Web-based Campus Virtual Tour Application using ORB Image Stitching

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***Abstract*— Information disclosure in the digital age has demanded the public to obtain information easily and meaningful. In this paper, we propose the development of web-based campus virtual tour 360-degree information system application at the State University of Malang, Indonesia which aims to introduce the assets of the institution in an interesting view to public. This application receives a stitched or panoramic image generated through the ORB image stitching algorithm as an input and displays it in virtual tour manner. This paper realizes the image stitching algorithm to present the visualization of the 360-degree dynamic building and campus environment, so it looks real as if it were in the actual location. Virtual tour approach can produce a more immersive and attractive appearance than regular photos.**

Keywords—web, campus, virtual tour, ORB, image stitching

I. INTRODUCTION

Information disclosure in the digital age provides space for the public to obtain related information to the public institution services effectively and efficiently. This era demands every public institution to open access for any individual who needs specific public information. Information disclosure can reduce the possibility of asymmetries information that often causes markets to be inefficient [1]. Better disclosure and transparency is essential to help public's encounter their minds on company's activities [2]. To realize this policy, ICT solution becomes a strategic choice. In fact, ICT facilitate the process of collecting, storing, processing, and disseminating of information in a digital format. ICT tools and services play an essential role in improving the availability of market information to the public who need.

Today almost all organization and institution utilize the Internet network to provide information to the public. Web application approach that runs on the Internet network is very appropriate used to introduce the assets of institutions and encourage public information disclosure. The web application approach considerably enhances corporations' ability to deliver their strategies and other relevant information directly to their primary stakeholders. [3]. The web application supports rich content, including multimedia contents such as text, audio, graphics, animation, and video. In fact, we can also include interactive content into web applications that make it more varied and exciting. Interactive is often used to describe the relationship of two things influencing each other [4]. Therefore, the presentation of public information should also be provide in an interesting, complete, and meaningful way.

In fact, there are still many institutions that provide basic public information system, for example in the State University of Malang (UM), Indonesia. The development of a web-based campus virtual tour 360-degree information system application is considered very appropriate to support the provision of interesting public information. Campus visual navigation is one of an example of a virtual reality application in modern education. This application focus on the campus digitalization and virtualization for optimized management, support campus plan and help decision-making of school development [5]. The virtual tour is emerging approach as an effective tool for destination marketing. To provide information in the virtual tour manner, we can take advantage of established and reliable public service, such as Google Virtual Tour. But there are still deficiencies in the service, among which are unable to uncover specific locations, especially private or indoor places. Therefore, the development of virtual tour applications is still highly relevant to current needs.

In this paper, we propose the development of web-based campus virtual tour 360-degree application. In this work, we utilize the ORB image stitching algorithm which is a combination of several algorithms in the field of computer vision. The result of this application can present the visualization of pictures of buildings and campus environment which moves 360-degree dynamically, so it looks real as if it was in the real environment.

II. RELATED WORKS

A virtual tour is an interactive simulation of an existing location on the earth, usually composed of a sequence text, still images, and panoramas. The term "panorama" denotes an unbroken tour/view because a panorama usually a series of images captured by the photographer or the video footage [6]. These virtual tours have taken from a series of panoramic photograph known as a vantage point.

Virtual tour basically is a virtual environment in computer which reconstructs a famous places virtually [7]. This method

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provides a special sensation to users as if the users visit the area in foregone. Virtual environments are being utilized in a wide range of academic and commercial applications.

The study of virtual tour application has been done and intended for various purposes. Wu et al. [8] proposed a project plan of "Virtual tour at Tsinghua University". In their research, Wu is still limited to produce panoramic images and has not provided supporting features such as rotation and user control. Yang et al. [9] proposed a feasible model and development environment to provide an interactive virtual navigation application for creating and utilizing digital campus approach. However, when considering this scheme in real-time interactivity, especially involved the large-scale data, in-depth research is still necessary. Manghisi [10] proposed a gesture-based interface solution to navigate a virtual tour application on display. This work is also comparing the implemented interface with a traditional mouse-controlled menu with the proposed gesture-based interface to gain the more user engagement.

Referring to the related studies we have mentioned, we can highlight the differences works with our proposed research. To generate stitched images, we utilize a very good-performing ORB algorithm proposed by Wang [11]. The output from this stitch stage we process using HTML and jQuery library to produce a 360-degree panoramic virtual tour. So, here we take advantage of existing and proven performance algorithms and then integrate into a virtual tour campus application that aims to introduce the assets of institutions and encourage public information disclosure.

III. METHODS

A. System Design

This paper describes the implementation of virtual tour 360 applications by utilizing the ORB algorithm. Development of application focus on a web environment that runs on the Internet network. The web app approach is apt as it provides broad access from all corners of the globe and allows various devices to access it, including mobile devices. The architecture of the proposed application shown in Figure 1.

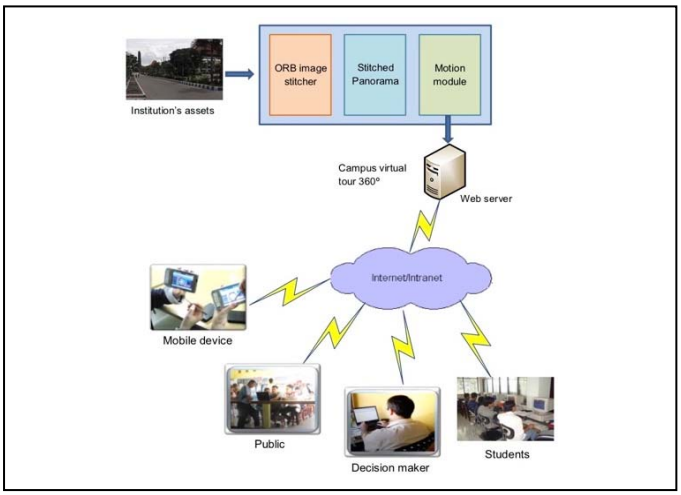

Fig. 1. System architecture

There are two main activities in the development of this system: image stitching, and panorama motion.

1) Stitching

Image stitching is an activity in image processing by combining a set of images into a larger panorama image with a wider field of view of the scene [12]. The goal of this process is to generate natural-looking mosaics free of artifacts that may occur due to some effects, such as relative camera motion, optical aberrations, and illumination changes. [13]. To generate stitched image we use ORB image stitching algorithm.

2) Motion panorama

After a series of stitched images generate an image panorama, the next step is to apply motion techniques to rotate the panoramic image display, so it looks immersive like the original. To implement this module we use the HTML script combined with the jQuery library. The working of this module is to rotate the image left or right to display the entire picture. This approach provides visualization as if the image is moving and the user is like being in its original location.

B. ORB Image Stitching

Image stitching is the basic construction process of a series of overlapping images into a single panoramic image with a high resolution. This activity is widely implemented in real-time applications and is an interesting topic in the field of computer vision and computer graphics experts. How the image stitching works are started by matching points that have similarities in two or more images and then produce a composite image form.

Until now there are various techniques in the field of computer vision to realize image stitching, one of which is Oriented FAST and Rotated BRIEF (ORB) developed by Rublee [14]. ORB is principally a combination of the Accelerated Segment Test (FAST), Harris, and Binary Robust Independent Elementary Features (BRIEF) algorithms. The working flow of the ORB algorithm shown in Figure 2.

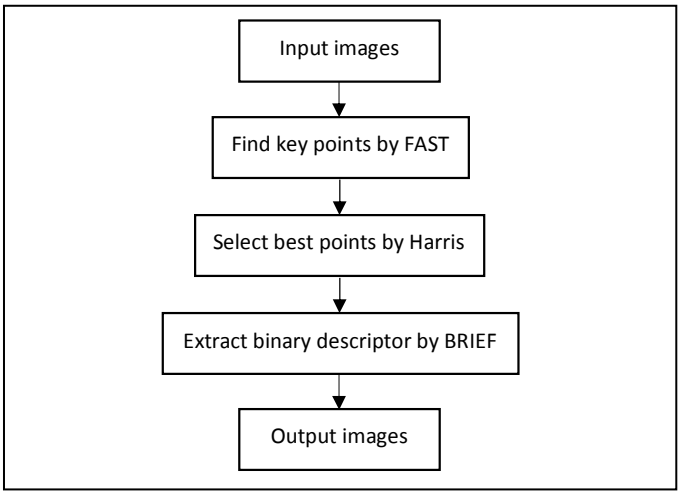

Fig. 2. ORB image stitching stages

The workings of the ORB algorithm start from the comparison and matching of two or more images. ORB builds on the well-known FAST key point detector to find the efficient corner key points. ORB utilize Harris corner filter to reject edges and provide a reasonable score. Finally, it uses a recent feature BRIEF descriptors to produce a smoothed image patch. This descriptor is used for image stitching, and shows good rotational and scale invariance [14].

IV. Result and Discussion

A. Result

As we mentioned, there are two main modules in this application: stitching and motion panorama. The first stage is the image that will be generated in a stitched image. To ensure the implementation of the algorithm, taking the picture is done using pure cameras without special features, such as panoramic. Examples of the results of two images with overlapping shown in Figure 3.

Fig. 3. Image sources taken by camera

To get a stable shooting result, we use a tripod on the smartphone camera. This technique is essential for obtaining optimal stitching results or reducing unmatched points. Shooting done on bright lighting is also proven to produce excellent stitching. The image stitching results are shown in Figure 4.

Fig. 4. Stitched image result

On taking pictures of locations on campus, we use a smartphone camera. This stage is conducted during the day by targeting places that become the assets of the institution. Shooting on location involves about six camera angles to get enough overlap area. If the stitching result of the series of images still shows a mismatch, then the location is retaken. In the final step, as a usual panoramic shooting process, we need to cropping the images to get the symmetrical area.

Stitching stage is the primary key to get an excellent panoramic image. The output of this stage will be processed by the panorama motion module to present the visualization of the virtual tour application. The implementation of web technology in this application provides easy and wide access advantages. The appearance of virtual tour web application in the State University of Malang shown in Figure 5.

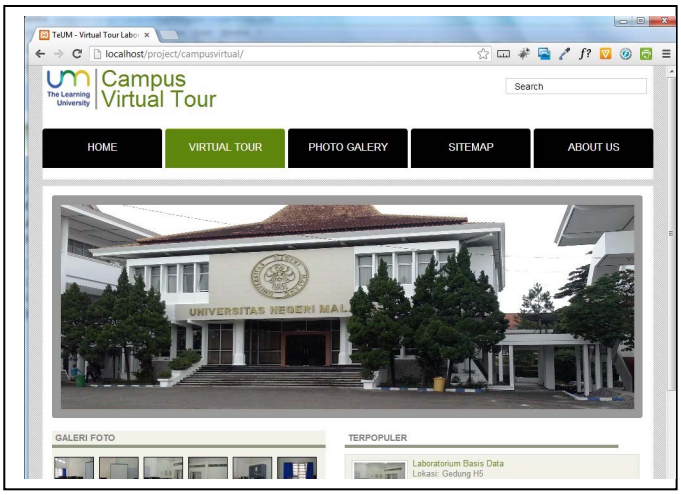

Fig. 5. Virtual tour panorama application

Utilization of web-based information system applications can be a publication media as well as effective promotions that can be accessed widely whenever and wherever without depending on space and time. The main feature provide on this application is a 360 panoramic virtual tour with user control navigation. Through this control interface the user can navigate like start/pause, scroll, and zoom in/out.

Once we succeed in developing the system, the next step is to ensure that the system is correct and properly constructed using a series of tests. Testing conducted using the black-box method and based on the scenario in each subsystem. There are two scenarios that we involve: normal and alternative scenarios. Alternative scenarios arise when there is branching, for example at the stitching stage, the result might be either successful and failure.

There are two main modules that will be a focus on testing, including stitching and motion panorama. The test procedure is performed sequentially from the smallest unit until the finish. The complete testing result is shown in Table 1.

TABLE I. Functionality Test

Module	Testing		
	Scenario	*Methods*	*Results*
Stitch	Normal	Black-box	Accepted
	Alternative	Black-box	Accepted
Motion	Normal	Black-box	Accepted

Module	Testing		
	Scenario	***Methods***	***Results***
panorama	Alternative	Black-box	Accepted

The black-box testing procedure is done by giving input to the system and observing its output. If the outcome has met, by the initial specifications, it can be stated that the product is working properly. Conversely, if the output does not meet, then be repaired and retested to fit. The overall results of the tests on the module, both normal and alternative scenarios, show that the product is working properly and no defects are found.

B. Discussion

Stitching images is an early stage in computer vision to produce panoramic images. Realization of image stitching is done by employ the ORB algorithm. The process of the ORB algorithm on the shots in bright places using a tripod looks very impressive, in which there is almost no mistake point between one image and the other. This process proves that the ORB algorithm has a good performance and can produce panoramic images.

Implementation of virtual tour application in this research is represented by giving motion effect to a panoramic image. This step is realized through the HTML code combined with jQuery library and PHP programming language. This approach is also used to provide user control, making it easier to navigate the panorama. In order to provide complete information to the public, the panoramic view is also complemented by mapping access to locations. Utilization of web-based applications strongly supports the publication of information widely.

The panoramic image approach is best used in campus virtual tour 360-degree applications aimed at introducing institutional assets and promoting public information disclosure. Compared to the use of static video, virtual tour panorama has several advantages, among which is lighter because in principle only in the form of images. The virtual tour also allows for better interaction supported navigation and user control, such as scroll, zoom in/out, and integration with other interactive menus. The results of the implementation show that the virtual tour approach can produce a more immersive and attractive appearance than regular photos, so it looks real as the original places.

V. CONCLUSSION

A web-based campus virtual tour 360-degree information system application is one of the appropriate strategies to support public information disclosure. The utilization of the ORB image stitching algorithm can produce a quality panoramic image with an excellent level of matching. Implementation of the motion feature makes the application more interesting as the real location. Finally, with the availability of varied information content, including text, images, and dynamic panorama provide a new experience for the public in obtaining the necessary information in a meaningful manner.

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