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A Step-wise Zoom Technique for Exploring Image-based Virtual Reality Applications

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***Abstract*—**Existing image-based virtual reality applications allow users to view image-based 3D virtual environment in a more interactive manner. User could "walkthrough"; looks left, right, up and down and even zoom into objects in these virtual worlds of images. However what the user sees during a "zoom in" is just a close-up view of the same image which was taken from a distant. Thus, this does not give the user an accurate view of the object from the actual distance. In this paper, a simple technique for zooming in an object in a virtual scene is presented. The technique is based on the 'hotspot' concept in existing application. Instead of navigation between two different locations, the hotspots are used to focus into an object in the scene. For each object, several hotspots are created. A different picture is taken for each hotspot. Each consecutive hotspot created will take the user closer to the object. This will provide the user with a correct of view of the object based on his proximity to the object. Implementation issues and the relevance of this technique in potential application areas are highlighted**.**

***Keywords*—**Hotspots, image-based VR, camera zooms, virtual reality.

I. Introduction

BASICALLY there are two approaches to modeling VR applications: 3D computer graphics and image-based. Traditional VR applications are based on 3D computer graphics to model and render the virtual environments in real-time. Despite its prevalence utility in various application areas, traditional VR applications have several drawbacks [1]. The creation of a realistic virtual environment is most often very complex and time consuming. Moreover, the demand for computing resources needed to render a complex virtual environment in real time is often very high. Image-based Virtual Reality (VR) represents an alternative approach to the traditional based VR application. It refers to the use of images or photographs stitched together to create a virtual environment displayed in a viewer which allow the user to pan, tilt, zoom in and out and move between pre-defined viewpoints [1]. Due to its quality and speed and display in full screen, QuickTime VR (QTVR) is one of widely used viewer. The benefits of image-based VR over the traditional 3D geometric approach include offering photography quality realism, simplifying the rendering process (not in real-time) and providing the user with 3D illusion during walkthrough despite the absence of geometric information [2].

Image-based VR has been used in a wide range of applications, especially those involving examinations of scenes which are too remote, unsafe and impractical to visit [1]. This includes explorations of remote places such as seabed and volcanoes. Previews of locations such as museums or cities in the tourism domain and virtual shopping over the World Wide Web are another popular use of image-based VR.

Unlike in traditional virtual environment, in which user's movement is unrestricted, user's movement in image-based application (for example commercial products such as QTVR [3]) is limited to panning, tilting, zooming in and out and jumping between pre-computed viewpoints. The zooming in and out, which allows for close-up and distant of view of object of interest, does not provide the user with the actual view of the object from that distant. For some applications, this is not critical , however others which requires the user to have a closer look at the object of interest for careful examination, current zooming technique does not provide the user with the intended view**.**

To address the problem, in this paper, a simple approach based on existing technique is presented. The rest of the paper is organized as follows. Section 2 will introduce image-based VR. The step-wise zoom technique is described in section 3. Implementation issues and potential application are presented next. The last section concludes the paper with future direction of work.

II. Image-based VR And Camera Zooming

Image–based VR, or panoramic VR is created using images or photographs of the environment or objects stitched together using computer techniques to form the virtual environment. Panoramic VR refers to a type of VR whereby the images enclosed the viewer within the environment of images [4]. The images are taken using normal camera or special panoramic camera with special lens. Images are taken overlapping each other. These images are stitched together using automatic stitching software. Basically, there are single row panorama with a single horizontal row of images and multi-row panorama which consists of several rows of photographs taken at different elevation. These could be further categorize by on the how the image is projected: cubic or spherical panorama and cylindrical. The former includes

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top and bottom images while the later do not. The images are projected mapped to faces of a cube or a sphere or a cylinder [4].

A single node representation or panorama is captured from a point in space, which give the user the impression of the environment around one single point. Multi-node panorama is created by linking several nodes to allow user to move from one location to another. In QTVR, the multi-node panorama is called scene and each node is called a movie. Hotspots are created in the panorama to allow to move or jump from one scene or node to another. Within a single node or movie, user can performs actions such as pan, tilt, zoom in and out.

The concept behind "camera zooming" is basically changing the camera's field of view; that is zooming in an out of an image space [5]. Since magnification or minification of the image will not provide more detail, multiple image resolution image zooming was proposed as an alternative solution. Different levels of image were created for each image. During a zoom in or out, the corresponding level of resolution is selected and presented based on the zoom factor [5]. Creating different levels resolution from the same image still would not present to the user with the accurate view of the image as seen from the actual distance as most often it is based on single source image. Zooming in or close-up view only brings the user view closer to the projected image. The Step-wise zoom approach, based on the" hotspot concept", is described in the next section

III. The Step-wise Zoom Approach

Whilst image-based VR application allows users to zoom in for a close-up view of an object, the view provided does not reflect an accurate view of the object from that distance. To illustrate, Fig. 1 shows a cylindrical panorama where the images are projected to the surface of the cylinder. The images which form the cylinder movie are taken from point A. A zoom-in, for example only takes the user's view through point B or C, and even much closer to the image at point D. This will erroneously presents the user with the same image but at closer proximity. For an accurate view, for each zoom-in the user should be presented with an image taken at the respective point.

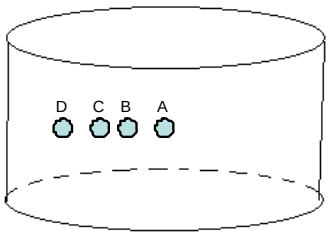


Fig. 1 Illustration of zoom technique in cylindrical panorama

Fig. 2 is used to further illustrate this misperception. If the image (Fig. 2a) was taken 10m from the pebbles on banks of the river; a zoom in to the pebbles (as highlighted by the arrow in Fig. 2a) with current image-based VR application is just moving the user viewpoint closer to this same image (Fig. 2b), thus incorrectly giving the actual view from the correct distant. If the resolution of the captured image is low, a closer view, may results in user seeing blur image or pixelated image. Most often a high resolution image is usually used to avoid the later problem. Despite this, incorrect view of the rocks from the actual distant still persists. For the current view, this is the closest possible "close-up" view provided by the zoom in. If there is a need to have detail examination of the texture of the pebbles it is not possible with the current zoom technique.



Fig. 2 (a) View from 10m from the pebbles (as shown by arrow) (b) view during a zoom to the pebbles

Fig. 3 shows what the user should see as he steps closer to the object of interest. Each picture is taken at varying distance but getting closer to the pebbles. The pebbles are hardly discernable in Fig. 2a. However, as the user approaches the object of interest (Fig. 2b and 2c), the pebbles get more and more visible.

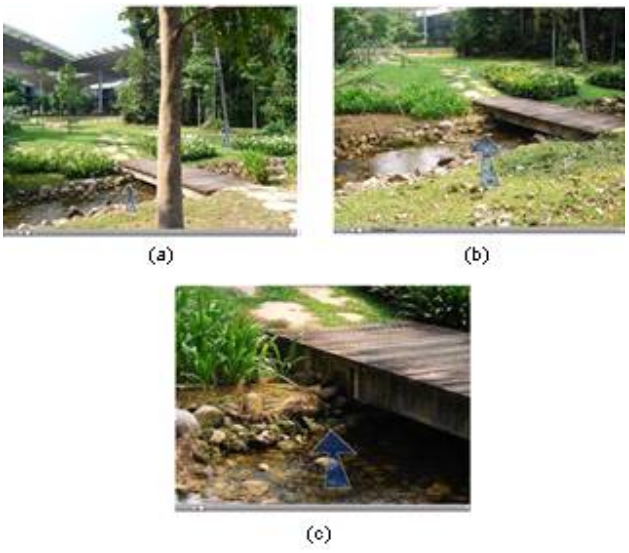


Fig. 3 To illustrate what the user sees as he progressively zoom to towards the pebbles

To deal with the misperception of image in current implementation of the zoom technique, the step-wise zoom approach which is based on this idea of presenting to the user correct image based on his proximity to the object of focus.

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we proposed. This simple technique is based on the 'hotspot' concept in existing applications. Hotspots in image-based VR application are often created to highlight location of interests and for the user to quickly move from one location to another. A click of a button or a mouse-over will often reveal the hotspots for the user to click upon. In the proposed approach, instead of navigating between two different locations, hotspots are used to focus into an object in the scene. The term "step-wise" refers to the technique of developing the application and method of zooming to the object. For each object of interest, several hotspots are created. A different picture is taken for each hotspot. Each consecutive hotspot created will take the user closer to the object. This will provide the user with a correct of view of the object based on his proximity to the object. Similar to the multi-resolution image zooming technique, users are presented with image based on his proximity to the object of interest. Whilst, multi-resolution technique is often based on a single source image, different images could be used [6] [7]. Similarly hotspot technique involves creation of different movies or nodes at those locations. The proposed approach was inspired on these concepts.

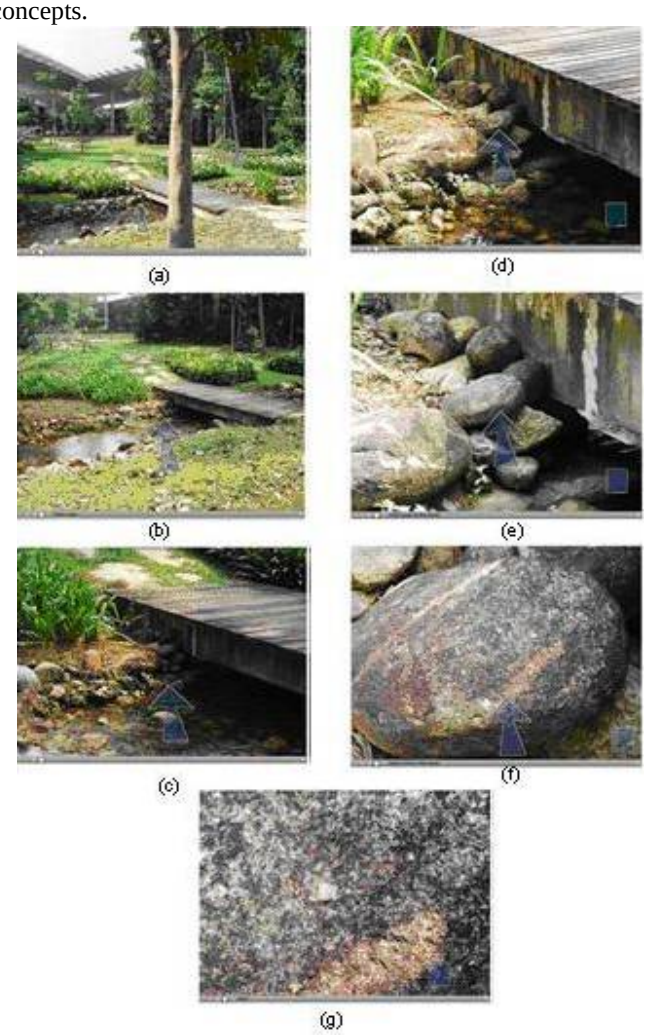


Fig. 4 A complete sequence of images (a-g) during a progressive zoom in

To illustrate this technique, a simple image-based VR application was developed. The complete sequence of images for Fig. 3 is shown in Fig. 4. Fig. 4 a-g represents the steps the user can take to focus in an object; in this case the objects of interest are pebbles near the small bridge. The arrows in the images represent the clickable hotspot that brings the user closer to the object.

The user is first presented with Fig. 4a. A click on the hotspot button will reveal the available hotspot, shown as transparent arrows in the image. A click on the arrow will bring the user to the Fig. 4b. Further clicks on arrows in subsequent images will bring the user closer to the object of interest which is a rock near the small bridge. Each image in Fig. 4 represents a movie file. With the exception of Fig. 2a, the movie files of Fig. 4 b-g is only based on a single image. Fig. 4a, which represents the splash screen is a cylindrical movie created using 10 images. Fig. 4a, is created in this format to allow the user to explore the area for hotspots. The rest of the images represent the steps taken to focus on an object whereby the focus of the user will be only a small area. Thus only a single image is necessary. However when user click on the image, they could still pan, tilt and zoom as in Fig. 2a. Included in each image (Fig. 4d-g) is a home button, represented by a square-shaped hotspot, for a quick return to the main page (Fig. 4a).

All images were taken using Nikon SLR D300 autofocus camera. Two types of lens were utilized. The first type, Nikkor AF-S 18-70mm (wide angle lens) was used to take the pictures for Fig. 4a. The images were taken overlapping and radially to create the cylindrical or 360^{o} view movie. The rest of the images (Fig. 4b-g) were obtained using Micro Nikkor AF 105mm F/2.8D (prime telephoto macro lens). The later lens allows details to be captured.

Realviz Version 3.5 was chosen as the main software for developing the image-based VR application. Realviz was selected due to the flexibility in customizing the hotspot features. Prior to exporting the images to Realviz software, Adobe Photoshop was used to prepare the images. In Adobe Photoshop the images were cropped/resize, adjusted for colour, sharpness and contrast. In the Realviz, the images were stitched together to form the panaromic movie.

A QTVR player needs to be installed to view the movie. In this case, the movie file was opened using internet explorer for hotspot to take effect when viewing with the latest version of the QTVR. One possible explanation is, the use of older version of the Realviz software to create the application may not be compatible with most recent QTVR player. Utilizing an up-to-date copy of the Realviz should let the user view the directly using the latest version of QTVR player

IV. Implementation Issues

Evidently, huge file size is a major implementation issue in the proposed approach. As the number of steps increases, the number of movies created increases. The use of better quality high resolution images also contributes to increasing the file

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size. In the proposed example, the application file size is approximately 19Mb. The first movie, which is a 360degeree cylinder movie type was created using 10 (640 x 480) size images, is the largest. The final rendered file size is approximately 4.73Mb. As the rest of the movies are meant for focusing on the object of interest, only a single image was used. After rendering, the average file size for each movie is about 2.5Mb. The decision to use a single image for the rest of the steps helps reduce the overall file size substantially. It should be noted that the images used in this example are of high resolution. Obviously, to further reduce file size is to lower the image resolution and reduce image size. When a the image size of all the movies was reduced to 480 x 320 pixels, a substantial reduction was observed. The first movie file size was reduced to 1.5Mb and the rest was reduced to 880Kb, giving the total file size of the application 4.8Mb. Reducing the number of steps or number of movies is another method of further decreasing the overall file size. However, with the current file size, internet deployment is not a viable option. The file size issue would escalate further for environment having many objects of interests.

V. Potential Application Areas

As highlighted in the previous section, image-based VR have been widely used in many application areas. One potential area where the proposed technique could be indispensable or become necessary is applications which require careful and meticulous examination of individual objects in the virtual environment. For example, virtual field trip applications for Geology. Virtual field trips which are digital representations of the real locations, has long been widely used as a cost-effective alternative to real field trips. Since virtual field trips only provide user with synthetic experience, designing an appropriate virtual field trip which provides realistic experience still remains a challenge. In the real physical geology field trip students are required to examine rocks with respect to the relative surrounding areas. Students need to describe and record the characteristics of rocks. Information such as texture, grain size, and other unique characteristic of the rock requires a close-up view. Furthermore examining the surrounding earth structures, noting the topography and unique structure and focusing on mineral orientation and soil characteristics also requires the students to have a very close view of the object of interest [8]. Thus, the proposed technique, which is not provided with the current zoom technique, would provide students with necessary details they need. Other subjects or fields which are of similar nature in task requirements would benefits from this technique.

VI. Conclusion and Future Work

Current example of step-wise zoom approach involves linear navigation and a focus on single object. User needs to go through all the steps before reaching the final image. Automating this zooming process for the user will allow the user to view object of interest quickly. Another consideration is giving option for users either to auto zoom or manual browse through the image. Future works may include having branching movies at other levels or steps; that is beside the first step, other subsequent movies will also provide several options. This would give user more choices of objects to focus especially at the last few steps. Usability testing would also be conducted to elicit user's acceptance of the technique.

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