JOIN (Jurnal Online Informatika)
p-ISSN: 2528-1682, e-ISSN: 2527-9165
Volume 8 Number 2 | December 2023: 186-193
DOI: 10.15575/join.v8i2.1030

Designing a Virtual Campus Tour using Image Stitching Techniques to Provide Information on College Entrance Test

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Article Info

Article history:

Received February 16, 2023
Revised November 10, 2023
Accepted November 14, 2023
Published December 28, 2023

Keywords:

Entrance test
Geolocation
Image stitching
Virtual tour

ABSTRACT

The University of Bengkulu administers college entrance exams, however some test takers still require assistance in locating the correct room, despite the building being marked. It is crucial to avoid errors in finding the right test room, as it can cause potential students to waste valuable time. Therefore, a more precise and practical solution is necessary to provide information on test locations. This study designs a location-based virtual tour that offers a 360-degree view, providing information on the location of each building and the conditions inside and outside each test room. The virtual tour encompasses 81 buildings, including test rooms, with 28 to 32 images captured at each location, then stitched together using image stitching techniques. The goal of the virtual tour is to create a comprehensive view of the test location and provide more detailed information on the room's condition. Furthermore, the usability of this virtual tour was tested on 140 high school students as potential test participants, utilizing the System Usability Scale (SUS) to evaluate its effectiveness, resulting in a score of 72.19. In other words, the virtual tour was found to be an effective tool in helping users understand the test location.

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1. INTRODUCTION

State universities in Indonesia are still the leading choice for students to continue their education. Being a student at a state university is a matter of pride for most people in Indonesia. What makes state universities unique is that the Indonesian government guarantees the continuity of education in state institutions (PTN) [1], [2]. Cheaper costs and adequate educational facilities are why many people choose PTN. The high demand for graduates from state universities in the world of work also provides opportunities and high ratings for state universities, thus making them more selective in accepting new students [3]. In general, there are two methods of accepting first-year students in college, the first is through the entrance examination, and the second is by merit assessment. The college entrance examination is carried out simultaneously nationally and is managed by a particular institution. The management of entrance examinations is distinguished based on a large area oriented to the geographical location of PTN. Implementing the entrance exam for at least the last five years was carried out using the Computer Assisted Test (CAT) method, and the announcement was disseminated via the internet. Meanwhile, the entry route through the academic assessment of students at the high school level is assessed based on academic reports and non-academic achievements of students, such as sports and arts.

There are an average of 12,000 to 14,000 participants per college who take the college entrance examination each year. However, not all participants get enough information about the test location, which is carried out directly in the test room. Universities do many things to get the best student input, especially in Indonesia. They compete to be the best by improving academic achievement and achievement as well as services for the public. Universities in Indonesia also open up great opportunities for prospective students from abroad. This certainly makes Indonesian universities have to provide better access to information, excellent help desks, and attractive visualizations as a representation of their institutions [4]–[6]. Building an international language academic website and providing scholarships and dormitories is a form of the seriousness of higher education institutions in Indonesia in responding to the competition [7]–[9]. Regrettably, test takers frequently encounter difficulties in locating their designated examination venue, which may result in unnecessary time wastage.

Providing complete and exciting information for prospective students is essential in demonstrating the existence and reality of the college [10]. Today's massive growth of virtual technology allows universities to develop applications to present visual information. Related to the previous explanation, this study discusses virtual campus tours' role in providing information for the public, especially for prospective students [11]. A virtual tour is a tour in the electronic version as a simulation of the actual situation to bring the user experience to tour the virtual world [9], [12]. Universities indeed need virtual tours as a medium for providing information and promotion. Prospective new college students need to be facilitated with location-based information equipped with visual information about the location of the test carried out in a 360° manner. A virtual tour of the campus that provides a comprehensive view is a practical solution for displaying information on college entrance exam locations. For prospective students whose location is outside the city where the test is held, of course, utilizing online media is needed instead of seeing it in person. Research on virtual campus tours has been done a lot [5], [9], [13], also with 360° visualization [14]–[16]. This research proposes the development of a virtual tour specifically for college entrance test locations with an image stitching approach with 360° visualization [13], [17]–[19]. Image stitching is merging images of two or more of the same scenes into a panoramic image. The image stitching method can be classified into two general methods: direct and feature-based. The direct method compares all the pixel intensities of the image with each other, while the feature-based method aims to determine the relationship between images through various features extracted from the processed image [20]–[23].

The stunning panoramic image that we have produced is the product of a meticulous process that involves merging multiple images. We take great care to consider the boundaries of each image, focusing on significant points during the capture of each one [24], [25]. Our research takes into account various factors that impact the final image, including shooting position, time, and weather conditions. To stitch the images together, we use a feature-based approach that requires a precise alignment of corresponding features [26]. Additionally, we have included the latitude and longitude data for each building, enabling us to provide directions to the building's location using the Google Map API. Prior to deploying a virtual tour within the community, it is crucial to conduct usability testing to guarantee user acceptance of the system under development. There are several techniques to perform usability testing; however, for this study, we utilized the System Usability Scale (SUS) method [27], [28]. We opted for the SUS method because it simplifies evaluations for respondents, differentiates between working and non-working features and programs, and necessitates a relatively small sample size while providing optimal results [29].

2. METHOD

To begin our research, we gathered all necessary tools and materials, such as cameras, pictures of the test location, and landmark buildings. To ensure the utmost accuracy of the test location, we conducted an interview with the test organizing committee at the University of Bengkulu. Based on the information gathered from the interview, we collected the coordinates of each location and the number of rooms. Our aim was to incorporate test location information into the system via the Google Map API. During the image collection stage, we utilized the Canon EOS 200D camera to capture 28-32 indoor and outdoor images of buildings and exam rooms at each location to obtain the optimal results. Following the data collection, we merged the images using the PTGui application's image stitching method [30]–[32], as shown in Figure 1. This process enabled us to create new images with a 360-degree view. We then imported the 360-degree images into the 3Dvista software to generate a virtual tour [33], [34]. Finally, we implemented geolocation information for each test location to apply the virtual tour to a website and perform usability testing of the virtual tour on respondents.

p-ISSN: 2528-1682
e-ISSN: 2527-9165

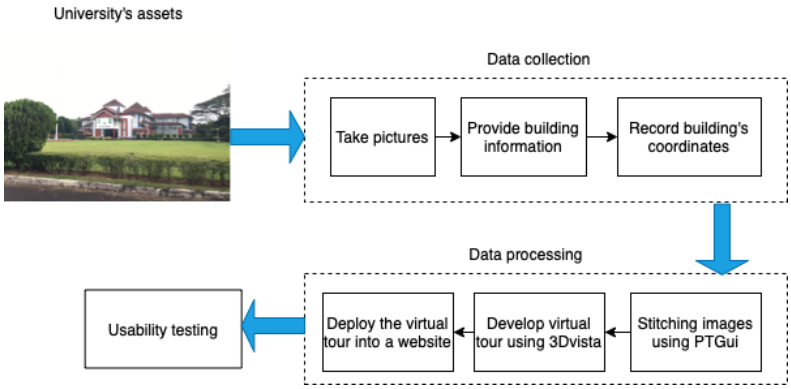

Figure 1. Research method

In order to guarantee that the virtual reality system is able to effectively communicate information to its users, a thorough usability test is conducted. As previously stated, the SUS method will be employed to carry out this test. The study involved 140 participants, all of whom were high school students from the Bengkulu province and had the potential to utilize the virtual reality system to acquire information concerning the location of college entrance exams at Bengkulu University. This research uses the MDLC (Multimedia Development Life Cycle) method, an appropriate method for designing and developing a media application that combines image media, video sound, animation and others. The MDLC method has six stages: Concept Design, Material Collecting, Assembly, Testing and Distribution [35]–[39].

2.1. Concept Design

In the initial stages of design, a virtual tour workflow is developed to enhance user experience. The main page offers users a choice between two options: information about the college entrance examination or the building where the test is held. As depicted in Figure 2, if the user selects the location option, the system will provide specifics regarding the building's description and location utilizing a digital map. Furthermore, if the user desires a more immersive experience, they may embark on a 360-degree virtual tour of a specific location.

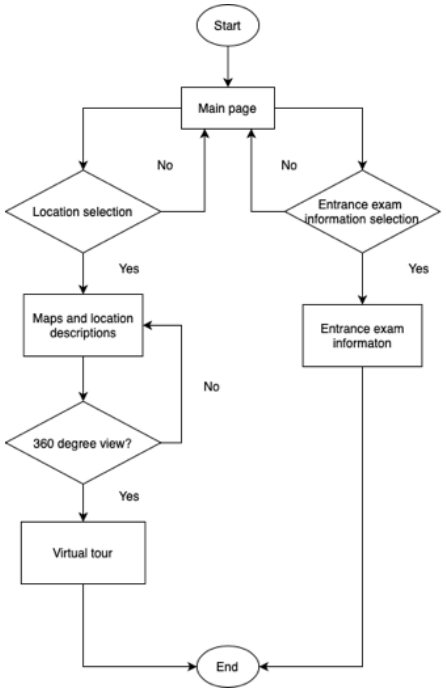

Figure 2. Virtual tour workflow concept design

2.2. Material Collecting

Capturing images is a crucial step in the process of collecting materials. It is essential to determine the appropriate time to take photos to ensure that the lighting and environmental conditions of the main object in the image can be easily managed during the stitching process. The act of act of shooting, whether performed in indoor or outdoor settings, is typically divided into three distinct segments: top, middle, and bottom. The technique for taking these images is depicted in Figure 3. This approach to shooting enables individuals to understand better and improve their technique, leading to more excellent proficiency and accuracy. It is worth noting that this segmentation strategy has been widely utilized by professionals and experts in the field, highlighting its effectiveness and importance. By focusing on each segment methodically and deliberately, shooters can gain a deeper understanding of the nuances and intricacies of the process, leading to improved results and heightened performance. This virtual tour showcases 81 locations at Bengkulu University, including 22 room used for testing. There are also 59 other buildings, such as departmental buildings, lecture halls, and rectorates, which are significant landmarks, which is not used for tests but is sufficient to provide information for test takers and the wider community. We took between 10 to 15 pictures of the building's exterior, with a focus on the front side that includes the courtyard, yard, or parking lot. For the interior, we snapped shots of the test room, taking as many as 10 to 17 pictures. The indoor images offer more details on the participant's table placement. Each table is equipped with a PC that has a unique sequence number, making it easy for the user to identify where they will take their test. We also record the building's coordinates during the material collection process, which are embedded in Google Map-based maps on the system.

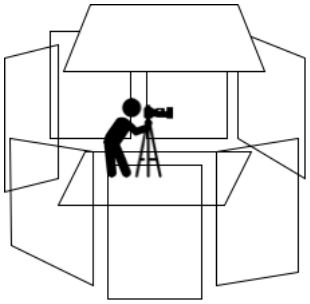

Figure 3. Technique in taking pictures

2.3. Assembly

During the assembly process, multiple images are merged to produce a comprehensive 360-degree view. This process involves two crucial stages: image stitching and virtual tour development. Image stitching entails utilizing PTGui to arrange and merge images, while paying attention to key-points. Key-points represent edges of the image that bear similarities to other edges. By identifying key-points, a complex object created with multiple images can be accurately portrayed. Once key-points are established, the stitching process commences, resulting in a seamless 360-degree image. The generation of 360-degree images is followed by the creation of a virtual tour using the 3Dvista software to produce a virtual tour. Through 3Dvista, researchers can customize interfaces, select preferred virtual reality features, and regulate navigation within the virtual tour. It is essential to be mindful of hotspot points when constructing a virtual tour with 3Dvista. These points serve as starting points for users to navigate through the virtual tour. Usually, hotspot points are situated at the entrance of the building and then lead to other areas, such as indoor sections, to direct users towards the testing room.

2.4. Testing and Distribution

The testing phase was conducted to evaluate the usability of a virtual tour that was developed. SUS method was selected for the usability testing [40], [41]. The study enlisted 140 participants who were given a scenario and were scheduled to take the test at a specific location through the virtual tour. Out of the total participants, 100 were new students at Bengkulu University, and 40 were third-grade high school students from Bengkulu Province. Our aim was to gather diverse feedback by combining the experiences of respondents who had taken the college entrance test the previous year and high school students who were yet to take the test [42], [43]. The virtual tour was accessible to the participants via the internet, and they were accompanied by a research team. Following their use of the virtual tour, the

p-ISSN: 2528-1682
e-ISSN: 2527-9165

participants were requested to share their experiences by completing the SUS questionnaire. The questionnaire instrument used consists of ten questions as follows:

1) I was thinking about using this virtual tour system again.
2) I need help with this virtual tour system.
3) I find this virtual tour system easy to use.
4) I need help from others when using this virtual tour system.
5) I feel that this virtual tour system's features (in terms of navigation, buttons and 360° display) are working correctly.
6) I feel that many things are inconsistent and need improvement in this virtual tour system.
7) I feel that others will quickly understand how to use this virtual tour system.
8) I find this virtual tour system confusing (in terms of navigation, buttons and 360° display).
9) There are no obstacles to using this virtual tour system.
10) I must familiarize myself before using this virtual tour system.

The results of respondents' answers to the ten questions will be calculated according to the testing mechanism through SUS. Each participant will provide a rating for each question in the questionnaire with a 5-point scale number from 1 (strongly disagree) to 5 (strongly agree). The score given by the participant for odd-numbered questions will be reduced by 1. Similarly, for even-numbered questions, 5 will be subtracted from the score given by the participant. Then, the total score of each participant will be multiplied by 2.5. Finally, the average score ($\overline{x}$) obtained from the total score ($\sum x$) of the 140 participants (n) will be calculated using formula (1).

$$\overline{x} = \frac{\sum x}{n} \quad (1)$$

3. RESULTS AND DISCUSSION

We collected a total of 2,504 images to construct this virtual tour. Table 1 presents detailed descriptions of ten specific spots that serve as examples of the 81 buildings and spaces photographed.

Table 1. Data of buildings

No	Location	View	Number of images			Total
			Top	Middle	Bottom	
1	Rectorate Building	Outdoor	10	12	10	32
2	LPTIK Building	Outdoor	10	12	10	32
3	LPTIK Room 1	Indoor	9	10	9	28
4	LPTIK Room 2	Indoor	9	10	9	28
5	LPTIK Room 3	Indoor	9	10	9	28
6	LPTIK Room 4 and 5	Indoor	9	10	9	28
7	LPTIK Room 6	Indoor	9	10	9	28
8	Laboratory of the Faculty of Engineering (LFT)	Indoor	10	12	10	32
9	LFT Room 1	Indoor	9	10	9	28
10	LFT Room 2	Indoor	9	10	9	28

The process of making this panoramic image is carried out by the stitching method with PTGui. The images stacked together will be used as key points where the key points will match each other so that the images can be stitched will be used as a 360° virtual tour. The image selection process can be done all at once or individually. After the image is selected, the next step is to align images, one step of analysis for the selected image by specifying a key point. It can be seen in Figure 4 that the key point determination and in Figure 5 are the result of stitching.

Furthermore, the panoramic images are used to create a virtual tour. The steps taken through 3Dvista are to import 360-degree images, specify skins and hotspot points. The skin is used for a graphical interface containing virtual tour elements. It usually consists of a viewer graphic frame in which the media is played and different optional button icons such as zoom-in, zoom-out, info/help, audio mute, and media list. Skins can have many different designs and come in various shapes and colors. In addition, a point hotspot is a point of placing information or a transition point to another room.

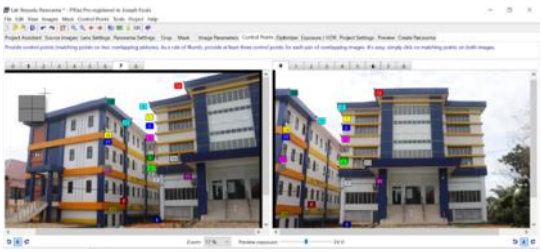

Figure 4. Determining key-points

Figure 5. Panoramic image of stitching results

Henceforward, creating a virtual tour is carried out using 3Dvista software. First, the stitching images are imported into the 3Dvista software. During the tour, we incorporate skins and hotspot points. Skins serve as a user interface that offers virtual tour elements such as a viewer graphic frame, and optional button icons like zoom-in, zoom-out, info/help, audio mute, and media list. Skins come in a variety of shapes, designs, and colors. We also use point hotspots as a way of providing information or transitioning to another room. The skin is positioned at the bottom = 0, top = 76.46, and there is a panel that functions as a container for other panoramas. Achieving smooth navigation while exploring a building is critical. It is essential to have easily accessible control buttons to ensure a seamless experience. 3Dvista's virtual tour elements are designed to enhance the user experience and include the viewer graphic frame and optional button icons, such as zoom-in, zoom-out, info/help, audio mute, and media list. These can be configured in a wide range of shapes, designs, and colors, providing developers with the flexibility to customize the look and feel of their virtual tour. Figure 6 illustrates how users can initiate their tour, starting from the white arrow-shaped hotspot, which serves as the entry point for exploring the building.

Figure 6. Providing hotspots in the process of creating a virtual tour

The next step is to incorporate the virtual tour into a website-based system. This will enable the virtual tour to be integrated with Google Maps by assigning coordinates. The web-based system can also provide additional textual information such as schedules, building names, room names, room capacity, and table numbers. The interface illustrated in Figure 7 provides users with access to location information that is relevant to exam location. The Google Maps API, which is utilized by the interface, enables users to obtain the shortest route to the specified testing site. This functionality ensures that users can retrieve the necessary information in a timely and efficient manner.

Figure 7. Virtual tour system equipped with location information

Following our comprehensive usability testing, we have determined that the total value accrued was 10,180, which we then divided by 140, resulting in a score of 72.19. These findings indicate that the virtual tour system can be categorized as "good" [44], [45]. Including images in a 360-degree view can provide a more comprehensive understanding of a location and lead to more accurate information than non-panoramic images [5]. In the important situation of finding college entrance test buildings and rooms, it is necessary to have complete information. This research offers a more specific approach in providing location information for the national college entrance test compared to other campus virtual tours [46], [47].

4. CONCLUSION

Navigating to the correct location at Bengkulu University can pose a challenge for exam-takers. However, a viable solution to this problem is virtual tours. These tours provide a wealth of information about the test location, including the schedule, room capacity, and geolocation data which can be accessed via Google Maps. The virtual tour boasts 81 building spots, showcasing both indoor and outdoor conditions, which includes the examination room. Moreover, the tour uses image stitching technology to display 360-degree images. The usability of this virtual tour was tested on 140 participants using the SUS method, which resulted in a score of 72.19, indicating a positive user experience. Although the virtual tour is currently limited to the exam location, it can be extended to encompass all buildings and campus amenities, maximizing its benefits.

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