Virtual reality interactive media for universitas sumatera utara – a campus introduction and simulation

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Abstract. Universitas Sumatera Utara is one of the public universities that have over 100 buildings with total area of more than 133.141 square meters. Information delivery on the location of the institutional buildings becomes challenging since the university land reaches 93.4 Ha. The information usually delivers orally, in video presentation and in the form of two-dimensional such as maps, posters, and brochures. These three techniques of information delivery have their advantages and disadvantages. Thus, we know that virtual reality has come to existence, touching every domain of knowledge. In this paper we study and implement virtual reality as a new approach to distribute the information to cover all of the deficiencies. The utilization of virtual reality technology combined with 3D modeling is aims to introduce and inform the location of USU institutional buildings in interactive and innovative ways. With the application existence, the campus introduction is expected to be more convenient so that all the USU students will be able to find the exact location of the building they are headed for.

1. Introduction
Information delivery about one location is done with oral, video and in the form of two-dimensional media such as maps, posters, and brochure. The two-dimensional shape is one of the most common ways used since it is easy to create and distribute. Although the conventional information delivery is more economical, the information contained is less interactive and attractive.

Information of the location, to be more appealing, can be delivered using video. Information delivered using video is more effective than using two-dimensional media since the information presented on video more detailed and clearer, such as the similarity of the color and height of the actual building. However, it costs a lot of time and money in making it, and the result is less interactive because we cannot receive any feedback from the user.

Another method to deliver the information is oral technique. This technique is considered as the most interactive approach since it offers two-way communication with the speakers, so it is easier to get and understand the given information. However, the drawback of this method is the lack of speaker’s availability to be ready 24/7 to deliver the information. Therefore, virtualization of the location can be considered as an efficient solution because it is able to overcome all the shortcomings of the above methods and accommodate all the advantages.

Virtual reality technology can be implemented in the virtualization of a location. The term of virtual reality (VR) first mentioned in several magazines and newspapers owned by Jaron Lanier, founder of Visual Programming Language (VPL) research company, in 1989. VR is a technology that uses
computers and electronic technologies to produce a realistic three-dimensional atmosphere so that users can feel through sight, hearing, touching and forming a virtual world [1].

According to Zhang & Zheng [2], VR technology is a type of interface technology between humans and machines that can simulate people virtually being in a natural environment through sight, hearing, movement and other actions. Not only can illustrate the real environment, VR also allows users to observe virtual environments and to feel like they are in that location. Therefore, VR technology creates a new approach for visualizing spatial information. The technology has three characteristics, namely immersion, interactivity, and imagination [3].

Today, VR keeps growing in the field of urban planning, urban development, and urban management [4]. The virtual world has also been used by many educational institutions, organizations, medical academies for education purposes, business and marketing, etc. In the medical sector, for instance, virtual reality provides various assets for rehabilitation that exceeds the reach of the traditional methods[5]. Our previous research was connecting virtual reality with digital cultural preservation [14][15][16] and historical game [17]. The technology also can be put to use to help the rehabilitation process of stroke patients [6]. As for educational institutions, virtual reality can be implemented in the development of virtual campus so that people are able to explore the campus virtually. There are currently 29 universities in the world that utilize the technology for campus tour [7].

University of Sumatera Utara (USU) has 151 departments in its land area of 93.4 Ha. It has over 100 building with the total area of more than 133.141 square meters. Although it holds orientation week and campus introduction for freshman year students every year, the students’ knowledge on campus area is considered below average. Therefore, a virtual visualization for USU campus is required to illustrate a clear, attractive visual representation and resembling the real campus area. In Indonesia, virtual campus tours are still limited to using combined photographs. In this research, the author will create a virtual tour using 3D model and integrate it with Oculus Rift so the experience will be more attractive and compelling.

In 2011, Didik Dwi Prasetya conducted research entitled Web-Based Virtual Tour Application as Tourism Promotion Media [8]. In the study, Didik used a set of images supported with music, narration, and text to simulate a tourist attraction location. The key to success which also serves the main component of a virtual tour is panoramic images. Moreover, the virtual tour is also combined with geolocation service for location mapping. The primary objective of the research is an innovative and interactive medium of tourism promotion and marketing.

In 2013, Nurul Mizaanatul Abror did a research entitled Virtual Tour Museum Prototype of E-Super Museum to introduce East Java and DIY Batik Culture [9]. In the research, Nurul did not use either audio or video, and only used a set of images and text to provide information. The images and texts were then compiled and processed using Macromedia Flash which would eventually be uploaded to the website.

In 2013, Fatchur Rohman Alhabso, Muhtadin, and Ahmad Zaini conducted research entitled 3D Object Visualization of Panorama 360 Virtual Touring [10]. In the web-based research, they use 3D scanners to reconstruct three-dimensional objects. Before implemented in the virtual tour, mesh decimation process and texture mapping modeling on the result of the reconstruction process. The main purpose of the research is to visualize museum collections that are not good enough to be visualized only in a two-dimensional form.

2. Methodology
The proposed method for this research consists of four stages, namely data acquisition, modeling, materializing-texturing and virtual reality environment. In data acquisition, USU maps that have been obtained from various sources are evaluated and perfected by conducting field inspections and interviews with experts. The initial 3D model design is performed based on USU maps in modeling stage. After conducting field inspections and interviews with experts, the initial 3D model is perfected into the final 3D model. The next step would be materializing & texturing. In this stage, the final 3D model is given the color and material for the model to look more real. The final stage is to create a virtual
reality environment. In this stage, the support of game engine is used to generate an environment that resembles the reality.

The general architecture of the proposed method is shown in Figure 1.

![General architecture of the proposed method](image)

**Figure 1.** General architecture of the proposed method

### 2.1. Data acquisition

There are three data resources for this research, they are USU maps, field inspection and interview with experts. Here we described every resources below.

#### 2.1.1. USU Maps

The USU map is used as the base for the development of 3D virtual USU campus. The USU map is divided into two types, namely 2D map, and 3D map. 2D map is a map printed in 2011 by the USU Press. This map can be seen in Figure 2.

![USU maps in 2011](image)

**Figure 2.** USU maps in 2011

In addition to the map printed by the USU Press, 2D map is also available from Google Maps. 2D USU map obtained from Google Maps in 2015 can be seen in Figure 3 below.
Figure 3. USU map based on Google Maps in 2015

The 3D USU maps created by the Architecture Studies Program have been used as references in this research. It can be seen in Figure 4.

Figure 4. 3D USU Map

2.1.2. Field inspection

Field inspections are required in this research because the information presented on maps is not sufficient. Moreover, field inspection is also useful to match previously-obtained data with the actual form of the field so that the final result can become information sources that closest to the actual data. We collect mostly every main building in every faculty and department, including its infrastructure, road and garden. The sample of field inspection result can be seen in Figure 5.
Figure 5. Field inspection of faculty of Computer Science and Information Technology

Figure 5 was taken at faculty of Computer Science and Information Technology. In order to obtain good modeling, the images of every building were taken from various angles.

2.1.3. Interview with experts

The mentioned expert for this research is architect experts. The purpose of this stage is to check whether the modeling results are in accordance with the actual form seen from architecture. If not, then the 3D model will be revised.

2.2. Modelling

There are three phases of the modelling process. The first phase is initial modeling process. Data used in this process is based solely on USU map. Once the rough draft is complete, the field inspections result is used to improve the initial modeling results. Afterwards, interview with expert is conducted to obtain the final 3D model.

3D model built in this research is a solid 3D model to generate more realistic results. There are two techniques used in modeling, namely subdivision modeling and NURBS (spline modeling).

Subdivision modeling is one of the polygon modeling techniques. The stages in subdivision modeling can be divided into planning, rough draft, rough detail draft, final detail, and clean up.

The planning stage begins with measuring and calculating the model size to be built. After the measurement is completed, the rough draft stage can be started by selecting primitive geometry objects, such as cube, cylinder, sphere, cone, pyramid, and torus. The objects are then placed in a position in accordance with the planning result. After the rough draft is complete, the basic shape of the model can be seen even though it is not detailed. Therefore, it is necessary to perform refinement to improve and refine the model. Refinement process is conducted several times to generate final model details. Sample result of the model details final stage is shown in Figure 6a. The final model is then cleaned at the clean-up stage so the unnecessary geometry objects can be removed.

Figure 6 (a). The result of the model details final stage (b). Mixed subdivision modeling and NURBS model
For the curved model, a non-uniform rational B-spline (NURBS) technique is required. NURBS has stable floating points error, requires less memory and is able to represent any type of curve or surface. In contrast to the subdivision modeling, a polygonal geometry, the NURBS model has no face, edge, or vertices. The NURBS model is built using two or more Bezier curves or also called splines. An example of a mixed subdivision modeling and NURBS model can be seen in Figure 6b.

2.3. Materializing and Texturing

Texturing or texture mapping is a shading technique to synthesize images where texture images are mapped to the surface in a three-dimensional scene, much like wallpaper affixed to a wall. The advantage of texture mapping is that it can add numerous details to an object even though it takes a little extra time when rendered [11]. Slightly different from textures containing bitmap data, essentially, the material is a shader or surface characteristic of an object, such as slick, solid or transparent. The material contains parameters that determine how light interacts with the model. The most commonly used materials are translucent, metal, stone and wood. This stage aims to make the final model look more real. Sample of texturing and materializing result is shown in Figure 9.

![Figure 7. Result of texturing and materializing](image)

2.4. Virtual Reality Environment

The environment is a very important aspect of virtual reality and must be built with caution, in order to provide an immersive experience to users. An immersive virtual environment can give the users a sensation as if physically in the virtual world [12]. About 80% of the information that humans feel comes from the eye, making visual perception plays an important part [13]. Therefore, the virtual environment is the key so that users can interact with the world entirely and allow the users to be unaware of the surrounding environment in the real world. In this research, game engine Unity 3D version 5 was implemented in the development of a virtual environment.

3. Experimental Result and Analysis

3.1. Virtual Tour Facilities

In 3D Virtual Campus USU application, there are several features to facilitate the user while improving the quality of virtual tour, which are Faculty building marker, Street marker, Minimap to mark the user location, USU full map, USU Bus, Teleportation to selected location, Choice of virtual tour duration, Guidelines in using the application.

3.2. Application Initial Display

There are several displays showed when application launches, namely the splash screen display, the welcoming title display and the main menu display. Splash screen display is shown in Figure 8a.
On the splash screen, three different time differences are available in the application, i.e., night, morning and dawn. The splash screen will appear for eight seconds. The time is used to load the required assets for the next scene.

The welcoming title view can be seen in Figure 8b. The welcoming title display aims to greet users while adding aesthetic value. The user can proceed to the main menu by pressing the Virtual Reality button.

The main menu display can be seen in Figure 9. In the main menu, there are four buttons, namely Start VR, Profile, Settings, and Exit. The Start VR button will bring the users into USU and conduct a virtual tour. The Profile button will display the names of all people who play a role in this research completion. The Settings button will display the settings for time duration and sound. The Exit button takes the users out of the app.

Figure 8 (a). Splash screen display (b). Welcoming title display

Figure 9. Main menu display

Figure 10 (a). Application usage guidelines display (b). Virtual reality environment
3.3. VR Display
Shortly after the user presses the Start VR button and enters the USU environment, the user will be
told how to access the application usage guideline, by pressing Tab key. The application usage guideline
is shown in Figure 10a. In Figure 10a, there is a building presented behind the application usage
guidelines. The building is one of building modeling and is the lecture building of Information
Technology department. A sample of virtual environments that have been built can be seen in Figure
10b. The built environment includes objects such as trees, grass, cars, street lights, etc.

3.4. Application Testing
Application testing is required to test all components that have been designed and implemented. The
test aims to ensure each part has functioned properly and has been in accordance with the expectation.
There are two methods used in testing, namely black box testing and pluralistic walkthrough.
In the black box testing method, testing was performed on the interface regardless of coding. Based
on black box testing, it shows that the interface has been functioning correctly.
In pluralistic walkthrough method, the test was conducted with end-user involvements. The purpose
of pluralistic walkthrough is to acknowledge the visualization results of the institutional building that
have been made. Numerous questions related to modelling results were given in the form of
questionnaires. There are 20 end-users from various backgrounds invited to the test. Based on the
questionnaires, it shows that more than 80% of end users stated that the modeling buildings could
represent the actual ones and 100% of end users stated that 3D Virtual Campus USU is able to help
inform the location of the college building in USU and benefit the students especially for new students
every year.

4. Conclusion and Future Research

4.1. Conclusion
In accordance with the testing of 3D Virtual Campus USU application, it can be concluded as follows:
1. The implementation result of virtual reality to the system is still depended on computers with
high memory capacities.
2. Virtual reality implementation in 3D Virtual Campus USU application can be a breakthrough
in providing information on lecture building locations to USU students excitingly and
innovatively.

4.2. Future Research
In the development of 3D Virtual Campus USU application, still, there are many drawbacks. Therefore,
numerous improvements should be done in future research. Here are suggestions that can be used for
further research:
1. Making 3D objects lighter, because the process of building rendering in large quantities will
require high-capacitated memory.
2. The addition of the institutional building interiors and other buildings. For example, public
structures such as a pavilion, gathering building and library.
3. More detailed activities on campus, such as walking and running students.
4. Artificial intelligence implementation to determine the shortest path to a location in the app.
5. The addition of multiplayer and chat features for the app to be used by more than one person at
a time and can exchange information in the virtual world.

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