Virtual Environment to Treat Social Anxiety

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Abstract. The aim of our work is to propose a Virtual Reality solution to treat social anxiety, applying cognitive-behavioral therapies, that preserves the sense of immersion without requiring the use of expensive special purpose hardware. We have developed an application, called Virtual Spectators, that creates a simulation taking place in a virtual scenario inhabited by animated virtual humans whose behaviors are dynamically controlled by the therapist. To evaluate the effective usefulness of the tool from the point of view of the therapist, we performed an evaluation of the application with a set of these professionals familiarized with the use of exposure therapy. Their feedback was positive and they were enthusiastic about the possibility of using such a tool to support a session of exposure therapy.

Keywords: Virtual reality, virtual humans, social anxiety.

1 Introduction

To experience some level of anxiety in our daily life is natural, and might even have a positive motivational value; nevertheless, in some situations, anxiety may be difficult to deal with, being highly debilitating in extreme cases. If not conveniently treated, these cases can evolve to severe anxiety disorders, such as social phobia or panic attacks.

To treat patients suffering from these conditions, cognitive-behavioral therapies expose patients to situations they fear. This exposure may be carried out either in vivo or by putting the patients imagining their triggering situations.

Some psychotherapists started using Virtual Reality (VR) systems during the 90's to apply exposure therapy to different types of disorders obtaining very encouraging results.

The use of digital platforms to support the therapeutic process has many advantages comparing to traditional techniques: it offers a greater variety of scenarios and reduces the cost of creating situations difficult or impossible to recreate. Additionally, these platforms support automatic data recording, are geographically independent, and

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are able to recreate situations that may be infinitely replicable. A single package of content may be used by many therapists, being available worldwide.

However, the use of VR platforms involves a significant investment: the purchase of sophisticated hardware components (e.g. VR glasses, head-mounted displays, CAVE) and their maintenance, as well as the software contents development. Besides, a considerable number of patients using these VR equipments experience uncomfortable sensations (dizziness or even sickness) that may prevent them to complete the therapy.

The aim of our work is to propose a solution to treat social anxiety, applying cognitive-behavioral therapies, that preserves the sense of immersion induced by VR systems without requiring the purchase of expensive special purpose hardware. Our solution is easy to install and maintain, even for people who do not have special expertise in the field of informatics, as it is the case of the large majority of therapists. Our solution resorts to a common apparatus, and it was designed to have a user-friendly interface that allows therapists to recreate in a controlled manner various types of stimuli.

The implemented application, called Virtual Spectators, involves: i) a simulation, observed by the patient, taking place in a virtual scenario inhabited by virtual humans with dynamically controlled behaviors and ii) an interface, used exclusively by the therapist, to control these behaviors as well as a set of events in the simulation.

The simulation is devoted to the fear of speaking in front of an audience and it attempts to recreate the realism of an audience which induces the sense of immersion in the patient using credible virtual humans and motion capture animations. During a therapy session, the patient will face the challenge of delivering a speech or a presentation before the virtual audience. While the patient is focused on his task and on the simulation, the therapist is observing his reactions and is controlling the stimuli using the interface commands.

The interface is simple and intuitive, giving the therapist a set of configurations of the auditorium and simulation events that can be used to adjust the level of discomfort to which the patient is subjected. This allows a higher level of control over the simulation than the one available in a recreated exposure therapy that involves real scenarios and/or real people, where unexpected events or behaviors may occur. Furthermore, it gives the therapist the possibility to go back and repeat a moment or a sequence in the exposure, in order to better train patients to deal with their specific difficulties.

We use free software tools that support the creation of video-games to create the simulation and a Kinect camera to record natural movements to incorporate in the virtual humans.

The simulations are displayed on a projection screen and in a way that the patient sees the projected elements of the environment with a size similar to their real counterparts; sound is also introduced in the simulations.

To evaluate the effective usefulness of the tool from the point of view of the therapist we performed an evaluation of the application. The feedback of the professionals that participated in the evaluation was positive and they were enthusiastic about the possibility of using such a tool to support a session of exposure therapy. Some of their suggestions were already incorporated in the application and have been considered in our on-going work.

2 Related Work

In the nineties some psychotherapists started using VR systems in exposure therapy for different types of disorders. Most of them seem to agree that VR is a valuable tool in treating phobic disorders [1], [2], [3], [4] and some concluded that VR Exposure Therapy (VRET) presents an efficacy level similar to that of traditional cognitive behavior therapies (CBT) [5].

Klinger (2004) studied, over 12 sessions, the evolution of the fear of public speaking in 36 participants [5]. Participants were divided into 2 groups, one treated with traditional CBT and other with VRET. The VRET was conducted using four virtual environments which simulated social situations involving performance (eg, public speaking), inter-personnel interaction (eg, a dinner conversation), assertiveness (eg, defending an idea) and evaluation (eg, talk while being observed). According to the study, patients in the VRET group showed a larger reduction of its social anxiety than patients in the CBT group. From a clinical point of view and taking into account psychometric criteria, the decrease in symptoms was similar in the two groups.

Herbelin (2005) published a validation study with 200 patients, confirming that his VR platform met the requirements of VRET therapeutic exposure for social phobia. Moreover, he also proved that it is possible to improve the clinical assessment with monitoring tools integrated in the application, such as eye-tracking [6].

However, these publications only present some of the features of VRET. These techniques have become the specialty of clinics and hospitals such as Virtually Better[7], Virtual Reality Medical Center [8] and Duke University Medical Center [9] and are the result of research carried out over many years.

3 Virtual Spectators

The application Virtual Spectators was conceived to be used by therapists to help in the treatment for Social Anxiety. The first implemented simulation is directed to the fear of speaking in front of an audience, taking place in a virtual auditorium populated with animated virtual humans whose behavior is controlled in real-time by the therapist who may also trigger a set of potentially disturbing events.

To overcome public speaking anxiety is a fundamental step towards personal and professional success in our society. However it may be a challenging and demanding goal that needs therapeutic monitoring, most probably using exposure therapy. The most important condition to perform a successful exposure therapy is provoking stimuli in the patient that are similar to those in real situations, causing in the patient the feeling of presence [6]. It is therefore important that the application generates a simulation interactively controlled by the therapist who is responsible for managing the stimuli caused in the patient.

Considering the course of simulation during a therapy session, the therapist has an active role while the patient has a passive one. The patient role is to perform a speech in front of the virtual audience that is facing him, while the therapist performs simultaneously two roles: i) he is aware of the behavior and responses of the patient to the stimuli caused by the audience and ii) interacts with the application to adapt the course of the simulation accordingly, either by changing the behavior of Virtual Humans (VH) or by triggering specific events in the scenario (e.g., turn on/off lights in the auditorium, make a mobile phone ring). The therapist is also responsible for configuring the initial scenario of the simulation, before starting a therapy session.

Our application was conceived to be executed and visualized in widely available equipment: a regular computer that executes the application, one projector and one projection screen and two nearby sound columns. Two separate windows are displayed: one for the simulation (Fig.1), which should be projected on the screen and another one containing the therapist interaction window (Fig. 2) which should be displayed in the computer screen and not visible to the patient.

The interaction window was conceived to be used by the therapist in two different moments: before and during the simulation. Thus, the interface is divided into two zones, with only one active in each of these moments. Before the simulation, the interface allows the configuration of the auditorium (left side of Fig. 2): set the number of male and female VH in the simulation, choose the colors of the physical elements of the room (walls, chairs), set the status of the lights of the auditorium (on/off) and the position of the camera within the 3D scene. The initial position of the camera can be adjusted within certain limits and along three orthogonal directions: zoom in and out (zoom), move to the right and to the left and move up and down. This is a sort of camera calibration, adjusting its position to the height and the position of the patient relative to the screen, so that the virtual elements are projected with a size similar to their real counterparts. Moreover, the virtual characters will also adjust the direction of their look in order to simulate that they are looking at the patient.

After setting up the scene, the therapist begins the simulation by clicking on the “Start Simulation” button. The string on this button changes to “Pause Simulation” and the button thus can be used to suspend the simulation.

During the simulation, the therapist can command the audience behavior (right side of Fig. 2): change the number of attentive or distracted characters, change the number of characters nodding in order to show agreement or the reverse situation, put some to sleep, trigger the occurrence of a whisper in the back of the room or the receiving of a text message on a mobile phone followed by the corresponding action of writing a response. Fig. 1 illustrates some of these situations.

The sound emitted by the columns is synchronized with the events "whisper" or "receive a message" happening in the simulation. There is also a button in the interaction window that triggers the generation of the sound of an airplane flying over the audience.

With this ordinary infrastructure, we have the advantage of using an inexpensive and easy to install equipment, projecting an image on a large screen, inducing in the patient the feeling of immersion. Moreover, it can be observed simultaneously by several persons, which may be valuable, for instance, in educational and training contexts/classes.

Fig. 1. The simulation window illustrating a possible situation during a therapy session: some of the characters are distracted, two of the girls are whispering, and one (on the left side of the scenario) has just received a text message on his mobile phone and is going to reply

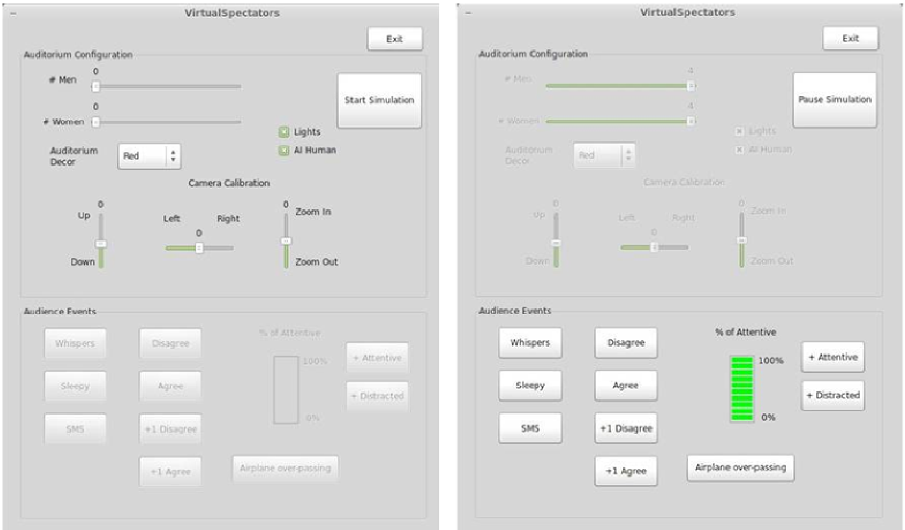

Fig. 2. The therapist interaction window. On the left: the configuration zone is active; on the right: the simulation mode is active.

3.1 Technical Details

The application Virtual Spectators was implemented following the architecture of a video-game; we have chosen Blender[10], a free and open-source tool used for creating 3D animated models and video-games. The Blender game engine manages the graphic content while the logical component of the system is implemented in the programming language Python.

The Virtual Humans and the Auditorium

The application MakeHuman [11] was used for the creation of 3D realistic models of human characters that exports models to Blender format. Resorting to different websites with free content for SecondLife and OpenSim and "The Sims 2" [12], [13], [14], [15] we have obtained credible clothing and hair for the characters, thus avoiding to develop them from scratch. With an image editor we produced a variety of clothing and hair by simply changing the base colors. Using this procedure, we have created several distinct VH models, each one with about 2200 vertices.

The animations of the VH body were produced using motion capture data recorded with a Kinect camera [16] and resorting to the software iPiSoft [17].

Due to restrictions of the Kinect camera drivers, animations do not contain the rotations of the hands and head. For this we added manually the animations of the head and hands using Blender features and created a set of animations for VH: "be aware", "be distracted" "receive a text message", "sleep", "whisper", "hear the whisper", "wink" and "sleep/wake". The more complex ones such as "being distracted" and "receive a text message", suffered a large number of amendments that were made manually in Blender's animation editor. To produce the "blink" movement in the VH's eyes we created shape keys.

As a proof of concept, one of the virtual characters in the scenario is provided with artificial intelligence, in order to have an autonomous behavior. Its behavior is not controlled by the therapist; the character changes its own level of attention according to the other VH in the auditorium. This feature allows the application to recreate simulations that are more similar to an exposure session in front of a real audience. Besides, the variability of the simulations from session to session, potentially reduces the "déjà vu" feeling of a patient subjected to a continuous therapy.

The auditorium was completely modeled and textured in Blender using standard 3D modeling techniques, such as mesh modeling, extrude, sculpting, among other. We have used textures from SecondLife/OpenSim.

All software used to create the auditorium and the animated characters is free except iPiStudio from iPiSoft; we used a free trial version available for 30 days.

The Interaction Window

To control the VH and trigger events in the simulation we created an interaction window that exchanges information with the simulation using inter-process communication, adopting the module pexpect [18]. To control the flow of messages we implemented threads that manage the Input/Output.

Fig. 3 outlines the articulation of our application with the Blender's game engine. The scenario is updated by the 3D game engine and is controlled via our Python script (Main Controller). The game engine is responsible for creating the simulation window while the interaction window communicates with the Main Controller.

The script receives the input from the interaction window and, besides triggering events, manages animations and provides access to objects and modifies properties, which are essential to set up the scenario such as visibility, textures, animations, among others.

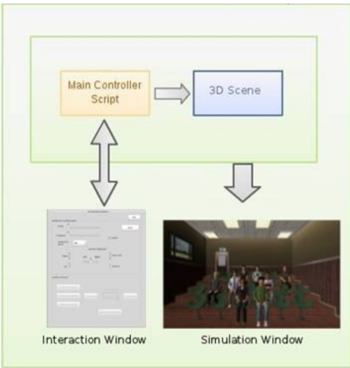

Fig. 3. Architecture of the application

3.2 Evaluation

The application was evaluated from the point of view of the therapists to assess its potential in supporting the realization of an exposure therapy session to treat the anxiety of speaking in front of an audience. Four therapists, one man aged 41 and three women aged 39, 41 and 44 participated in the evaluation. They were all familiarized with the use of exposure therapy and had no prior contact with the application. Moreover, they all felt at ease using the computer and were comfortable with the idea of using a VR tool to support exposure therapy.

For each therapist there was an individual test session in a room with the necessary equipment: a laptop to run the application and to display the interaction interface, a projector, a projection screen and two sound columns. Each session consisted in two successive phases: the first was a familiarization period with the application and the second was an exposure therapy session with a volunteer patient.

The first phase took five to ten minutes and was used by the therapist to explore the available functionalities in the interface, observing their practical effect in the simulation. In the second phase, which took seven to ten minutes, four students volunteered, one for each therapist, to play the role of patient. The therapist played his/her own role using the application to control the level of stimulus induced in the patient.

The therapists were unanimous saying that they would use this application to support a session of exposure therapy. They found no critical aspects in the interface and they all considered that the simulated events are interesting.

The aspects classified as more interesting were the credibility of the behaviors creating situations similar to those of a real auditorium, specially the possibility of having characters nodding in order to show agreement or disagreement, inducing positive or negative reinforcement.

The following improvements/additions were suggested: increase the number of characters (up to the limit of the auditorium capacity); improve the realism of the virtual humans, their animations and the movements of the eyes; increase the number of simulated events (for instance, characters entering and leaving the scenario, talking or speaking loud, using a laptop, taking snapshots or filming with a mobile phone or a camera); include the possibility of choosing different scenarios and the possibility of changing the appearance of the characters (for instance, the clothes, the age).

After the sessions the four volunteer students, aged around 22, gave an informal testimony of their experience. They all reported that, despite they knew the audience is virtual, the fact that the virtual humans move and exhibit variation in their behaviors somehow induces the sense of immersion and really affected them during the session.

This fact suggests that a person suffering from anxiety when talking in front of an audience can really profit from this application in a therapeutic context.

They suggested inserting more sounds in the environment, such as cars honking outside or the sound of the air conditioning system, to introduce more variability in the animations. The main identified problem is the lack of variability in facial expressions which were considered too neutral.

After these tests and from our own experience we conclude that there are important improvements that should be introduced in order to obtain a higher level of realism in the simulation. Some of the flaws are possible to solve in newer Blender versions (for instance, the movement of the eyes looking at the camera), while others may be easily attained or solved if manpower is available (for instance, more animated characters in the auditorium). Nevertheless, the realism can only be improved up to the limit of maintaining the rendering of the simulation in real-time.

4 Virtual Assessment Interview

Currently, we are working in a scenario to support the treatment of the anxiety caused by an assessment situation that is conceived to be used with the same equipment. We are still using Blender to produce the scenario setting but we are using a different technological approach. The simulation is generated by Unity3D game engine [19] that allows the development of video-games that can be played in the web or in the traditional devices such as desktops, mobile devices and consoles.

This simulation has peculiarities that make it significantly different from the simulations described above. These simulations are conceived to contain up to three VH sitting in a table facing and looking at the patient (Fig. 4). The therapist interface will provide functionalities to choose among a set of predefined models from both genders, different ages and wearing formal or informal outfits.

The assessment interview scenario is more intimidating to the patient comparing with the auditorium scenario: despite there are fewer VH, they are closer to the patient and clearly have a decisive evaluation role. Our main focus is the expression of emotions through body and facial poses. An Artificial Intelligence module will be developed in order to simulate distinct states of mind and personalities in VH. Unity supports this integration gracefully. For the time being we are not dealing with automatic speech recognition, but this will be a future challenge.

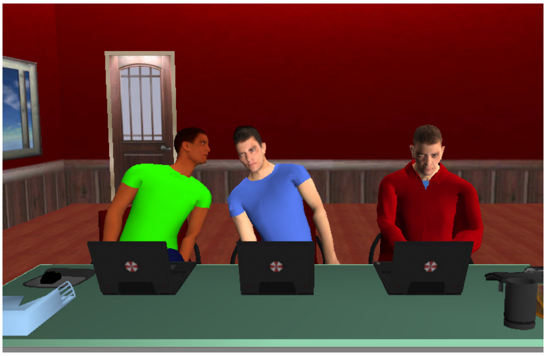

Fig. 4. Virtual assessment interview simulation

5 Conclusions and Future Work

We propose a low-cost solution to perform exposure therapy using Virtual Reality. During a therapy session, the patient will face the challenge of delivering a speech or a presentation before a virtual audience displayed on a projection screen. While the patient is focused on his task and on the simulation, the therapist is observing his reactions and is controlling the stimuli using the interface commands displayed in the screen of his computer. This interface provides a range of configuration options in the auditorium and a set of controllable events in the simulation.

The simulation tries to represent as realistically as possible an audience that cause "impact" on the patient using VH and accurate animations. For this end, convincing VH models were used and natural animations were developed using motion capture data. However, in this kind of applications, one must always find a balance between the realism of the 3D environment and the need to render the animation in real-time. So, up to some level, we had to sacrifice realism to obtain real-time response to the user interaction.

The development of the application has been closely followed by a therapist who has informally assessed the successive versions and has given clues to the next steps and features to implement.

We have carried out an evaluation process with a group of four therapists with the purpose of assessing if the application can support their work during an exposure therapy session to treat the anxiety of a patient caused by speaking in front of an audience. This evaluation included a configuration of the scenario by the therapist and a simulated session of exposure therapy with a volunteer "patient". The analysis of their answers to a questionnaire has lead us to the conclusion that our solution is not perfect and needs improvements but has a good potential for being useful in these therapies.

Informal testimonies recorded among the volunteer-patients suggest that our solution may be effectively useful in these therapies, inducing in the patients the sense of immersion and really affecting them during the therapy.

More scenarios are being developed to extend the application, e.g., with an assessment interview scene where we want to explore the expression of facial and body emotions. An artificial intelligence module concerning the simulation of emotions will be developed. We consider that this type of scenario might be interesting to use, for example, with graduate or undergraduate students to help some young people suffering from anxiety to speak to an audience or to a more limited set of people in an assessment situation. We are aware that there is a significant number of students that uses the existing psychology offices in colleges to ask for support in these specific situations. We are planning to perform user tests to evaluate the sense of immersion caused by this type of scenarios.

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