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Virtual Reality and it's Assets in the Rehabilitation

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Abstract

Nowadays the virtual reality (VR) is very popular. It is an artificial world, which is made in a computer environment and the user try to enter fully into the spirit of her or his role in this unreal-world. Virtual Environment (VE) technology has undergone a transition in the past few years that has taken it out of the realm of expensive toy and into that of functional technology. Recently, in the field of Mental Healthcare, the considerable potential of VEs has been recognized for the scientific study. This paper summarizes the application of VR and presents the VR education and research in the University of Veszprém.

Categories and Subject Descriptors: [Education and other fields of Applied Informatics or Computer Graphics]: Virtual Environments

Key Words and Phrases: Virtual Reality, application, rehabilitation, education

1. Introduction

There are a lot of definitions of Virtual Reality. One of these is the definition of Prof Riva: Virtual Reality is a multimodal interaction with dynamic and responsive computer generated or so called synthetic environments. [12] It's goal is to produce in the user the same feeling or most similar feeling as in the real world creates thus it should produce the into same effect as in vivo. Another definition is Prof Rizzo's definition: VR is a way for humans to visualize, manipulate, and interact with computers and extremely complex data in a more naturalistic fashion. [13]

Virtual Environment (VE): is a three dimensional data set describing an environment based on real-world or abstract objects and data. Usually virtual environment and virtual reality are used synonymously. But some authors reserve VE for an artificial environment that the user interacts with. [17]

The concept was used originally for the immersive virtual reality. This is an environment that corresponds completely to that of a real environment. At present the borders get blurred, as e,g, one usually groups here also such three dimensional worlds, realized on a graphic display or stereo projector, where the user can orient itself with the help of a mouse. There also such virtual realities that mix the virtual objects with real environments, such are the augmented/mixed realities.

Augmented reality: the use of transparent glasses on which a computer displays data sothat the viewer can view the data superimposed on real-world scenes. [17]

When using VR people often experience a feeling of actually being in the computer generated environment, a feeling described as 'presence'. (Presence: illusion of being part of a virtual environment. The more immersive a VE experience, often the greater the sense of being part of experience. [17]) Presence can more explicitly be defined as a mediated experience that seems very much like it is not mediated. [2] When a user experiences a high level of presence, it is even possible for the user to develop fear in response to simulated anxietyprovoking stimuli. Experiments have for instance and fear of heights. [11] This makes it possible for VR to be used in the treatment of phobia, where patients have to be exposed to the stimuli they fear. VR has already been shown to be effective in the treatment of fear of heights, fear of flying, arachnophobia, claustrophobia and agoraphobia, the fear of being in places from which escape might be difficult or embarrassing. [14] VE cannot and should not be viewed as a replacement of medical treatment. [12]

1.1. The application of VR

There are many application of the VR for example

Medicine - Surgical training, NASA Space Program - Hubble repair, Military - Terrain and Battlefield Simulation, Training - Manufacturing, Firefighting, Virtual Science, Entertainment - DisneyQuest, Mental Health - Phobias, Pain, PTSD, Physical, Speech & Occupational Therapy, Neuropsychology - Assessment and Rehabilitation of Cognitive & Functional Behavior. [13]

Micro- and Nano-technology, Aero and Space Engineering, Defense - Airforce Avionics Training - Close Range Weaponry Simulation - Navy Submarine Qualification, Heritage - Heritage in the Ceramics Industry, Database and Scientific Visualization. [17]

Civil infrastructure, National security, Design and manufacturing, Efficiency among small- and medium-sized businesses, Environmental monitoring, Education, training,and lifelong learning, Access to information: digital libraries

For us the most important applications are the Mental Health (Phobias), Neuropshychology (Rehabilitation of Stroke Patients), and Education.

Education increasingly uses distributed virtual environments in training. Research is sought that will provide a theoretical basis for the use of simulation and

virtual reality in individual and team training. These researches should address issues such as cognitive and perceptual processes, the conditions that promote transfer from simulated to real tasks, the use of feedback in training, and the effects of spatial abilities. [13]

1.2. The VR assets

Virtual reality can help especially in three areas of mental hygiene and psychology: int he scientific investigation of perception and the study of processes, in neuropsychologycal studies and in the cognitive rehabilitation (rehabilitation via cognition). Such method can be applied to rehabilitate people who suffered brain damage or have neurological defects. (Alzheimer patients, cerebral haemorrhage, patients with Parkinson disease, etc.), who have learning or evolutionary problems (hiperactivity, autism, concentration disturbance, mental retardation, etc.).

Virtual reality has also advantages int he investigation, evaluation and therapy of perception, behaviour and neuropsychological studies, such as

- Ecological validity,
- Stimulus control and consistency,
- Repetitive and hierarchical stimulus delivery possible,
- Cueing stimuli for "errorless learning",
- Real time performance feedback,
- Self-guided exploration and independent practice,
- Stimulus and response modification contingent on user's impairments,
- Complete naturalistic performance record,
- Safe testing and training environment which minimizes risks due to errors,
- Graduated, systematic exposure,
- Distraction,
- Gaming factors to enhance motivation,
- Low cost functional environments that can be duplicated and distributed. [13]

2. The VR education at the University of Veszprém

The subject of Virtual Reality is a choice subject for informatics engineer students from 1999 on. The main thematic of this subject:

- The definition and application of VR.
- Required hardware and possible software.
- 3D modelling.
- Building and grouping predefined shapes /objects, positioning objects, rotating objects and scaling objects.
- Polygonal and NURBS modelling.
- Keyframe and path animations.
- Skeletons and kinematics.
- Dynamics.
- Assigning structure and texture, controlling appearance with matherials.
- Controlling shading, lighting the worlds, creating shiny shapes using materials, the colours of worlds.
- Controlling details, controlling the viewpoint.
- Sensing viewer proximity and action.
- Producing program scripts I.
- Producing program scripts II.

The course consist of two lecture hours and three practice hours per week. In the practice classes the students learn the use of Maya and VRML. They have to prepare some objects and virtual environments for the research work going on in the Laboratory.

3. Presence

One of the most important aspects of a VE is to induce a state of "Presence", which is defined as "the observer's subjective sensation of 'being there' in a remote environment". [3] The importance of the construct has generated multiple views for the quantization and measurement of presence. The measurements can be broadly classified into two types: subjective and objective measures. Questionnaires that have previously been developed have been used as subjective measures in a majority of studies. [10, 16, 20, 23] They include such questions as: "How aware were you

of events occurring in the real world around you?" or "How strong was your sense of presence, 'being there', in the VE?" While analyses of presence questionnaires may elucidate the phenomenology of immersive experiences, they largely remain post-test measures that are dependent on memory of the event. Presence has also been measured during the virtual experience by using a hand-held sliding scale. [3, 4] However, it is unclear exactly what participants were responding to and how responses were affected by the disruption of continuously assessing one's own experience.

Objective measures involve monitoring the impact of a VE on physiologic processes such as heart rate, respiration rate, skin resistance, skin temperature and peripheral brain wave EEG activity. Unfortunately, there are only a few studies that examine the relationship between presence and physiological responses. [1, 8, 20] One of these studies combined the selfreported questionnaires with the physiological measures and revealed that percentage change in heart rate and skin resistance had a high level of correlation with presence, degree of realism, and immersiveness. [22]

4. The research and development

Several people suffer from various phobias, while most of them can surmount it by simple self-suggestion and it doesn't cause too much trouble for them, for others this form of fear could significantly limit their life. A phobia is a type of anxiety disorder. Phobias can be divided into three categories: social phobia, agoraphobia and specific phobia. Social phobia is a fear of being judged in social or performance situations. Agoraphobia is a fear of public places and open spaces. Specific phobia is a fear of a specific object or situation, such as airplanes, spiders or heights. [19] Aim of our work at the University of Veszprém and SOTE was creating virtual environments, which could be used in treating phobias. Of course we were unable to undertake the research all of the existing phobias, we created virtual worlds for treating agoraphobia (fear of wide, open spaces), acrophobia (fear of height) and .specific phobia (fear of travelling). Our investigation were the first ones in Hungary.

The first environment is a simple balcony of a two-storied house. It has a large tiled floor and low fence all around it. On the initial scene we could see the top of some trees and some houses (Figure 1.). After starting the animation the viewpoint takes the users closer and closer to the fence and makes them look down to the garden (Figure 1.) [6]

Figure 1. Virtual balcony: the initial scene and looking down.

The external glass elevator environment shows a ten-storied building with an external glass elevator. At the beginning the elevator is on the ground floor (Figure 2.). Then the elevators starts and finally one has the view from the top of the building. These VE were created by the help of VRML.

Figure 2. The city from the ground floor, looking up from the 2nd floor and looking down from the 8th floor.

The internal glass elevator will be very similar to the external one, but there are some differences. The main difference is that we developed this virtual environment by using the program Maya. The main reason for using another method for developing is to compare the developing environments. First we made real video recording in the Atrium Hyatt Hotel in Budapest. The model of the internal glass elevator is made on the base of the real pictures of these video recordings. We would like to compare not only the developing environments (VRML and Maya) but also the virtual worlds (Figure 3. and Figure 4.) with the real video recording in treating phobias too. [5]

Figure 3. Entering into the virtual Atrium Hyatt Hotel and view from the first floor.

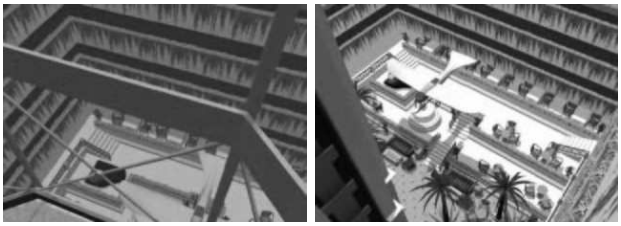

Figure 4. View from the glass elevator and from the 8th floor.

For specific phobias (fear of travelling) we modelled the underground travelling in Budapest. (Figure 5. and Figure 6.) [9]

Figure 5. The escalator and the underground waiting hall.

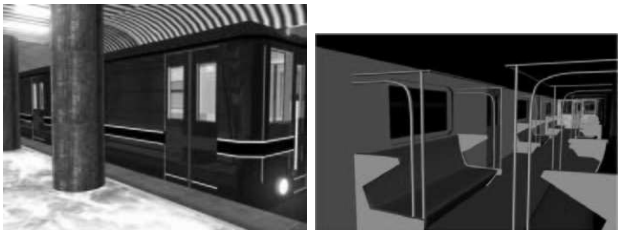

Figure 6. The underground carriages outside and inside.

We developed VE for claustrophobia too: a closed lift and a room, where the wall can be moved. [7] We are finding and building the appropriate hardware configuration for testing by the help of a psychological institute (Semmelweis Medical University in Budapest) and some students, who suffer from light phobias. Thus up to now we haven't tested the environments on individuals, who suffer from high, complex phobias.

For the education we developed a virtual shopping software for autistic children. (Figure 7.) This educational software was developed using Dark Basic programming language. We are testing the virtual shopping scenario in a special school for mentally disabled children in Veszprém. [15]

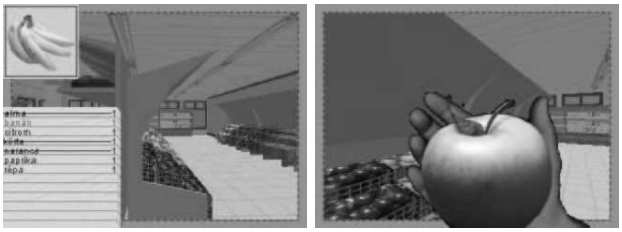

Figure 7. The virtual shopping

5. Integrated portable VR system

The applications above are currently being imported into a high performance Portable virtual reality platform, called the Virtual Human Interface (VHI) [18]. The VHI was specifically developed to place user into a closed loop VE in which they are facing a variety of challenges to help them overcome their respective disorders in a fast and effective manner. The support this functionality the VHI system not only presents complex, photo-realistic stimuli to its users but also measures reactions as part of the interaction process. A unique feature of the VHI is its ability to create and animate high fidelity digital humans capable of expressing subtle facial expressions and nonverbal signals or body language. Our goal is to integrate all previous applications into the VHI environment and use it as the foundation for future research.

6. Future plans

Our next plan is to develop VEs for the rehabilitation of stroke patients (virtual home and everyday tasks). The second is developing a virtual class for young children who have fear of speaking and answering the teacher's questions in public. We intend to this virtual class both in schools of healthy children and in schools of mentally retarded children. A futher project is the collection of questionnaires asking childrens avatars of computer games they like the most. On the basis of answers we will develop new avatars and make a recommendation for the VE designers. This should help the designer to choose among the different avatars depending for which age group they develop their programs.

References

[1] Dillon, C., Keogh, E., Freeman, J. Davidoff, J.: Aroused and immersed: the psychophysiology of presence, Presence 2000- 3rd International Workshop on Presence

[2] Ditton, T., Lombard, M., At the Hearth of it all: The concept of presence, Journal of Computer- Mediated Communication, 3(2), September, 1997

[3] Freeman, J., Avons, S.E., Pearson, D.E., Ijsselsteijn, W.A.: Effects of sensory information and prior experience on direct subjective ratings of presence, Presence: Teleoperators and Virtual Environments 1999, 8(1), 1-13

[4] Ijsselsteijn, W., Ridder, R.H., Hamberg, R., Bouwhuis, D., Freeman, J.: Perceived depth and the feeling of presence in 3DTV, Displays 1998, 18, 207-214

[5] Laky, V., Sik-Lányi, C.: Using virtual reality in psychology (Virtual words in treating agoraphobia and acrophobia), 7th European Conference for the Advancement of Assistive Technology in Europe, Dublin, 31 August - 3 September, 2003. pp. 628-632.

[6] Laky, V., Sik-Lányi, C: To develop Virtual Reality worlds for treating agoraphobia and acrophobia, VRIC Virtual Reality International Conference, Laval, 13-18 Mai, 2003. pp. 127-133.

[7] Laky, V.,: Virtual Reality in the Psychology, MSC Thesis Work University of Veszprém, 2002

[8] Meehan, M.: An Objective Surrogate of Presence: Physiological Response, Presence 2000 3rd International Workshop on Presence. http://www.presence-research.org

[9] Posztós, N., Tóth, G.: To develop wirtual worlds for treating fear of travelling, Scientific Youth Club Work, University of Veszprém, 2003

[10] Regenbrecht, H.,Shubert, T.: Measuring the sense of presence and its relations to fear of heights in virtual environments, International Journal of Human-Computer Interaction, 1998, 10(3), 230-250

[11] Regenbrecht, H.T., Schubert, T.W., Friedmann, F.,: Measuring the Sence of Presence and its Relation to Fear of Heights in Virtual Environments, International Journal of Human-Computer Interaction, 10(3), 1998, 233-249,

[12] Riva, G., Wiederhold, B.K., Molinari e.(Eds.): Virtual Environments in Clinical Psychology and Neuroscience, From Toy to Tool: The Development of Immersive Virtual Reality Environments for Psychoterapy of Specific Phobias, IOS Press Amsterdam, 1998

[13] Rizzo, A.S.: Virtual Reality as an Assessment, Treatment and Research Tool for Psychological, Cognitive and Physical Disorders, Tutorial on the Laval Virtual 5th Virtual Reality International Conference, Laval, 13-18 May 2003

[14] Schuemie, M.J., van der Mast C.A.P.G.: Presence: Interacting VR? http://www.schuemie.net

[15] Sik-Lányi, C., Tilinger Á.: Producing virtual worlds for the rehabilitation of desabled people (Simulating shopping for autistic children), 7th European Conference for the Advancement of Assistive Technology in Europe, Dublin, 31 August - 3 September, 2003. pp. 633-636.

[16] Slater, M., Usoh, M.: Depth of presence in virtual environments, Presence: Teleoperators and Virtual Environments 1994, 3(2), 130-144

[17] Stanney, K.M.: Handbook of Virtual Environments, LEA, London, 2002

[18] Takács, B., B. Kiss, (2003), The Virtual Human Interface: A Photo-realistic Digital Human, in IEEE Computer Graphics and Applications Special Issue on Perceptual Multimodal Interfaces,September-October 2003.

[19] The Virtual Reality Medical Center, http://www.vrphobia.com

[20] Usoh, M., Catena, E., Arman, S., Slator, M.: Using Presence Quastionnaire in Reality, Presence: Teleoperators and Virtual Environments 2000, 9(5), 497-503

[21] Wiederhold, B.K., Davis, R., Wiederhold, M.D.: The effect of immersiveness on psychology, In Riva, G., Wiederhold, M.D. (Eds.) Virtual environments in clinical psychology and neuroscience. Amsterdam: IOS Press 1998

[22] Wiederhold, B.K., Jang, D.P., Kaneda, M., Cabral, I., Luire, Y., May, T.: An Investigation into Physiological Responses in Virtual Environments: An objective Measurement of Presence, In Riva, G., Galimberti C. (Eds) Towards CyberPsycholgy: Mind, Cognitions and Society in the Internet Age, Amsterdam IOS Press, 2003, 175-184

[23] Witmer, B.G., Singer, M.M.: Measuring presence in virtual environments: A presence questionnaire, Presence: Teleoperators and Virtual Environments 1998, 7(3), 224-240

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