

Development and Evaluation of an Interactive 360° Virtual Tour for Tourist Destinations

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Abstract

This paper describes the development and evaluation of a virtual tour prototype for tourist destinations. Four interesting destinations in Perlis, located in the northern region of Malaysia were selected. It allows the users to navigate and to listen to the background sounds and narration, as well as to read brief information about each place. Each panorama contains hotspots that enable the users to further explore the surroundings. All pictures were combined using photo stitching technique to produce panoramic images. The planar panorama was set as the panorama type. The first usability test was conducted to gain user feedbacks towards the virtual tour and to make refinement to the prototype. The second usability test was intended to measure its usability in terms of user satisfaction and effectiveness. The virtual tour received positive feedbacks and all participants agreed that it could attract tourists to visit the actual place.

Keywords: Planar panorama, photo-stitching, usability evaluation.

Introduction

Virtual reality (VR) can be defined as a three-dimensional multisensory, immersive, and interactive digital environment that has triggered public imagination as future technology that will dominate our work, education, and leisure (Roussou, 2004). On the other hand, virtual tour which possesses virtual reality elements is virtual navigations of landscapes that exist in the real world (Li, Lien, Chiu, & Yu, 1999). According to 360-virtual-tour-company.com, virtual tour is an immersive technology that places the viewers inside the image, enabling them to significantly enhance situational awareness and providing the highest level of functionality for viewing, capturing and analyzing virtual data. Virtual tour can be clarified as a simulation of an existing location that is composed of a sequence of video images. In addition, it can be developed from photographic-based media or panoramas that have an unbroken view. All of these techniques used to develop virtual tour were derived from virtual reality itself that is created by computer to generate an experience of virtual world (Zhang, Lv, Zhang, Chen & Zhang, 2009). The virtual tour developed in the research consists of still images that were combined using stitching technique to produce panoramic images. The four destinations chosen were a snake farm, a recreational lake, a cave and a waterfall. These places are among the most popular and mostly visited by tourists when they come to Perlis.

Related Work

Wu et al. (2005) defined the three steps to realize tour in electric world whereby the first step is to convert the entire real environment into electric models. The second step is to stitch the photographs of actualities into a picture of virtual environment. Finally the third step is to mix the previous two steps, by setting up the scene using 3D models combined with photograph conjoining. However, the previous study made by Chen (1995) demonstrated a better technique because it consisted of linking process that can link between the hotspots and the compression steps in order to have a small size for fast loading.

In his study, Chen (1995) wrote on about the five steps in panoramic movie making, as opposed to the three steps defined by Wu et.al (2005) which starts with node selection to maintain the visual consistency when moving from one to another. The second step is stitching process to create seamless panoramic image from a set of overlapping pictures. The third step is hot spot marking which is to identify regions of panoramic image for interactions, such as navigation or activating actions. The fourth step is linking process where it connects and registers view orientation between adjacent panoramic nodes. The last step is dicing and compression in which the panoramic and hot spot images are diced before they are compressed and stored in a movie.

On the other hand, Li et al. (1999) focused on generating animations of customizable tour paths and its associated human/camera motions. The system is capable in providing customizable guided tours to a remote user. Besides that this system also incorporates motion-planning algorithms to generate collision-free paths for the tour guide and for the virtual camera.

Improvements from Li et al. (1999) study were applied in a study of virtual tour into the picture using a vanishing line and its extension to panoramic image that was done by Hyung et al. (2001). They used spherical panoramic images that allow users to view from a camera which are mapped onto the base sphere centered at the camera position. Finally they successfully shown modeling scheme that naturally extended to navigation into a panoramic image. Furthermore they provided the real sense of walk-through or navigation into the panoramic scene by enabling continuous camera translation as well as rotation.

Besides studying the articles of previous virtual tour project, observation on technique used in several virtual tours which were available through the Internet has also been made. Harvard Virtual Tour that can be accessed from harvard.edu was designed and developed to allow people around the world to take a look of the campus surroundings. It contains twenty places inside the university that can be viewed virtually. They used Quick Time Virtual Reality (QTVR) as a player to play the virtual tour. The virtual tour used cylindrical panorama in order to stitch images and view the surroundings. It provides map for each location and a link to enter the hotspot, as well as textual description of each place.

UiTM Virtual Tour that is embedded into UiTM Perlis website was developed to provide its visitors with better snapshots of the campus. The images were stitched using spherical technique and the virtual tour was displayed as cylindrical panoramas. This virtual tour provides four hotspots that can be clicked. User can use its navigation tools to view in 360° rotation to zoom in

and to zoom out the surroundings. However, there was no narration or background sound embedded into it.

In similar context, Rice University provides virtual tour with 300-acre campus view and its urban surroundings that is embedded in its website located at www.rice.edu/virtualtours/. The virtual tour was developed using high quality pictures and equipped with the university map to allow users to click on the hotspots and further view the surrounding. This 360° degree panoramic view put user in the centre of the university. The cubic panorama was adopted to display the panoramic images. User can select an image to navigate around the places. Each panorama was accompanied with brief description and useful links that give further insight into why Rice is such a best place to study, work and play.

In contrast to other samples of virtual tours, virtual tour for University of Denver was developed using sequence of video images. This virtual tour provided testimonials by the students who were studying there. The video will change the scene depending on the student explanation. User can easily choose another location if they wanted to change the scenery since the menu is placed at the left side of the virtual tour itself. Nevertheless, the drawback is it does not provide any navigation tool for the user. As such, user can only play, pause or stop the video.

On the other hand, the Mohave County virtual tour from virtualtourmedia.com provided more choice of navigation where user can use keyboard to move around horizontally and vertically. User can also zoom in or out while traversing the panorama. Since the photos used were high in quality, the panorama remained clear and consistent while the user zoomed in. However the virtual tour did not provide any clickable hotspot. Thus, user needs to choose another location through hyperlinks that were displayed on the website.

Development

Techniques

Image stitching or photo stitching is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama or high-resolution image (Ward, 2006). The stitching quality is measured visually by the similarity of the stitched image to each of the input images, and by the visibility of the seam between the stitched images (Zomet, Levin, Peleg and Weiss, 2006). Nevertheless, researchers have proposed techniques for stitching multiple photographs into single contiguous panoramic picture. Recent full view stitching methods allow automatic picture stitching if they are taken in arbitrary order or spatial arrangement (Baudisch, Tan, Steedly & Rudolph, 2005).

Software Used

The software packages used in developing this virtual tour application were Pixtra Panostitcher v1.5, Easypano Tourweaver v5, Adobe Photoshop and Sony Sound Forge 8.0. Pixtra Panostitcher was used to assist photos stitching process. It helped developer to stitch the images and also allowed developer to manually adjust the overlap between photos during stitching process. Adobe Photoshop was used to adjust the color balance and the brightness of the panorama. Moreover,

the process of editing and recording the sounds was done by using Sony Sound Forge software. Finally, the Easypano Tourweaver was used to develop the application by importing the panoramas, integrating the sounds and adding navigational features.

Steps

The prototype was developed by adapting the five steps defined by Chen (1995).

Node Selection

Node has been selected to maintain visual consistency when moving from one point to another. The camera was mounted on a tripod and centered at its nodal point. Then the camera was rotated in 360 degree of x-axis from the start point to the end point. Each image must have overlap with the start point.

Photo Stitching

The purpose of stitching is to create an ideal panoramic image from a set of overlapping pictures. In producing a good panoramic image, 50 percent overlap pictures is needed because the adjoining pictures may have a very different brightness level (Chen, 1995). But it also may vary depending on the image features in the overlapping regions. For a normal stitching session, the pictures were stitched automatically and some pictures were stitched manually by adjusting some points as remarks that were used to adjoin the pictures.

Image Compression

After stitching and editing process were completed, the panoramic image was resized to the optimal size that can be rendered by the application. The image was compressed by reducing the size from more than ten thousand pixels into 4996 pixels width.

Sound Recording and Editing

In this phase, the narration for each place was recorded and edited. Besides that, the background sounds were also edited using the Sound Forge software. The editing was necessary to remove noise that will affect the sound quality when it is integrated into the prototype.

Interface Design

Before developing the application, the template has been chosen from the software library. Some hand drawn sketches were made to guide the design process. There were some adjustments made to the template based on the sketches.

Sound Integration

Next phase is integrating the sounds into the virtual tour software. Sounds were imported into the software after completely edited. The sound supported by software is in mp3 format. There were four types of nature sounds that were imported which were sounds of bird, cricket, waterfall and snake. Besides that, four sounds that contain the narration of each place were also imported.

Hotspots Marking

Hotspot (hot area) identifies regions of a panoramic image for interactions, such as navigation or activating actions. The hotspot image does not need to have the same resolution as the panoramic image. By clicking on the hot spot mark, this application will bring user to the hotspot region. Arrow symbols were elected as indicator where this application will bring user to the hotspot areas once it is clicked.

Panoramic Linking

The linking process connects view orientation between adjacent panoramic nodes. The links were attached to a hot spot so that the user may activate the link by clicking on the hotspot. In linking process, besides creating a link between panoramic images, transition effect from the current scene to the hot spot scene can also be selected. In addition, transition duration was set up in this phase.

Usability Evaluation

The prototype was embedded into a university website and has undergone the first phase of formative evaluation. The usability tests were conducted to gain user feedbacks and to measure the usability of the prototype pertaining to user satisfaction and product effectiveness. The usability tests were conducted in the computer laboratory of the university. One of the researchers acted as the facilitator, who conducted the session. The participant was introduced to the prototype and was briefed on the purpose of the usability test. In order to provide a comfortable atmosphere during the test, the facilitator assured every participant that he or she was invited for the purpose of evaluating the prototype only. Since it was found that testing with around five users will discover most of usability problems in a particular interface (Nielson, 2000), the first usability test was held with ten participants aged 20 to 40 years old; four males and six females. The participants came from technical and non-technical background, and have never seen or used a virtual tour before. However all of them have used the computer for more than three years. They were four university students, two computing lecturers, one non-computing lecturers, two Information Technology support officers and a clerk. All participants were required to interact with the prototype according to a set of tasks.

The tasks centered on navigating the prototype such as exploring a destination, entering a hotspot and viewing its surroundings as well as using the navigation tools and reading the textual description. Only mouse was used as input device. After the usability test session, each participant was informally interviewed regarding their opinion towards the prototype. The feedbacks gathered from the test were used to make some refinement.

Then, the second usability test was performed with another five participants in the same age range. They were a male general worker and four females who were a computing lecturer, a non-computing lecturer, a preschool teacher and a primary school teacher. The participants were required to perform the same tasks. Once they had accomplished all tasks, they were asked to fill in an evaluation questionnaire to rate their satisfaction towards the speed of scene movement, image quality, sounds and attractiveness of the virtual tour. In addition, they had to rate the effectiveness of the application pertaining to the terminologies used, its navigability and the textual description. The answers ranged from 1 (Strongly Disagree) to 4 (Strongly Agree).

Discussion and Findings

The first usability test elicited a few requirements and useful suggestions. They are summarized in Table 1.

Table 1. Results of Usability Test 1

Evaluation Criteria	Feedback
<i>Speed of scene movement</i>	Moderate but when the navigation panel was clicked, the speed became too fast.
<i>Navigation</i>	Easy to navigate.
<i>Background sounds</i>	Most participants liked the sounds. However, some felt that the cricket sound were frightening.
<i>Terminologies</i>	Some terminologies were confusing such as there were two terms of 'Exit Cave' in different locations of a destination named Cave of Darkness.
<i>Quality of scenes/images</i>	Image quality was mostly satisfied by the participants, but there should be a closed-up photos of Snakes in the Snake Farm
<i>Voice description</i>	Suitable and clear, but there were some uneven tones.
<i>Text description</i>	Clear and readable.
<i>Attractiveness</i>	Yes, attractive.
<i>Suggestions</i>	Add more attractive and famous places. Scene lighting and color need to be enhanced.

Some refinements were done in term of sounds, button, speed, terminologies and transition effects. The volume of cricket sound that was used as the background sound was reduced and changed to a smoother sound of cricket to provide a more enjoyable experience while navigating. Snake sound were edited to make it more similar to the real sound of snakes. From the observation, none of the participants changed to full screen view since there was no button for it. Initially, users had to right-click on the screen and choose full screen features. From the feedback, one participant wanted to turn off the sound. Thus, the two buttons (full screen mode and sound control) were added into the prototype. Furthermore, the problem in the speed of scene movement was solved. The speeds for each panorama were decreased to three seconds per frame. Terminologies that were used in the scene have been altered to more suitable terms that will guide the user in their virtual visit. For example 'Exit Cave' that appeared twice in the scene was changed to 'Enter Cave' and 'Bath Area' was changed to 'Recreational Area'. Finally, the transition effect such as slide, circle, spin and blinds were applied to all hotspots that were set for each place.

In the second usability test, all evaluation criteria were either agreed or strongly agreed by the participants. This indicated that the virtual tour received positive feedbacks from all participants. Three participants agreed that the speed of scene movement and the background sound were suitable. Four participants agreed that the images used were of high quality and that the virtual tour could attract tourists to visit the actual place. In terms of the terminologies used, four participants agreed that it was appropriate while three of them agreed that the textual description in the application helped users to know the place better and that it was easy to navigate.

In general, all users were satisfied with the application. However, based on the score, there are areas of improvement to make it more appealing. For example, it should be combined with Flash animations, especially when the hotspots are clicked. More places should be added so that tourists could get a glimpse of the interesting destinations in a particular state. Besides that panoramic view of places such as the Snake Farm can be improvised by having a closed-up image of snakes instead of image of snake cages and its surroundings. This application can also be enhanced by showing the real activity that can be done at the selected places such as canoeing activity by the lake area and integrating video of snake shows at the Snake Farm. Moreover, to enhance the user experience while browsing through the application, it should be provided with a 3D walkthrough. Nonetheless, it was observed that users could easily adapt to the virtual tour and enjoyed themselves while visiting the places virtually.

Conclusions and Recommendations

The research discovered user preferences towards a virtual tour for tourist destinations. It was found that virtual tour can be used as a tool to promote tourism since it provides attractive panoramic view as compared to still images found in brochures and websites. However, since the target users come from all walks of life and varied in age range, more usability tests should be done so that the end product will satisfy the requirements of most users.

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