Affordable Virtual Environments: Building a Virtual Beach for Clinical Use

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Abstract. Virtual Reality has been used for clinical application for about 10 years and has proved to be an effective tool for treating various disorders. In this paper, we want to share our experience in building a 3D, motion tracked, immersive VR system for pain treatment and biofeedback research.

1. Introduction

Presently, Virtual Reality (VR) systems have a multitude of uses: architectural design, task training, vehicle design, education and certainly gaming and entertainment [1]. In most cases such VR application development requires expensive and unique hardware and software solutions that are developed for very specialized uses. This limits the general use of such systems to well-funded efforts of large institutions. There is a growing category of VR applications that can be effectively implemented on a relatively small budget. This new area is the use of VR in clinical applications. For a review of the current state of the art we refer readers to Hodges et al [2]. These applications address clinical approaches to a variety of anxiety disorders, post-traumatic stress disorder, substance abuse and chronic pain.

The purpose of this paper is to show that creating a clinical VR system is not as difficult as it may seem. Specifically, we want to share our experience in building a VR beach simulation to study the incorporation of virtual environments with biofeedback and psychotherapy in pain control.

2. Project specifications

The beach simulation is utilized to provide a relaxing, stress-free environment. The user can “walk” around and enjoy the scene that is populated with pleasant and engaging animated interactive objects. Overall, the scene is designed to convey the sense of peace and calmness. From the technical perspective, the following goals were defined: (a) creating 3D content; (b) stereo rendering at 25 fps; (c) tracking of user's head and hand for viewing and interaction; (d) navigation system; (e) 3D sound effects; (f) event scheduling incorporating user input.

3. VR Equipment

3.1 Computer system

To minimize cost a single PC configuration is used. Images are generated for left and right channels by a rendering engine and sent to HMD and VR console monitor. The sound server runs on the same PC and provides 3D positional playback of various sound effects, such as ocean waves crashing on the shore, bird cries, sounds of falling coconuts, etc. The entire beach simulator runs on a 2.4 GHz dual-processor computer at 25 frames per second in stereo mode. For the 3D engine, we used *Flatland* system, developed in the University of New Mexico under supervision of Thomas Caudell [3].

3.2 Motion tracking

For motion tracking, we used *Flock of Birds* by *Ascension, Inc*, which provides high accuracy tracking at 1.8 mm. The beach simulator communicates with the motion tracking system by reading translation and rotation data from two sensors: one for the head (camera in VR), and one for the hand, which allows an immersed person to use a virtual hand for interaction with objects on the scene.

3.3 Head Mount display

The choice of HMD is no doubt the most crucial for making the VR system as immersive and engaging as possible. From the user point of view, the most important factors are: stereo capability, field of view and image resolution. We have tried four stereo-capable HMDs: V8, Kaiser ProView, 5DT, nVisor SX from *NVIS Corporation* and have chosen the last one for its superior image quality (1280x1024 pixels) and wide field of view (60 deg diagonal).

4. Content

What does it take to make subjects believe that he or she is on a beach? For that, we need content - a set of objects and events that create the sense of “presence.” Content may be created and delivered in a variety of ways. For instance, one can place a subject in the middle of a 3D cube and stream prerecorded video on all or some of its faces. That would create a realistic, but totally non-interactive environment. The opposite side of the scale is a completely synthetic CG environment, without video footage at all. In mixed systems, video sequences can be projected onto some objects of the CG environment. That technique works very well for indoor scenes, especially if the user can be restricted from looking at these video-textured objects from arbitrary angles. On the beach, the user is should free to walk and look in any direction. This was the main reason why we have chosen completely virtual settings. An additional advantage is the consistent level of representation of all objects. With uniform CG environments, there’s no need to worry if a bird on a video background looks more realistic than a CG bird walking by the user on the foreground. All models and animations for this project were created by *Sprite Entertainment* [4]. Two snapshots from the beach scene illustrate their work.

5. Things to do on the virtual beach

On the virtual beach, one has no tasks to accomplish, no levels of game play to move up, and no specific time limits set. As on a real beach, people enter at will, spend some time and leave at will. The beach is there for them "living its own life." It is up to the user how far he or she wants to explore it. We programmed several events that happen in the scene to enhance a sense of presence. Here are some examples.

A large seagull lands near the beach chair, walks around it and takes off (see left figure). A crab crawls out of the ocean, approaches the chair and runs back into the water. Another seagull makes a wide circle in the sky. Coconuts drop from a palm tree with a *thump* sound. That happens twice during the session and each time when the user hits a palm tree while walking around. A flock of sea gulls lands on the distant shore (right figure). If the user tries to chase them, the birds take off with a loud noise. Dolphins jump up from the water at random times. Two butterflies fly around the beach, sitting occasionally on various objects. The user can catch a butterfly with the virtual hand - then the butterfly sits on the hand, flapping its wings slowly until released. For adventurous types, there are more attractions. Various seashells are lying on the shore, they can be picked up and examined. Fallen coconuts, palm tree leaves, straw hat and a couple of dry crabs are also interactive. One "not so dead" crab is hiding in the water that user can grab at his/her own risk. (The crab starts twitching when picked up). Overall, the scene provides enough activities to keep users interested for 20-30 minutes.

6. Conclusions

Modeling and animation work was completed in 3 months by 3 CG artists. Programming was finished in 6 months, by 2 programmers. The whole project turned out to be a good example of how a low-budget production can yield effective and interesting results.

7. References

[1] F.P. Brooks, Jr., "What's Real About Virtual Reality?", IEEE Computer Graphics and Applications, vol. 19, no. 6, Nov./Dec. 1999, pp. 16-27.
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[4] Sprite Entertainment http://www.spritee.com/