ViCT—Virtual Campus Tour Environment with Spherical Panorama: A Preliminary Exploration

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Abstract—ViCT, or spelled "VISIT", is the name of a web-based application that is being developed to display various points and locations from the campus environment that can be accessed virtually. ViCT aims to help users, students, and the public explore campus with digital freedom of movement anytime and anywhere, educating users about campus facilities and services with an immersive technology experience that is eco-friendly and fun. The application development concept is unlimited visits and easily accessible via desktop and mobile, saving resources and costs. In this chapter, the focus of the researchers discusses the initial digital mapping of the campus environment, which is the object or study area of the development of virtual campus applications with 360-degree panoramic image techniques. Spherical panorama images are the primary basis of the virtual reality environment in this application. Each panoramic image is processed and merged into a unified whole on a web page. Spherical panorama photos captured using ultra-wide-angle lenses at the front and rear of the camera (dual fisheye) generate a visual field with a horizontal and vertical angle of view close to 360 degrees.

Keywords—ViCT, virtual campus tour, spherical panorama, preliminary exploration, MDLC

1 Introduction

In the last two years, the Covid-19 pandemic has spawned many changes in style and way of life [1], starting from the culture of working from home or work from home (WFH) [2], physical restrictions and mobility, as well as conditions full of uncertainty [3]. The pandemic condition has also triggered the acceleration of digital transformation [4]. The presence of many new technologies that are stuck-ing out and hotly discussed, for example, such as augmented reality (AR), and virtual reality (VR) can be seen in Figure 1, blockchain, NFT, metaverse, and web 3.0. All this technology is considered to be a trend and will change human life in the next few years [5][6].

VR is a compound word from English, namely 'virtual' which means close 'reality' means real things that we experience as humans [7][8]. Thus, it can be concluded that VR is a technology that can make users 'closer to reality' [9]. VR is a technology that allows users to interact with the environment in a virtual world that is reproduced by a computer, giving them the impression that they are in that area [10], [11]. VR can

be found in various ways, for example in a training simulation such as doctor practice training [12], airplane flight, mining or shooting simulations, video games, virtual event, and virtual tour services [13]. VR technology also provides an immersive and interactive experience for users [14]. This technology has been employed in a variety of disciplines, including medicine, culture, travel, education, and architecture [15]. From guided museum visits to the dissection of a muscle, VR allows us to cross boundaries that would otherwise be unimaginable and impossible.
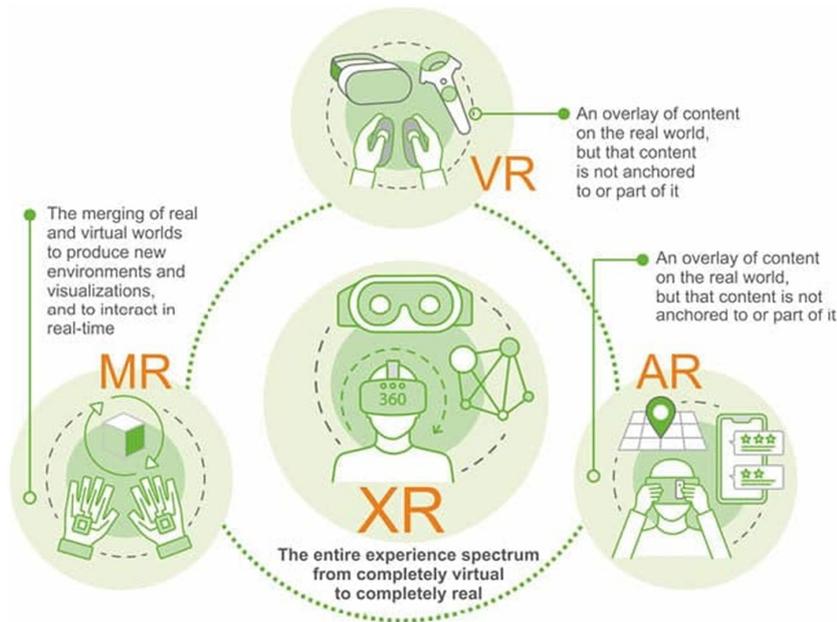

Fig. 1. AR/VR/MR/XR technologies

Various sectors, such as Google Maps, have implemented this technology into their operations. Google Maps Street View is a virtual representation of a real environment made up of millions of panoramic images [16]. A panoramic image is one with a nearly 360-degree field of view. The panoramic image method is also known in virtual reality photography (VRP) [17]. VRP is the interactive display of panoramic photos, generally including a 360-degree circle or spherical view can be seen in Figure 2.
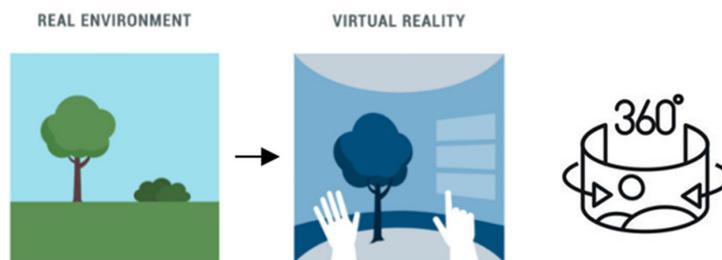

Fig. 2. Reality-virtuality continuum (panoramic images illustration)

In this study, we used VR technology to create a website that facilitates students, the public, and users to explore the faculty of engineering virtually by integrating panoramic images into the virtual tour web page named ViCT or VISIT (Virtual Campus Tour) with roaming both outdoors and indoors equipped with a voice guide that guides users about important information, services, facilities, and about the location to users. According to the results of the questionnaire survey, 97% of engineering students strongly agree or agree with the development of a virtual campus environment in the engineering faculty.

The present researchers selected the panoramic images method because of the low cost of image construction and the ability to create realistic and immersive visual effects [18][13]. This study explored student acceptance of virtual campus tours by using a questionnaire survey. The original web design was then modified based on student feedback. In this paper, the authors also discussed and proposed suggestions to improve the quality of panoramas, camera parameter settings, and panoramic image processing.

1.1　　Panorama

Panorama is a free and open natural landscape. The name "panorama" was invented by the English painter Robert Barker in 1787 for his paintings shown on a circular surface. The term panorama is derived from the Greek words pan ('all') and horama ('view') [19]. M. Garrela of England, patented a camera that rotated around its own axis in 1857, and it accomplished the job. This is the first camera to use a fan-adjusted clockwork mechanism to record a complete 360-degree view. Nowadays, many panoramic cameras are present in the market; With today's technology, we can easily see a beautiful panoramic view of a place in another part of the world without having to be directed there [20]. Not like conventional panoramic photos with limited viewing angles. 360-degree panoramic photos that are projected into a virtual form presenting a wider perspective. Observers can feel a unique experience by looking in all directions, left-right, up, and down [21]. The types of panoramic photo projections can be illustrated as shown in Figure 3.
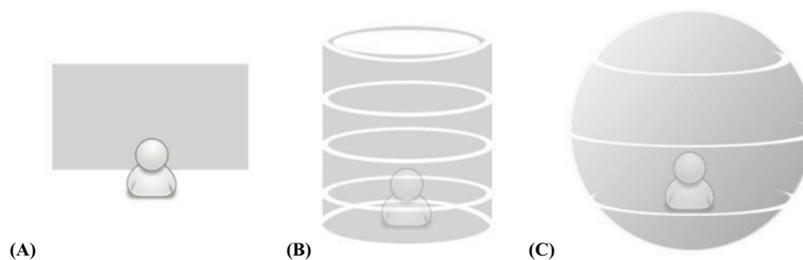
(A)　　　　　　**(B)**　　　　　　**(C)**

Fig. 3. Illustrations of kinds of panoramic images: flat (A); cylindrical (B); spherical (C)

In general, the types of panoramic photo projections can be divided into three parts, namely:

a) Flat panorama is one photo or a combination of several photos taken with a limited viewing angle and projected in a flat form (Figure 3A).
b) Cylindrical panorama is a combination of several photos taken rotating 360º from left to right or vice versa and projected in the form of a cylinder. (Figure 3B).
c) Spherical panorama, namely photos taken not only rotate 360° from left to right but also 180° up and down. Projected in the form of a sphere, we as observers are in it. (Figure 3C).

In this study, the shooting targets were several location points consisting of some engineering faculty buildings. The point of view in the photo is mostly landscape. Therefore, each shot does not fully cover the vertical landscape. Depending on the range and angle setting, photos taken in this study were considered 360-degree panoramas or spherical photos. Cameras in the digital era already use digital sensors and no longer use a film roll to capture the image. The advantages of digital sensors it is no limit in taking pictures and more cost-effective production [13]. The large size of the camera sensor in making pictures of panorama has an influence on the width of the lens used. So, when using a camera and a lens that has a wide-angle 90-degree view means creating one 360-degree panoramic image requires a minimum of 5 images by calculating overlapping each image.

Panoramic images are created by stitching one image onto another. This is called the stitching process [17]. The stitching process requires the help of software for the process. Stitching works by sewing parts of a picture onto the same part of the picture. This is called overlapping. The stitching process is very susceptible to error; if there is an error when taking pictures, it is necessary to calculate the correct lens and camera so that the overlapping process can occur.

1.2   Virtual reality (VR)

Virtual Reality (VR) is a technology that allows users to interact with an environment that is simulated by a computer [22]. VR can generate simulations that allow users to experience, learn, and observe objects freely in a virtual space in real- When users move, the computer quickly performs complex calculations and returns the correct screen display to create the impression of a real presence [23]. In 2020, a documentary video circulated on the internet with the title "Meeting You" showing a mother being able to reunite with her dead child through VR technology [24].

VRP or virtual reality photography is a technique to be able to interactively view panoramic photos that have a wide viewing angle. A VRP in general is a wide photo view that covers a 360-degree angle and can cover the entire spherical view. VRP is a type of interactive visual production that takes the shape of panoramas and video objects. A panorama is an image that displays a wide viewing angle. VRP basically gives a view as if the user is in an image or location captured by the photographer. The resulting image can be given an effect using a computer. The final result, known as VR Panorama, can be viewed via an interactive interface application (can rotate horizon-

tally and vertically, as if you are in a real-world scene). Meanwhile, a virtual tour is a place simulation comprised of a succession of films, photographs, and other multimedia components such as background music, narration, and text [25].

1.3   Web-based application

Applications can run on multiple hardware devices, such as desktop, mobile, and other devices. Applications that can be run on a web browser via an intranet or internet are commonly called web applications (web applications or web apps) [26]. Web applications or e-applications can be accessed by users using a browser as a client. The browser acts as a medium between the system that was built and the functions that will be executed by the user of the application.

1.4   Information technology

The Faculty of Engineering, Universitas Negeri Padang (FT-UNP) is one of the faculties that are in great demand by prospective students. In particular, the Department of Electronic Engineering, which has many study programs, certainly needs to be supported by adequate information facilities. Various ways have been attempted by the university to convey information about facilities, services, and other information to the public, especially prospective new students. The forms of promotion carried out are in the form of websites and brochures. However, the above media still display more static images along with some one-way videos, so they cannot provide something that provides an immersive technology experience for the users [10].

Immersive technology is a technology that is able to blur the boundaries between the real world and the digital world or the world of simulation so that users can feel an atmosphere that is similar to the real world [27]. Images are one of the most popular information media because today's image media is the most trusted means of information in conveying information. The development of image information media that is currently developing is 360-degree panoramic images [28]. By using the panoramic method combined with VR technology, virtual reality can be developed that is able to provide a visualization of reality with a 360-degree roaming angle, with smartphones and the internet [28].

2   Method

Figure 4 shows the research procedure. The research stems from problems faced by students at the engineering faculty, Universitas Negeri Padang. In developing the virtual tour application, it adopted the Multimedia Development Life Cycle (MDLC) method which consists of conceptualizing, designing, collecting, assembly, testing, and distributing materials as illustrated in Figure 5. The discussion in the paper is more of a preliminary exploration of the early stages of virtual tour development with MDLC, starting from concept, design, to collecting materials.
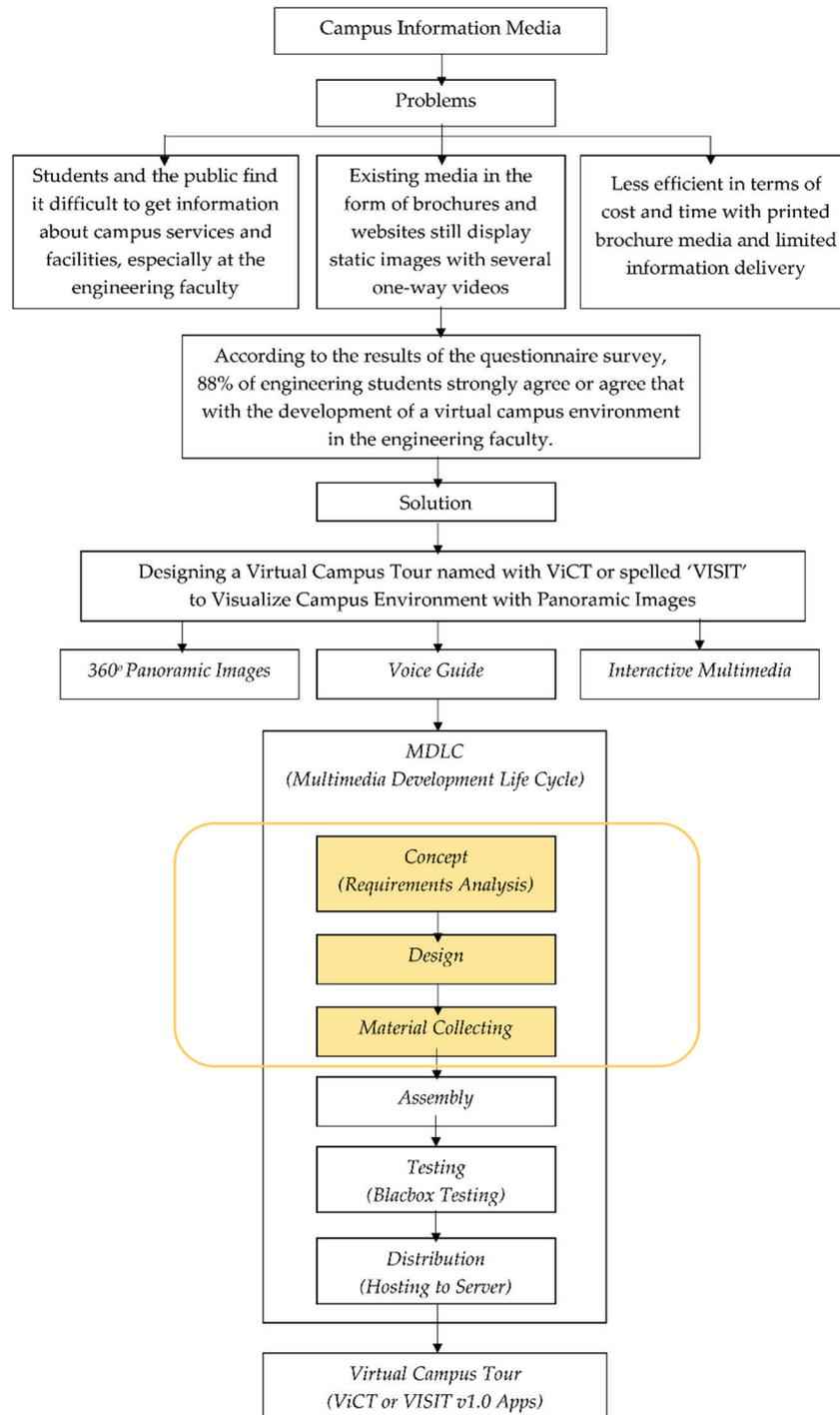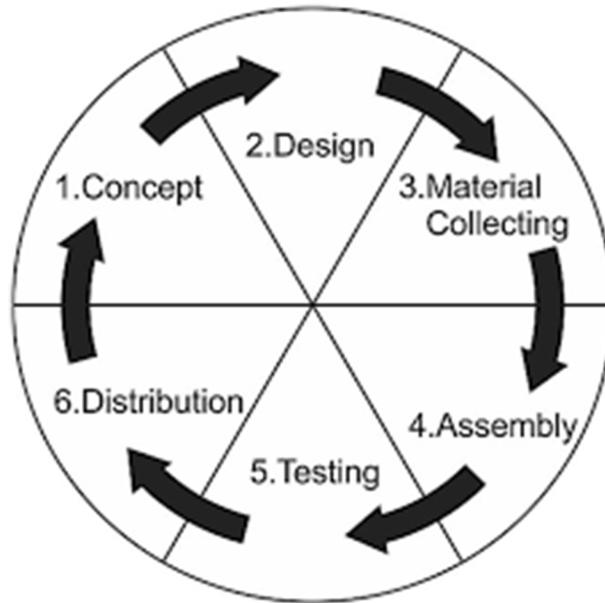
Fig. 4. The research procedure

Fig. 5. Multimedia development life cycle (MDLC)

2.1 Concept

The initial process is the concept stage discussing the analysis of device requirements needed in application development, consisting of hardware and software. Users and study areas are also determined at this stage can be seen in Table 1.

Fig. 6. App logo

Table 1. The conceptual of apps

App Name	ViCT or VISIT (for the app logo see Figure 6.)
App User	Students, Public
App Purpose	Provide Information, Educate Users, Virtual Tour
Input	Panoramic Images, Voice, Music, Text, Videos
Output	Virtual Campus Tour Based on Web Application

The study area that is targeted as the object of taking panoramic pictures is the environment of the engineering faculty, Universitas Negeri Padang precisely at the coordinates 0°53'51.5"S 100°20'57.9"E, West Sumatra, Indonesia as can be seen in the regional mapping in Figure 7. For a larger image, see Figures 8 and 9.
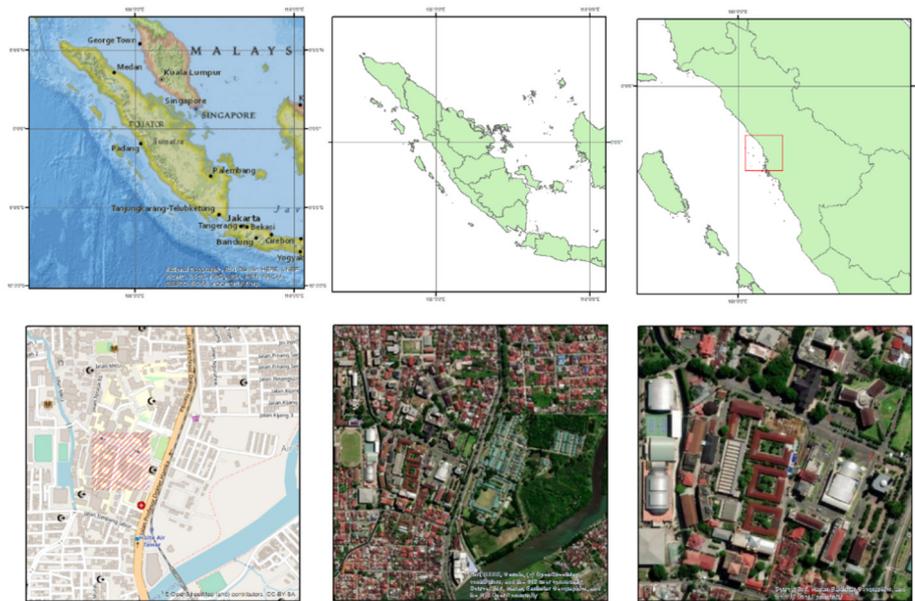

Fig. 7. Study area mapping

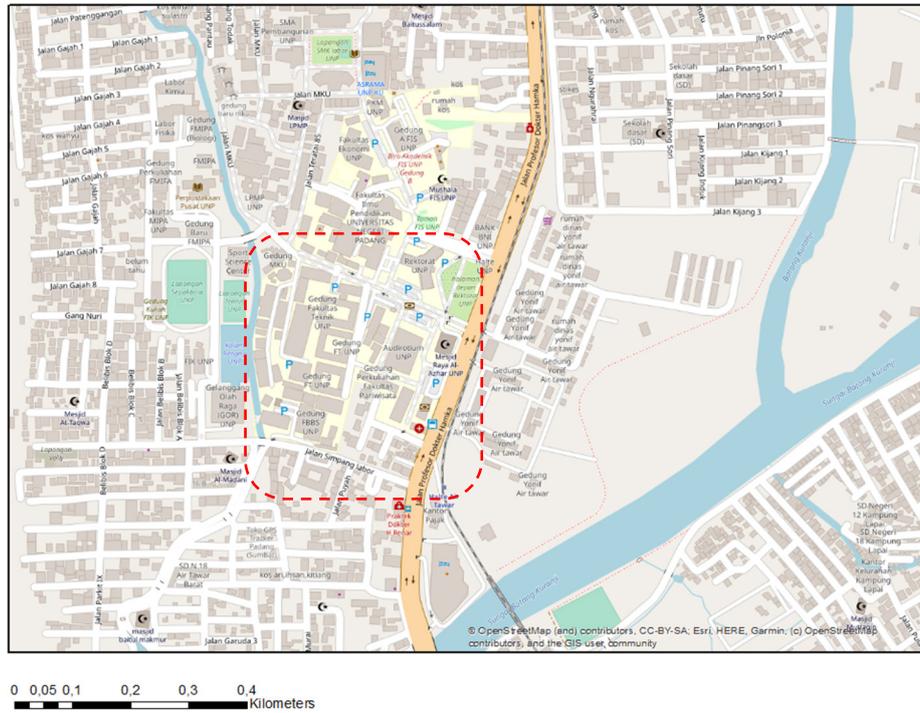
Fig. 8. Study area mapping (A–B)

Fig. 9. Study area (Cont.)

The hardware and software requirements needed are as follows:

1. Ricoh Theta Camera
2. Tripod
3. PC or Laptop, W10 8 GB RAM i5
4. Audio Recorder
5. Adobe Photoshop CC
6. 3D Vista Suite
7. ArcMap

2.2   Design

At the design stage, the route and location points for the virtual tour can be seen in Figure 10 (A–B), application storyboards and web page interfaces are determined. The development of this application, it focuses on the area of the engineering faculty environment, which consists of 20 location points that are used as targets for taking panoramic images. Details of location points can be seen in Table 2. The 20 location points or referred to as hotspots above are spread over the 3 main buildings. Namely, the electronics major block (A1; B2); an integrated laboratory building consisting of 4 floors, namely G. LT1, G. LT2, G.LT3, and G.LT4.

Table 2. Location point list

| No.	Building Name	Location Point
1.	Electronics Department Office	A1
2.	VR Laboaratory	A1
3.	Animation Laboratory	A1
4.	Electronics Laboratory	A1
5.	Signal Processing Laboratory	A1
6.	Lecturer Room	B1
7.	Computer Laboratory	A1
8.	Communication Systems Laboratory	A1
9.	Library	B1
10.	IoT Laboratory	A1
11.	Classroom E64	A1
12.	Classroom E65	A1
13.	Classroom E66	A1
14.	Lobby	G. LT1, G. LT2
15.	Digital System Laboratory	G. LT2
16.	Computer Network Laboratory	G. LT3
17.	Multimedia Laboratory	G. LT3
18.	Electrical Physics Laboratory	G. LT3
19.	Telecommunication Laboratory	G. LT3
20.	Software Engineering Laboratory	G. LT4
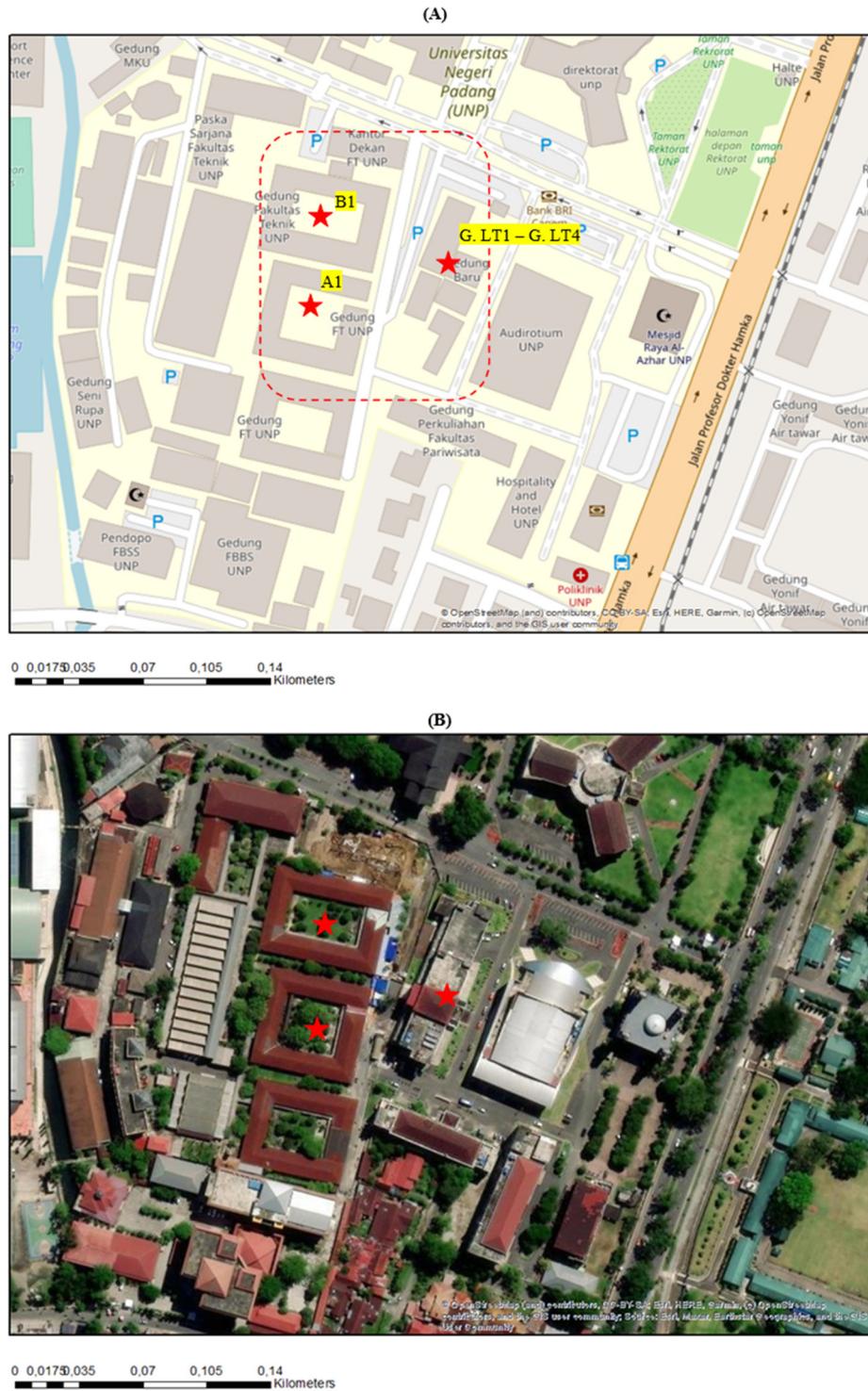
Fig. 10. Shooting target location point (A–B *marked with a red star)

The web page user interface designed with 3DVista can be seen in the following Figure 11.

Fig. 11. Web-page user interface

2.3 Material collecting

At this stage, the material needed for making panoramic images is collected, starting from determining the shooting point, and taking pictures using the 360-degree panoramic images technique. Take pictures using a dual fish eye digital camera consisting of a front and rear camera. Image stitching is a crucial step in panorama generation.
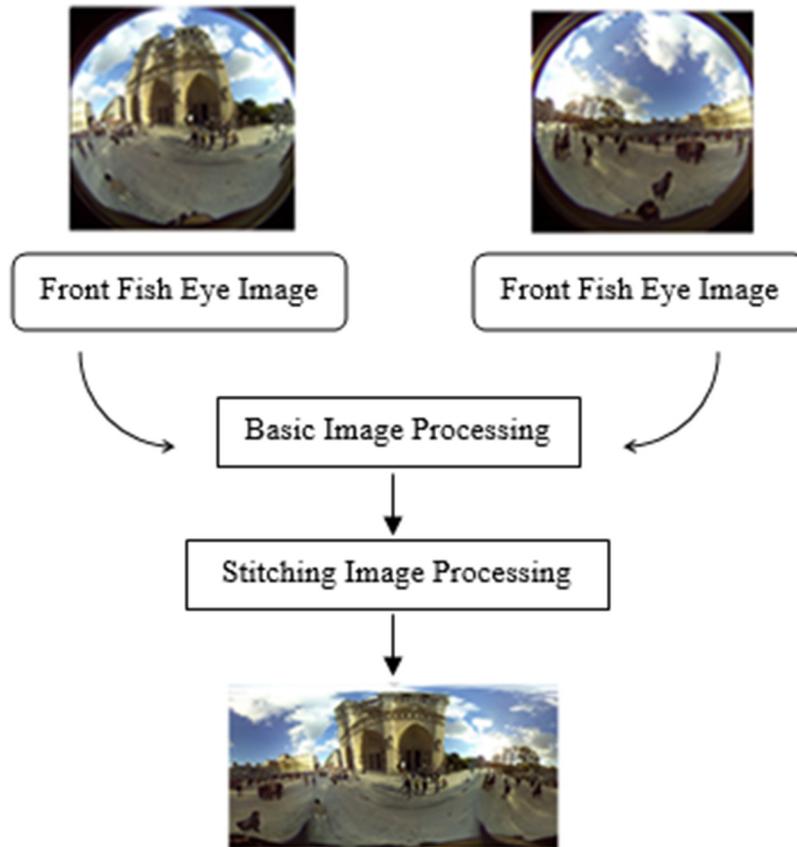
Image processing.

Fig. 12. Image processing

To begin, image data from two image sensors are utilized to perform basic image processing. Following that, images are processed to extract the proper brightness and coloring from the two image sensors, in addition to the fundamental image processing carried out on conventional digital cameras. Specifically, as shown in Figure 12, the individual sensitivity variations between the two image sensors are rectified, and exposure compensation is done for each image sensor based on a complete judgment generated from the brightness identified in the data of both images.
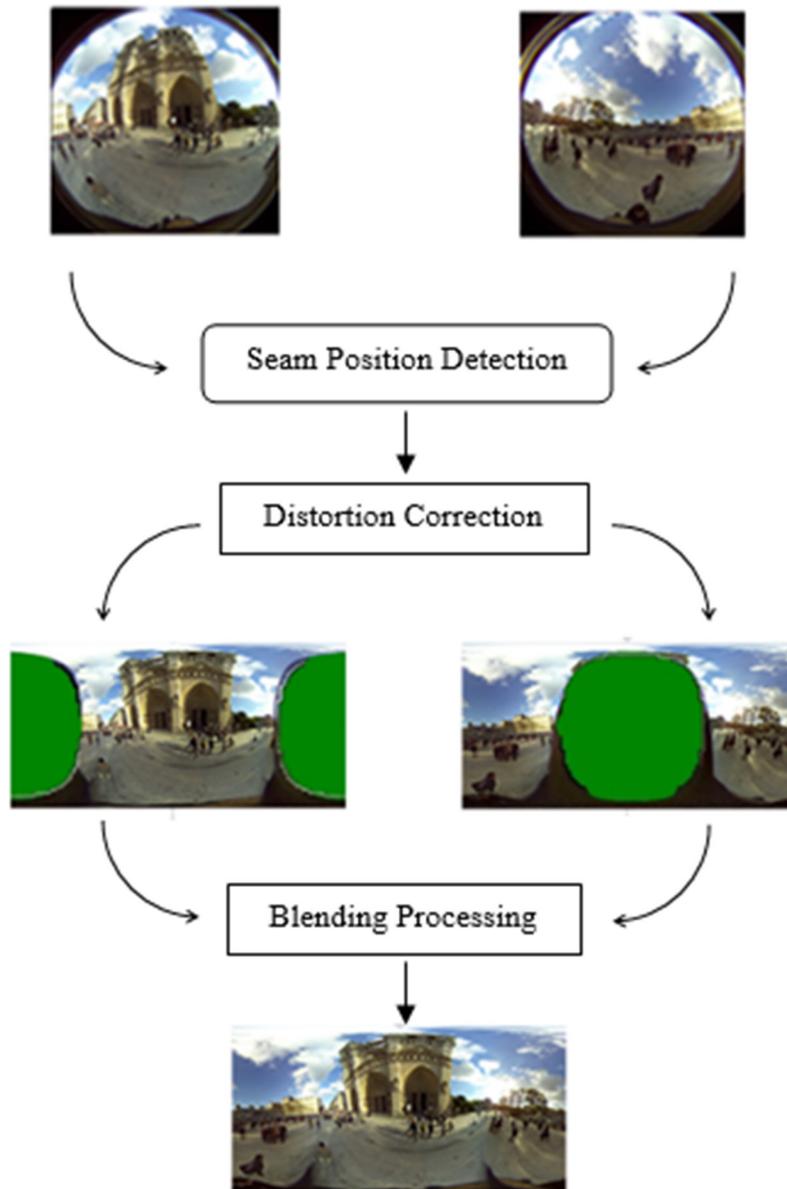
Image stitching.

Fig. 13. Image stitching

Image stitching is performed on two images. To detect the stitching position, pattern matching calculates the offset amount between the reference image and the comparison image in each region for each of the two images [19]. The two images are then

transformed into a spherical image format using the determined stitching position and the features of each optical lens system. Blending the two spherical image formats results in a single spherical image. As shown in Figure 13, pattern matching recognizes the stitching position and applies it to the image conversion parameters to the spherical image format, resulting in a dynamic stitching process that permits the real-time stitching of two images.

3   Result and discussion

3.1   Virtual campus tour with spherical panorama

The following are the results of taking pictures using the dual fish eye camera used:

Fig. 14. An integrated laboratory building consisting of 4 floors, namely G.LT1, G.LT2, G.LT3, and G.LT4

Fig. 15. Software engineering laboratory (G.LT4)

Fig. 16. Animation laboratory (A1)

3.2 Camera settings

The shutter speed, ISO sensitivity, and white balance are adjusted automatically according to the shooting environment. The image correction method can also be selected from the noise reduction, DR compensation, and HDR rendering. Appropriate exposure and focus are essential for taking a suitable picture. Many people think that the light in a room, like in an office that is illuminated by fluorescent lights does not differ much from sunlight, so they do not hesitate to set a low ISO (100–200).

Actually, the condition of the light is much darker than sunlight. Our brain and eyes work like auto-ISO in a camera, adjusting to the existing light conditions. But according to the camera, the man-made lamp is much darker than the sun's light. The unit of measurement for light for photographers is usually expressed in EV (Exposure Value). The values assigned vary according to the ISO setting. Increasing ISO 100 to 200 means increasing 1 EV. Exposure Value can also be expressed as a combination of aperture and shutter speed, assuming the ISO is set to 100. On a sunny day with the sun, the EV value is 15, with a combination of ISO 100, f/16, and a shutter speed of 1/125 or for convenience, 1/100th of a second. This combination is often called the Sunny 16 rule. While indoors, such as in a bright office room, the EV value is reduced to EV 8 with a combination of ISO 100, f/2.8, and 1/30 second. When shooting in a dark or overcast room, the EV value drops to about EV 5 (ISO 100, f/2.8, 1/4 second). Shortly after sunset, also called twilight, you will get EV 2 (ISO 100, f/2.8, 2 seconds).

Moonlight or night light without light pollution from buildings/residential is usually around EV –3 to –6 (ISO 100, f/2.8; 1 minute to 10 minutes). Of course, the combination of ISO, aperture, and shutter speed is flexible, meaning that we can choose many combinations for the same light and dark. The setting in a bright room, EV 8 (ISO 100, f/2.8, 1/30 sec) can also be changed to ISO 800, f/5.6, 1/60 sec to get the same light-dark results. By understanding EV, we can better understand why when shooting indoors or in a dark place requires a very different setting than outdoors. ISO 100 is sufficient for

outdoor photos, but not high enough for indoors except when using a large aperture lens or relatively slow shutter speed (there is a risk of a blur if we do not use a tripod).

3.3   Main page design

Figures 17 and 18 are the creation of the main page skin on a virtual tour of the Department of Electronics Engineering. Panoramic images will be displayed on the main skin of the main page.
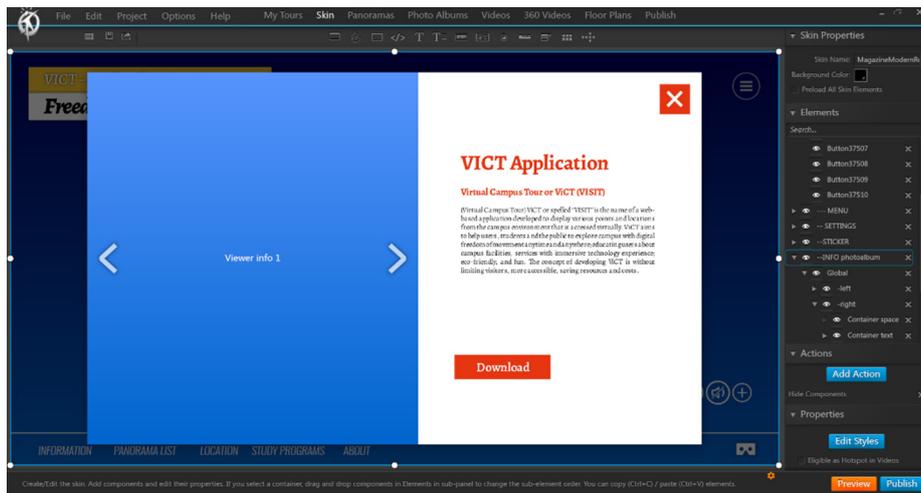

Fig. 17. Main page design

Fig. 18. Virtual campus tour (ViCT) interface *(initial design)*

4   Conclusion

There are generally two approaches to capturing panoramic images. One is to use a 360-degree spherical camera. The other is to use a platform with a camera to capture and stitch images together. The former makes it easy to create panoramic images, but the resolution is second to none and there is no potential to improve image quality. The platform-based method, on the other hand, requires stable conditions for capturing the image. This is a compromise between these operations for creating panoramic images. Camera settings, shooting time, and the number of shots have an effect on the outcome of a panoramic image. Then the more the number of shooting points, the wider the area that can be explored.

5   Limitation and further investigation

The discussion in this paper is limited to the process (Concept, Design, and Material Collecting) only because the ViCT application development process is still ongoing. The shooting process was carried out at 3 points, namely at A1, B1, and at an integrated laboratory building consisting of 4 floors, namely G.LT1, G.LT2, G.LT3, and G.LT4. These three points are the area of the engineering faculty. For the assembly, testing, and distribution stages of the development process, this virtual tour will be discussed in the next discussion. For exterior information, it includes several buildings and roads that have been determined as shooting targets as shown in Figure 10 (A–B). Meanwhile, interior information includes classrooms, laboratories, libraries, department rooms, and lecturer rooms in A1, B1, and G.LT1–G.LT4 as shown in the previous Table 2. Furthermore, after the material collection process, future application development is continued at the merging or assembly stage, which is the process of combining all the panoramic images that have been collected at the material collection stage. Then the stage of testing functionality and online distribution using a special domain that can be accessed online by users.

Determining the point of taking panoramic pictures can be influenced by several factors such as 1) the location must have information values from all angles, such as front, side, and rear views. Images as much as possible are taken from the center point of the location; for example, if the case is a room, then the point of taking is in the middle of the room; 2) available point to create a hotspot. Ideally, a virtual tour is a collection of panoramic images that are connected to other panoramic images, so there must be a point that will later be used to install a hotspot. 3) Shooting should consider sufficient lighting and weather conditions. All the MDLC stages of the development of this virtual tour will be discussed again in more detail after the development of this virtual tour is completed. In the future, it will also be studied about how the response and the level of user acceptance of this ViCT application after it was built. It is hoped that the development of this application will also be developed by exploring wider roaming routes or the entire campus area; then the level of information can be increased on the existing equipment in the laboratory to provide more detailed information to users.

6   Acknowledgment

7   References

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