

Analysis of Virtual Reality Contribution to Treatment of Patients with Post-Traumatic Stress Disorder

Sanja Mrdeža
PSE Zagreb
Siemens d.d.
Zagreb, Croatia
Sanja.Mrdeza@siemens.hr

Igor.S.Pandžić
Faculty of Electrical Engineering and Computing
University of Zagreb
Zagreb, Croatia
Igor.Pandzic@fer.hr

Abstract— Post-traumatic stress disorder (PTSD) is one of the most devastating psychological consequences of war that affects mental health of veterans. Medications and psychotherapy are common ways of dealing with this anxiety disorder. In the last couple of years virtual reality exposure therapy is introduced to the field of exposure based therapy. By helping patients to better re-experience and then re-process the traumatic event virtual reality (VR) is improving their healing process. A short survey of existing VR applications used for PTSD treatment as well as other academic studies related to connection between VR technology and treatment of PTSD disease is presented in this article. We propose an implementation concept for new VR application based on virtual reality exposure method and oriented at specifics of Croatian homeland war.

Keywords- *post-traumatic stress disorder; virtual reality exposure; virtual environment*

I. INTRODUCTION

Post-traumatic stress disorder (PTSD) is an anxiety disorder resulting from an exposure to traumatic events in which person experienced or witnessed a life/physical integrity threatening situation responding to it with extreme fear, helplessness or terror. Symptoms include recurrent thoughts of traumatic events, increased arousal, avoidance of activities related to the trauma, emotional numbness. The concept of PTSD was first introduced after the Vietnam War, and didn't catch much attention in Croatia until after the Croatian homeland war.

Prevalence in the general population ranges from 1% to 14% depending on the methods used for data gathering. High-risk sample studies (war veterans, refugees, war prisoners.) show 3%-58% prevalence. In Croatia there are few researches of PTSD prevalence which indicate prevalence of 16,22% for war veterans and 49,8% for refugees [1].

Commonly present disorders that accompany PTSD include: 50-75% depressive illness, 20-40% anxiety disorder, 5-37% phobias, 6-55% alcohol abuse, illicit drug abuse 25% [4]. As a result of this complex disorder there is an increased rate of divorce, unemployment, suicide and accident among PTSD patients.

Conventional treatments include individual and group psychotherapy, coping skills training and medication. This kind of therapy is insufficient because it is aimed only at stabilizing and preventing deterioration.

Exposure therapy as the part of cognitive-behavioural therapy plays the key role in reducing symptoms and increasing functionality within the patient [3]. While gradually exposing the patient to trauma-inducing event, the therapist is helping him to re-live the trauma again and this time deal with fear in an appropriate way. Combat scenes are obviously not suitable for in-vivo exposure. The next best solution is an imaginal exposure. The task of virtual reality (VR) is to build virtual world inside which the patient can re-experience event similar to the one that triggered trauma [2].

II. SURVEY OF VR APPLICATIONS USED FOR PTSD TREATMENT

A VR application dealing specifically with PTSD disease has been in regular use since late 1997: "Virtual Vietnam" [5] created by L. Hodges and B. Rothbaum. It uses the concept of virtual reality exposure (VRE) therapy and is successfully introduced to therapy of Vietnam veterans 30 years after the end war. Virtual Vietnam world simulates two environments:

1. Riding a combat helicopter over Vietnam jungle, rice paddles, rivers etc. with the possibility of landing,
2. Walking in the hostile zone represented with an open field surrounded by jungle.

The application uses a head-mounted display (HMD), body tracking devices and sensory input devices to create a sense of immersion in a Vietnam-like environment. Auditory effects vary from jungle noises to mine explosions, mortar bombardment, gunfire, soldiers yelling and helicopters.

During therapy-sessions reactions of patients were monitored. The virtual scenes were adapted according to patient's stories, which made it even more realistic. Case studies showed that patients were relating virtual environment (VE) back to their own memories of the real world of the Vietnam War. When the veterans returned home they were responding to their families in the similar way as they did in combat. Back then they were taught to be numb to the surroundings and now they are unable to change their attitude. The goal of this therapy was to improve patient's receptiveness to their families.

Uncontrolled treatment study based on 10 cases shows substantial reduction of PTSD symptoms [3]. Virtual Vietnam continues to be successfully used at Veterans Administration

hospitals in USA (Boston and Atlanta). Therapy usually requires 7 to 15 office visits. Many insurance companies in USA cover the cost of VR therapy now, because VRE is accepted as a form of successful exposure therapy.



Figure 1. Jungle clearing environment (Courtesy of Virtually Better Inc.)

Another example of VR applied to anxiety disorders is the pilot study “Technological Diagnostic Learning Centers” by Marion J. Wolsey, in which she proposes the use of virtual reality for helping students with psychological disorders such as attention deficit disorder, deficit hyperactive disorder and PTSD [6]. Ms. Wolsey encourages the use of non-immersive VR software Virtual Walk Through Pro for building virtual worlds in order to help student to better focus on the learning process (e.g. in mathematics, geography, history, physics...). The goal is not only to improve their academic success but also their mental health in general. “The student who suffers from these particular psychological disorders often feels a lack of control of his/her world. However, in the technological environment, the child is in control of making the decisions for his/her world at that particular time. ... The student leaves this environment with a feeling of success, accomplishment, and control instead of negative feelings of failure.”

No follow-ups of this pilot study regarding evaluation of this approach to students with special needs have been found. Although there are some papers published in the magazine “VR in the Schools” (<http://www.soe.ecu.edu/vr/pub.htm>.) covering application of the above mentioned software package in learning mathematics and history for general student population [7].

III. IMPLEMENTATION CONCEPT OF A VIRTUAL REALITY EXPOSURE APPLICATION FOR PTSD TREATMENT

This potential VRE application is to be focused on Croatian war veterans and fulfil their needs in terms of visualization of “typical” Croatian war scenes.

A. Motivation

The analysed studies and reports indicate that exposure therapy helps patient to trigger trauma during session with

therapist who then teaches the patient to deal with it. Patients begin with less threatening situations and after a period of habituation they gradually advance towards more anxiety producing situations.

The benefits of VRE therapy include ease of use, increased confidentiality, public appeal and greater control. For the patients who can not imagine well or have lost fragments of memory, VR experience is the only chance for exposure therapy.

B. The application focus

The sense of presence is assured with a HMD, sound effects and locomotion abilities. Head mounted display is very important since it shuts out the real world (auditory and visually) and therefore enables full immersion. There is no need for high reality of the scenes. Stress is on the interaction in the virtual environment. Exposing the patient to virtual war scenes shall induce traumatic experience. The scenario has to be designed having in mind that anticipation of horrifying events is crucial to emotional response. Certain changes in the war scene appearance should be possible even after the implementation is completed. Tailoring of the war scenes for a particular patient is important to assure the sense of reality.

C. The scenario proposal

We propose an initial draft scenario with potential traumatic content and more anxiety levels. A war scene depicts the most common combat situation in a Croatian city.

1) Scene 1: Street

The scene consists of an empty street, with ruined houses on both sides of the street. Initial scenario set-up can additionally include: night conditions, fog, corpses lying around and blood.

2) Scene 2: House

When the subject enters the ruined house, he or she sees only one room, two windows, and broken furniture.

During session a variety of options can be introduced: weapon fire, shell explosions, flames, men yelling, tank moving down the street.

Patient has the ability to move through VE using a hand-held 3D navigational device. Communication with therapist is only verbal. There is no need for the therapist to be immersed in the VE, because virtual environment is controlled and monitored on graphical user interface described in chapter F.

If the therapy session requires decreasing of level of patient’s anxiety, combat activities can be slowed down. Tank can get out of the street, and war sounds can fade away, leaving the street completely empty as it was in the beginning of the session.

D. Elements of simulation

1) Virtual models

The following needs to be modelled: street, houses on the left and right side of the street, interior of one house and a tank. Houses are already ruined and have broken windows, a lot of bullet holes and a few grenade hits.

Textures are to be applied to the surface of objects, and far away objects shall be visualised using a photograph integrated in the VE.

2) Audio effects

Special attention is given to the weapon sound samples since it is known that veterans very well distinguish a variety of life-threatening factors like distance, direction and type of weapon. Sound database include samples such as: men yelling, tank moving down the street, shell explosions, mortar fire, small arms fire and other weapons.

3) Animations

In animation sequence tank is moving down the street. Firing and ruining the wall is also an option.

Trajectories of the camera include moving all around the street. When inside the house camera can search the room or look through the window at the street.

E. Proposed user interface for the therapist

Therapist's main goal during VRE therapy is to determine level of patient's fear, change the experience of the patient and solve any ambiguity that the patient might have. In order to achieve this aim, he or she has to control appearance and events in VE and observe or initiate patient's feedback. User interface is designed to facilitate these tasks. It should display a combination of 2D - 3D console [8]. 2D terrain map should improve navigation and relocation of the patient. 3D view shows the same image as displayed in HMD. Graphical representation of different controls for altering elements of VE (e.g. weather, sound effects, introducing new virtual objects, etc.) is a necessity. Tool for keeping track of patient's reported level of fear should be introduced. It enables therapist to evaluate the progress of therapy.

It is also useful to record objective level of fear either during the session or initially for diagnosing the level of PTSD disorder within patient. This can be done by using different biofeedback devices (monitoring EEG, heartbeat rate, blood pressure, muscle contraction, etc.) connected to a separate PC or with the help of a simple polygraph device.

The above listed characteristics of the user interface improve the usability of the VR system. However not all of them can be included due to the scope of this application prototype.

F. Hardware requirements

Effective VR systems used for treating phobias have to insure a sense of presence in VE. In order to achieve that, not only the high realism of scene, but also the good quality of the VR hardware is necessary. Especially is important the head-mounted display. It's quality and fidelity is determined by resolution, contrast of the screen, field of view and the stereoscopy option. Latency of the system has to be low and it depends on the motion tracker characteristics. It becomes completely invisible to the user when it's lower than 20ms [9]. Stereoscopic HMDs can be supported only with graphic cards with two outputs. To the above mentioned VR specific hardware we can also add an input device used for navigation

in the virtual space. The rest of the hardware required for a complete VR system is a plain personal computer.

In order to run the VR application it is minimally required the following:

- Standard PC with CD drive, mouse, keyboard, monitor, speakers
- 128 MB RAM
- Pentium III, 700 Mhz,
- 20 GB HD, 7200 rpm
- Graphic Card (e.g. GE-Force-2) with at least 32MB
- Sound Blaster Live Card
- Windows 2000 / XP
- Head-mounted display with motion tracker (e.g. VFX3D from IIS), 3D mouse

IV. CONCLUSION

VR technology has the great potential in the future treatment of psychological disorders because it strongly reduces the gap between the person's imagination and the traumatic vision of reality buried in memory. And that is just the right moment for the therapist to begin the verbal disclosure of traumatic material and work through the emotional content leaving space for new images with healthier approach to be imprinted in patient's memory. VR as a powerful tool in the hands of the specialist can help in finding a way out from the chaos of trauma jungle for the tortured mind.

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