RECONSTRUCTING MAJAPAHIT KINGDOM IN VIRTUAL REALITY

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Abstract: In the last decade the development of technology led us to the era of virtual reality. Virtual reality is a computer-based technology that provides a realistic experience, interactive, or a sense of an object. Virtual reality has the ability to describe the functionality of the object thoroughly, describing the environment, enabling user to immerse and involve in the environment without physical process and and placing it at the center of user experience. The ability of virtual reality in representing environment can be used in reconstructing the Majapahit kingdom in 13-15 century AD. As one of the great kingdom, Majapahit civilization is still slightly exposed, compared to some other world civilizations. Method used in this research is histeriographic where Majapahit written literature and artifacts can be used as reference. This study is aimed to produce a Virtual Reality (VR) application which can be used as a media to reintroduce the Majapahit Kingdom to the public. Outcomes of this study is a prototype that displays simulated visual reality of Majapahit kingdom.

Keywords : *Virtual reality, Heritage, Majapahit*

1. INTRODUCTION

The development of technology enables a new interaction between humans through an object. Virtual reality (VR) is technology that allows users to interact with an environment simulated by computer (computer-simulated environment), a technology that emulated environment based on imagination. Virtual reality has capability in forming a virtual world that provides immersion to users.

Reconstructing of Majapahit history in this study is aimed to show the greatness of Indonesian history. Through technology offered by Virtual Reality, we intend to re-construct the kingdom of Majapahit through virtual reality as a media of education as well as media for recreation, and also as a sample of the cultural computing application. As a great kingdom, there are lots of physical heritage have been damaged by various factors. Some historians give interpretation based on the literature such as *Negara Kertagama,* some temple reliefs and other Majapahit artifacts.

The focus of research is concentrated in the area Trowulan-Mojokerto which lead exposure of Majapahit civilization. Majapahit as a bridge between Indonesia classical civilization and modern civilization, become an important era that needs to be explored further.

2. THEORETICAL BACKGROUND

2.1 Virtual Reality

Cultural computing uses various methods so that users could interact and experience these cultures through modern computing applications (Edirisinghe et al. 2011). One of cultural computing application which is popular in the last couple years is the using of virtual reality in representing the history. Virtual reality defined as human–computer environments in which users are immersed in, and able to perceive, act, and interact with a 3D world (Bowman et al. 2002; Milgram and Kishino 1994). Virtual Reality will provide new means to create and transform culture, and provide

us with the possibility of immersion within multimodal interactions (audio, video and haptics) to enhance user presence in digitalised culture (Haydar et al. 2011).

Virtual reality becomes affordable media for a broad audience, along with the development of Head Mounted Display hardware which more easily obtained. In the last 5 years some manufacturers released some HMD tools technology such as *Nintendo VR, Oculus Rift, HTC Vive, Playstation VR, One Plus* dan *Google Cardboad*. (Ruddle et al. 1999) found that the ability to look around with HMD allowed users to be less static in the environment, as they do not have to stop travelling, and the ability to ''look around'' add more immersion. The effectivity of Virtual Reality open opportunities to use virtual reality in various fields, including archeology.

One example of Virtual Reality in archeology is the display of ancient Greece for the broad public by the Foundation of the Hellenic World in a museum. It has received an enthusiastic welcome (Gaitatzes et al. 2001); In this case, Virtual Reality was only a tool to display historical object visualization. However, (Barcelo´ 2000) stressed that virtual reality in the archaeology field should not be used only as a visualisation tool but also as a way to manipulate the archaeological interpretation. Through Virtual Reality, we can presents complex simulation including cultural environment and all of its elements such as architecture and also the social life of the society.

2.2 Majapahit Kingdom

Majapahit kingdom is the great kingdoms existed in 1293-1500 AD. Majapahit is an agricultural country which rely on the ability to trade and region expansion to support the economy. Majapahit reached its peak of glory during the reign of Hayam Wuruk, with the famous *mahapatih* Gajah Mada (Ricklefs, 1991: 19). Majapahit conquered areas including Sumatra, the Malay Peninsula, Kalimantan, Sulawesi and parts of the Philippines which made the Majapahit as one of the great kingdom whose existence is widely known.

The capital of Majapahit experienced switching locations several times, but the most famous is Trowulan (Resink, 1968: 21). Trowulan located about 60 kilometers of west Surabaya, a former center of the Majapahit kingdom. Various ancient building that resembles a temple, a bathhouse or the royal family and the scattering of the stone archway Majapahit legacy can be found in Trowulan. Majapahit artifacts can be seen in the collection of ancient objects in the archaeological Trowulan museum temples. Trowulan surrounded by temples such as *Lawang* temple, *Tikus* temple, *Tawon* temple, *Gentong* temple, *Berahu* temple and *Menakjinggo Sitinggil* temple. Also in other ancient buildings such as *Bajang Ratu* and Princess Tomb *Campayang*. The main sources used by historians to write a history of Majapahit is *Pararaton* ('Book of Kings') which written in the *Kawi* language and *Nagarakretagama* which is written in old *Javanese* (Johns, 1964: 91).

The cause of Majapahit fall believed because Majapahit loss of major figures such as Hayam Wuruk and Gajah Mada. In addition, the outbreak of war Paragreg year 1401-1406 which is the civil war for control subordinate area has an impact setback for the kingdom of Majapahit (Ricklefs, 1991: 18).

3. THE RESEARCH METHOD

To build a virtual landscape with high accuracy to deliver a realistic representation of Majapahit Kingdom, we adopt classical archaeological methods which called historiography (Gottschalk, 1986: 32). Historiography is an imaginative reconstruction of the past, according to data obtained by taking the test and critically analyze the records and relics of the past (Gottschalk, 1986: 39). In historiography, literature about the kingdom of Majapahit and physical evidence in form of visual documentation interpreted and translated into a concept design of the Majapahit kingdom community life simulation through virtual reality technology.

Through this method, the main source used to visualize Majapahit Kingdom is Javanese text *(Pararaton dan NegaraKertagama),* consulting a wide variety of cartographic sources and

interpreting what remains in the present-day Trowulan landscape sites. Javanese text which is used are *kitab Negara Kertagama pupuh VIII* until *pupuh XII* which describe some geographic condition and physical environment which is explained in verbal forms. Furthermore, the field data in the form of reliefs which is attached to the temples like *Tegowangi* temple, *Penataran* temple, and some of collections relief from *Trowulan* museum. To obtain a suitable 3D dataset of an area of Trowulan (Majapahit Capital), we can use GPS technology satellite positioning system, GIS (Geographical Information Systems) software and Google Earth. From the data obtained several architectural visualization Majapahit kingdom.

4. RESULT AND DISCUSSION

4.1 VR Environment

In developing the Majapahit Kingdom using Virtual Reality, the output of the research is the Panoramic 360 Video. To produce the output we need a virtual environment derived from field data related to the Majapahit kingdom. The virtual environment was created using Autodesk 3ds Max, which composed of several three dimensional models as follows.

Figure 2 Majapahit house in museum Trowulan

Figure 3 developing computer generated imagery of Majapahit traditional house
Source: Personal documentation

a. Traditional House Building
   The form of the Majapahit traditional houses can be found in the museum Trowulan, on the replica of the house foundation is made of bricks, tiles and roofs made of clay, while the structure of the walls of houses made of wood and bamboo.

b. Form of gate and fence
From the relief of candi Penataran, Candi Tegowangi, and from the explanation in *Negarakertagama,* the form of the gate can be visualized as follows:

Figure 4 gates based on candi Penataran relief
Source: Tribinuka, 2010

Figure 5 development of computer generated imagery of Majaphit gates
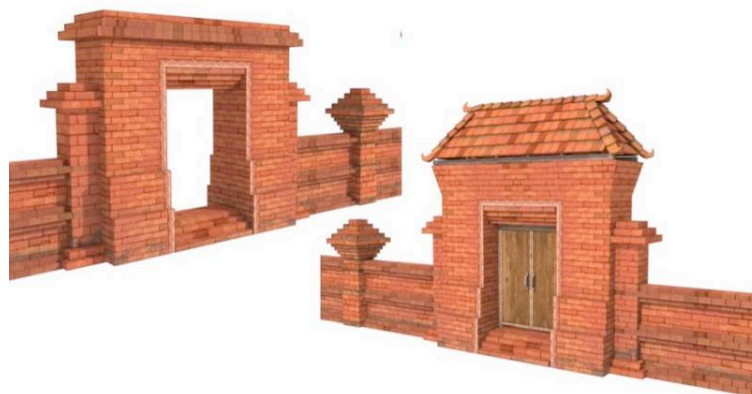Source: Personal documentation

Figure 6 development of computer generated imagery of Majaphit gates and fence
Source: Personal documentation

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c.   The form of Bajang Ratu Temple / Gate

The Bajang Ratu gate or also known as Bajang Ratu Temple is a Majapahit artifact located in Temon Village, Trowulan sub-district, Mojokerto regency, East Java-Indonesia. The form of this gate is a gate building called "*paduraksa*"

Figure 7 Candi Bajang Ratu
Source: Personal documentation

Figure 8 developing computer generated imagery of Candi Bajang Ratu
Source: Personal documentation

d.   Map dan Model Positioning

Based on *GPS satellite positioning system*, GIS (*Geographical Information Systems*) software, *Google Earth* and from the literature study concluded that the outline of Trowulan map as Majapahit capital visualized as follows:

Figure 9 geographic structure of Trowulan Sites
(Source: Memories of Majapahit, 1993 :43)

Furthermore, based on the book of *Negarakertagama* chapter VIII to XII described some of the geographical and environmental conditions of the Majapahit kingdom. Description on the chapter written can be simply visualized as follows:
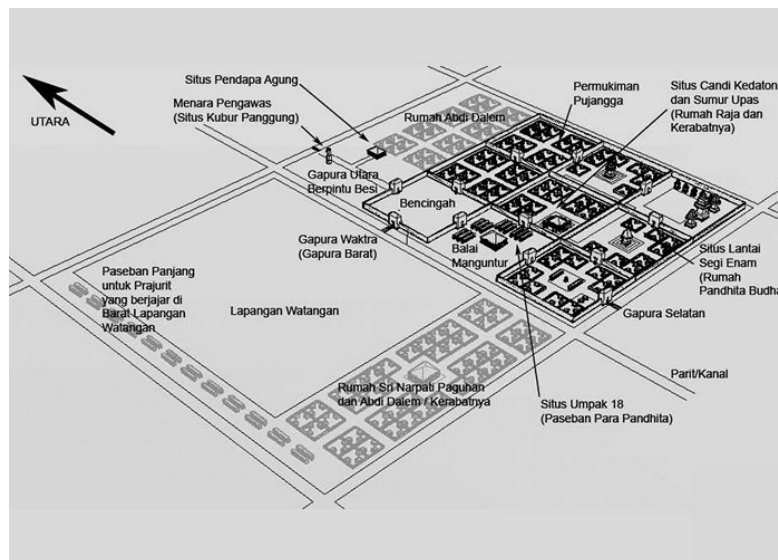

Figure 10 CGI of Majapahit environment structure

4.2 VR in the Form of Panoramic 360 Video
In case of capturing static 2D panoramas, this condition is usually achieved by rotating a single camera at a tripod with a revolving camera head. For video, however, this approach is impractical due to the need of using multiple cameras on one hand and the physical dimensions of each camera on other hand. Solution used in this research by using *VRAY Camera* with focal point arrangement 360 degree. The rendering process will be produced a panoramic video, which can be further displayed by applications (such as VR Video Player, Youtube Cardboard etc) through the medium of HMD. To display the Majapahit kingdom in virtual form, camera is moved through a certain path that moves around the virtual environment. By setting the path that passes through the

important parts of Majapahit kingdom, we can generated panoramic video with a duration of 2 minutes and the user will get the impression imersive walk around the kingdom of Majapahit.
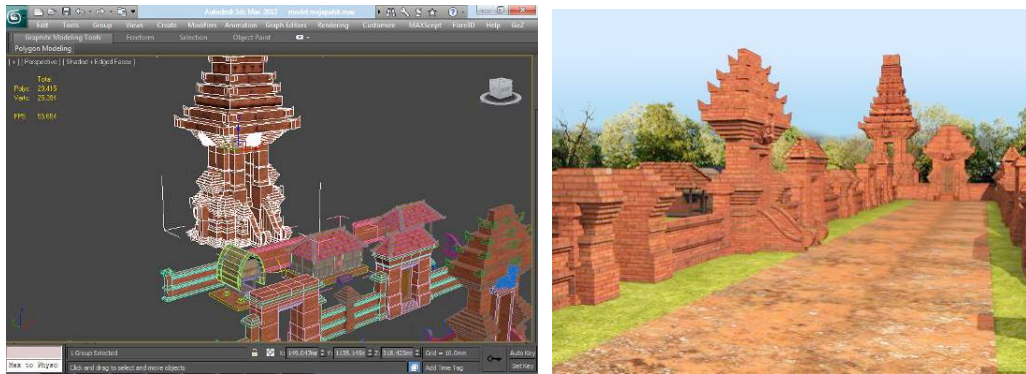

Figure 11 modeling process
Source: Personal documentation

Figure 12 VR Result

Through the application developed in this study, user is able to access places or sites that have been damaged and no longer exist, unreachable due to a distant geographical location or unreachable because of some factors such as time speculation, distance, scale, security, and cost. The novelty element of the application exepected to motivate and encourage the user to learn more about Majapahit kingdom.

5. CONCLUSION

Virtual Reality technology at the moment is relatively easy to get along with the development of HMD (Head Mounted Display) equipment. Furthermore, Virtual Reality opens opportunities to rebuild a historical artifact in the form of a virtual environment, one of them is virtualization of Majapahit kingdom.

By using display technique 360 panoramic video in this study, Majapahit kingdom can be represented virtually, enhancing the opportunities to introduce the greatness of Majapahit civilization as a part of the historical and cultural heritage of Indonesia to the wider community, both in domestic and abroad. The development of this study in the future allows learning with the alternative methods which interactive, collaborative, responsive.

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