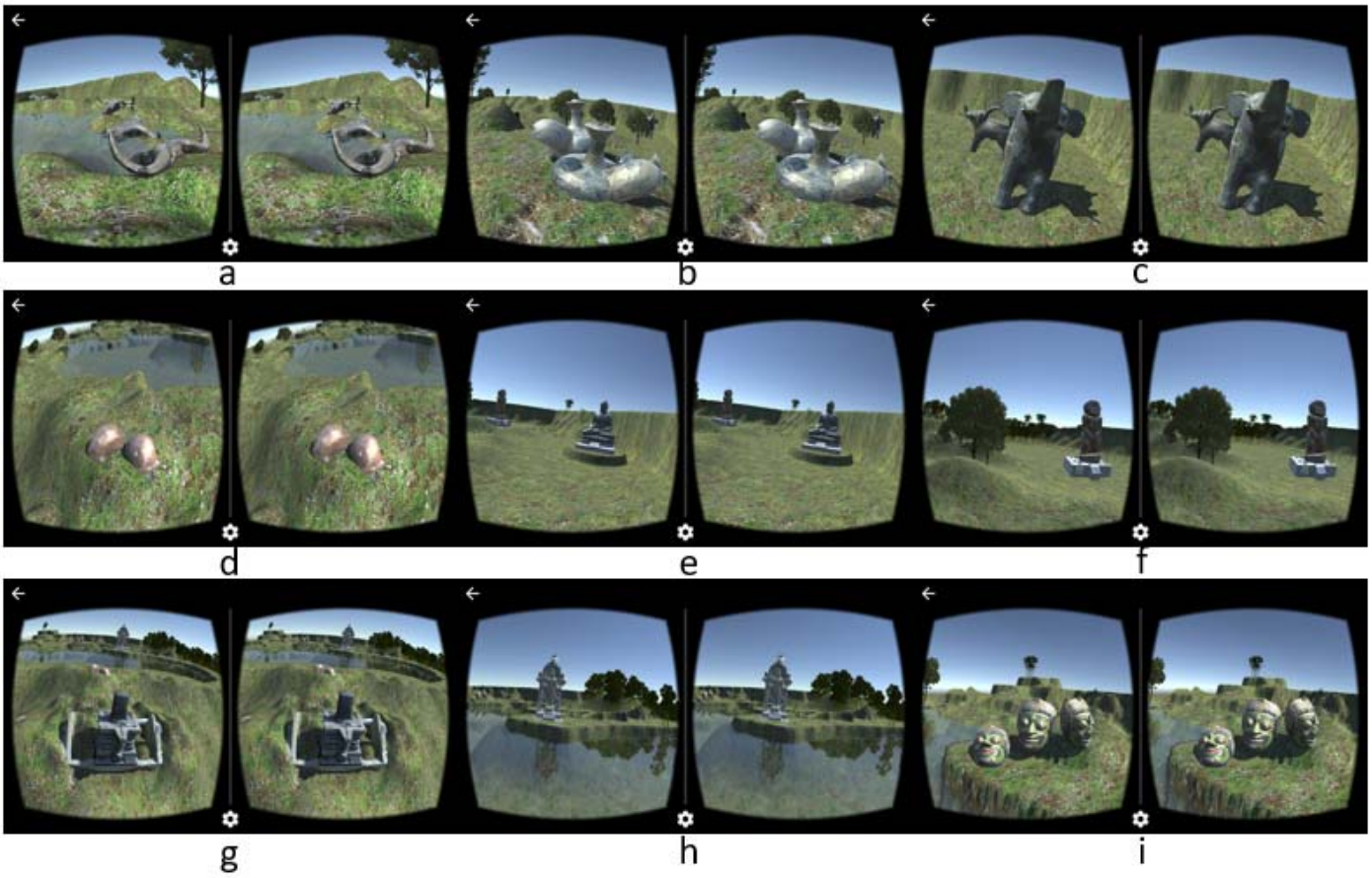

Fig. 1. Object placement in virtual environment.

panoramic view. However, it is enough for specific users and it is a relatively low cost[11].

C. 3D Stereoscopic Viewers Movement.

This movement must be specifically setup. It related with the comfortable of the viewers. Some research shows that wrong setups can trigger dizziness and vomit because of unbalanced coordination between the eyes and the brain[18]. The detail of these preparation need to pay attention on several things called parallax view. When user sees an object far behind the screen, then this situation called positive parallax. It shows no effect of stereo. When user sees object in front of the screen, then this situation called negative parallax. In this situation there will be a sense of depth between the object viewed and the environment supporting it[19]. However, this situation should not occur in an extended period. The longer the period of negative parallax, the dizzier the user felt.

III. Developing The Application

The development of this application to support an exhibition. We try to give an impression for the visitor to fill that they are inside an environment and can travel along within it. Therefore, the development process consists of three parts.

A. Virtual Artifact Selections

Several artifacts have selected to reconstruct in a 3D virtual form. The artifacts be the era of civilization. The first is a fossil of water buffalo. The second is a milk ceramic. The third is bronze statue of elephant. The fourth is a fossil of pithecanthropus erectus skull or best known as java man. The fifth is a stone statue of Buddha. The sixth is a stone statue of primitive figure. The seventh is a Linggageni statue (fertility symbol). The eighth is Bathara Surya and the last is Javanese mask. All of these artifacts are collection of Mpu Tantular Museum in Sidoarjo East Java Indonesia. All is shown in Fig.1 sequentially labeled.

B. Virtual Environment Development

In supporting these 3D virtual artifacts, an environment should mimic the original location. It is not to be precise, but nearly resemble the original location can bring visitors to immerse in the situation. As it seen in Fig.1 The environment consists of open landscape, trees, lake, shrub, hills, and rocks. Those selected 3D virtual artifacts will have scattered inside the virtual environment.

C. Movements Setup

There are seven artifacts placed inside the virtual environment. Therefore, it needs a path which will be a route for a stereoscopic camera resembling visitor's eyes to move.

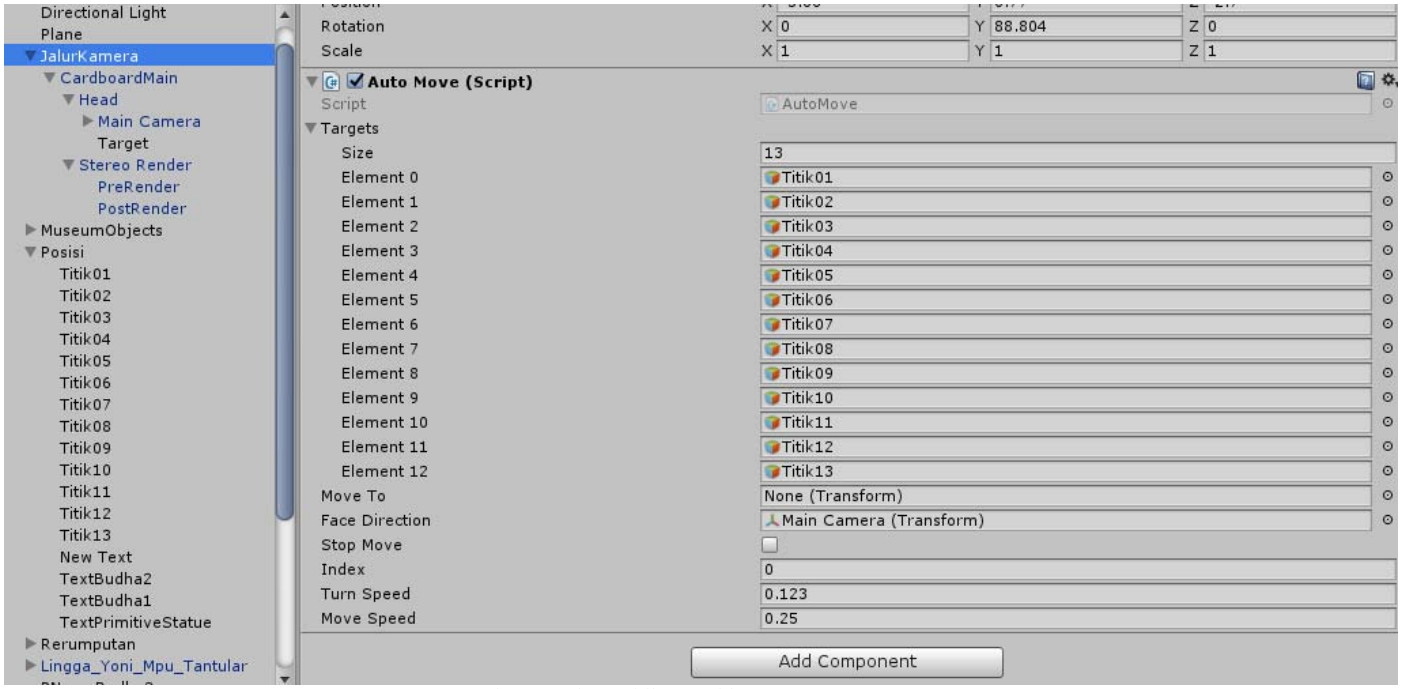

Fig. 2. Points (Titik) to guide camera movements.

to avoid camera sharp turn, each point need two added points. These points place before and after an artifact.

D. Camera Movements Programming

We were using Unity3D to setup the objects inside the virtual environment and C# to write the script. The main script consists of an AutoMove class supported by System.Collection.Generic, EventSystem from UnityEngine libraries. There are six global variables namely: List<GameObject> targets, moveTo, faceDirection, StopMove, index, turnSpeed and moveSpeed.

The program begins with a private function start with void parameter. It consists of two command that give target[0].transform value to moveTo variable and false to StopMove variable. The second void function is Update. It consists of two conditional statement. The first one is for controlling the camera movement from point to point. The second conditional statement is for maintaining the camera in continuously move along the predefined path. Several scripts can be seen in Fig.4.

IV. Results and Discussion

The finalization process is installation. This application need a cellular phone with Android Operating System. The android least Version is 4.4. "Kit kat" and a gyroscope sensor within it. Pan movement to any direction controlled by the gyroscope sensor. It will give an immersive experience to the viewer when traveling along the predefined path. There are several smartphone screen sizes which is suitable for the application. It is ranging from 4.5-inch to 5.5-inch screen diagonal. There is another equipment need to go with the smartphone and this application, it is the head-mounted display which gives a 3D stereoscopic sight to the viewer.

Using a 3D stereoscopic application with a head-mounted display, suggesting the user to sit down. For some unexperienced user, a sudden virtual movement within the application can cause an unbalanced feeling. That is why the user should be in sit down position. To prevent dizziness, the camera movement from predefined points set to the number of 0.25 and the turn speed to 0.123 as seen in Fig. 2. These numbers have pass several tests by from the newbie users. The higher speed can also cause dizziness to the user.

A complete immersive experience will have got the feeling when a natural sound is adding in it[20]. That is why we add sound of chirping bird as a background. The original size of the application is about 26 megabytes. It expands to 56 megabytes after the sound addition. For some user it is using too much spaces in their smartphone. However, for the recent smartphone which has larger spaces of read only memory, it is not a big problem. The added sound gives different impression compare to soundless application.

Publishing the application to the google play store need another meticulous works. First it should have announced as free apps without monetization. It is important to gain more users. Prevent the application to access user phone number because it is trespass the users privilege. Lastly, follow all google guidance.

This application is using key word *Virtual Artifact*. It will appear on the list of available apps on user's smartphone if it consists gyroscope sensor within it. The installation takes less then one minutes. Smartphone with acceleration sensor can also install this application. However, it is a try and error to run it without gyroscope.

In the museum exhibit, a sign placed near the selected object to tell the visitors that they can use this application. The exhibit committee gives free WIFI for the visitors, so they can

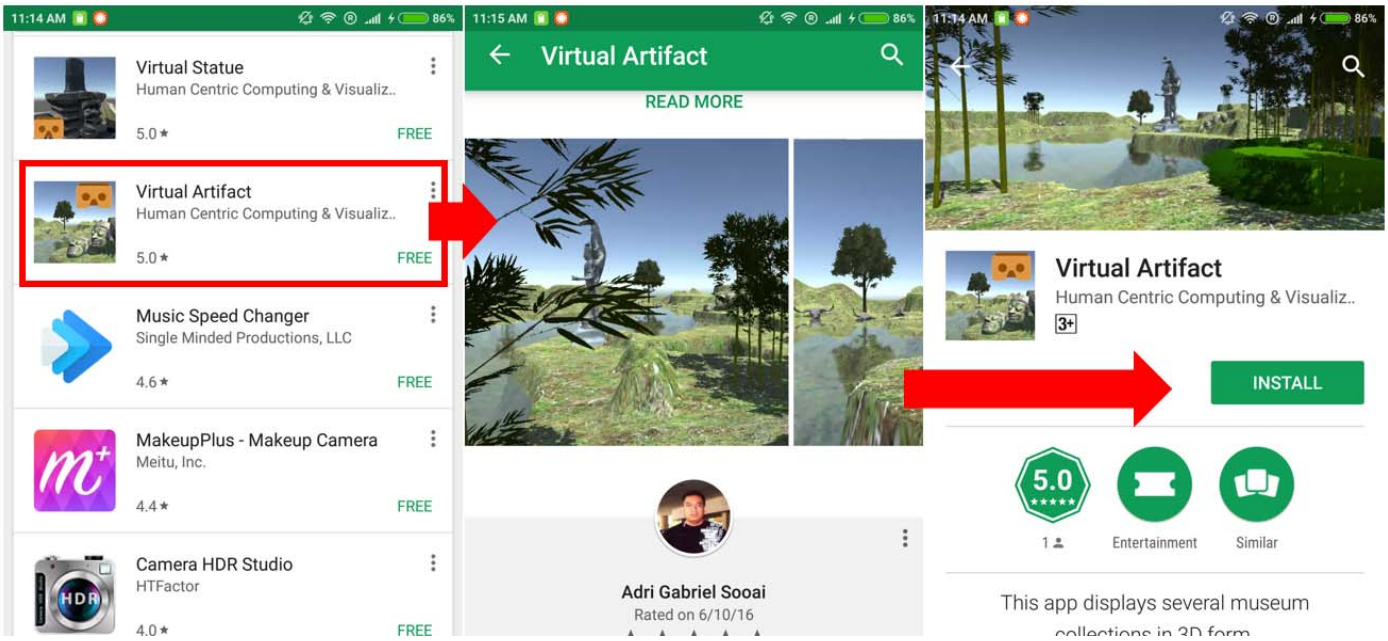

Fig. 3. Application is available on google play

try to explore the realm of 3D Virtual Cultural Heritage Ancient Collection using their smart phone. Several pairs of head-mounted display are available for the visitors to use it with their smartphone.

CONCLUSION

Supporting museum exhibit can be fulfill by kinds of innovation. This study tries to bring recent technology that can be setup fast and affordable. The preparation starts from selecting which object is suitable to support the exhibit. Usually a fragile object is better to explored virtually. That will prevent the real artifact from damage. An environment for background supporting is also important to give nuance to the virtual object. It can have placed orderly by time of the ages. Another important thing for user to have immersive experience is the camera movement within the application. Several key factors must have arranged for the shake of the users: the camera speed for moving and turn. It needs to setup precisely based on user experiences. Recommended to use this application is sit down on chair. This is to avoid unbalance in the brain when the stereo camera inside the application starts to move. Lastly is the accompanying background sound. Besides bird chirping, there are other sound such as wind blow or flow of water streaming the creek which can increase the virtual reality environment reach its goals. However, this is a 3D stereoscopic visualization application, it is not complete without head-mounted display. This is only a sample whether museum exhibit can have enhanced with recent technology. It gives the opportunity for the visitors to feel the realm of ancientness in a virtual world. For young generation it gives a joyful in learning new thigs from the museum exhibit. College student and researcher can use this application to gain more information from an object which is virtual artifact, exploring it without damaging the real object. This application is free, and it is available in google play as it seen in Fig. 3.

Further works are open for kinds of modification and improvements. There are two ways that can be achieved by enriching this application. First, from the software side: we are preparing a couple of improvements to add, i.e. moving control for the user to stop at any time anywhere in the virtual environment and gamification to grow new curiosity for the users in the exploration. Second, from the hardware side, using a near field communication which can bond the real artifact with the virtual one inside the application. This bond can trigger kinds of gamification to raise curiosity to the user for more exploration.

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