Engineering a Showcase of Virtual Reality Exposure Therapy

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***Abstract*— Numerous research studies and controlled trials have unveiled the potential of serious games in various health-related areas [1]. Their range of application can be even further extended by the use of virtual reality (VR) technology, which allows the realistic representation of interactive contents. Virtual Reality Exposure Therapy (VRET) is a very promising novel use case for the development of serious games. Held in a virtual environment (VE) adaptive to the needs of the patient, this form of therapy can outperform traditional real-world measures [2], [3]. One of its major success factors is the engagement of the patient, which can be increased by an immersive gaming experience. We show a demonstrator of VRET application for a fire-related post-traumatic stress disorder (PTSD). In this demonstrator, features to support actively guided VR experiences are improved on, focusing on the interactive adaptivity of the VE.**

I. Introduction

In exposure therapy, an experienced therapist exposes the patient gradually to stimuli that induce his pathological fears. By this means he can reflect his undesired behavioral patterns and develop effective countermeasures [4]. Lack of accessibility and adaptability of fear-inducing stimuli is this therapy's major disadvantage—consider the fear of flying and the therapist's lack of control over an actual airplane [5]. VRET transfers the concepts of the real-world approach to a VE that can be adapted to the specific needs of a patient. Over 20 controlled trials have proven that VRET performs at least as well as its real-world counterpart [6]. Yet due to the lack of knowledge to build a VR application that fits their specific needs, therapists largely refrain from using VRET [6], [7]. The company Virtually Better, Inc. (VBI) is the market leader in VRET applications. One of their key features is the interface the therapist uses for controlling the VE and monitoring the patient. It shows the player's view, layout panels with input forms to trigger game events as well as a separate form to log and make notes about the player's health condition. In VBI's products, some phobia scenarios are video recorded instead of rendered in real-time, which reduces adaptability. Although the global game environment can be modified at run-time with a slider menu, direct control the parameters of certain stimuli is missing. The therapeutic interface also lacks a preview mode of intended changes. User interaction is also limited, e.g. lacking the means to control one's movements, to interact with 3D objects, or see one's own body. This lack of interaction lowers immersion which, in turn, lowers the effectiveness of a serious game [8].

II. Concept & Realization

A generic therapy cycle underlies all VRET use cases [9], which we have condensed into the diagram shown in Figure 1. The therapist continuously identifies, classifies the stimuli that cause pathological fear according to the severity of symptoms and perceived threat levels, and controls them [10]. For VRET, the application requirements reflect

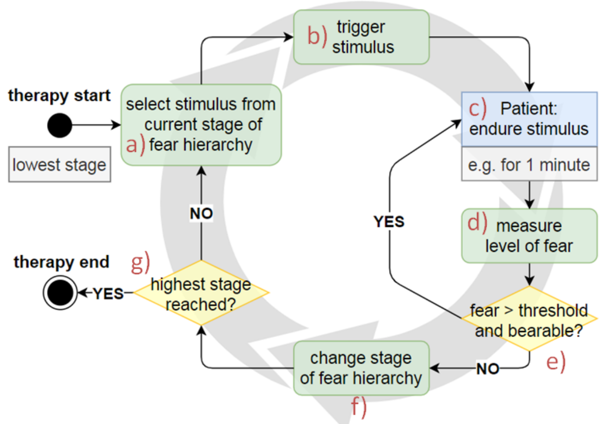

Fig. 1: In VRET, the therapist (a) selects an adequate stimulus to (b-c) confront the patient. Based on (d) its impact, the (f) the stage of the fear hierarchy is adapted and/or (g) the session is stopped.

the needs of the therapist to control the outlined therapy cycle and of the patient to ultimately be in charge of the progression of the therapy at his own pace and that game decisions are made based on his own free will. In addition, he has to be praised and encouraged to step further [11]. Figure 2 shows the supervision monitor, the interface of the therapist of our demonstrator of a VRET for fire-related PTSD. It allows him to interact with the VE and observe the patient's situation. Fear-inducing stimuli in the overview at the bottom are represented as red pins with a preview icon. Clicking on a pin, a contextual window is opened that allows the therapist to modify the respective stimulus' intensity, see Figure 3. With the help of a preview mode, the therapist can estimate the possible impact of planned changes before confirming and actually presenting them to the patient. As shown in Figure 4(a), the trajectory of the patient's teleportation is visualized by a trail of footsteps. He can pick up notes that let the narrative progress or give him a hint on other interactive elements. These notes are represented as blue pins on the floor map and can be highlighted by the therapist. The patient can observe his heart rate in real-time by a pulse sensor that is attached to his wrist and represented by a fitness watch in virtual reality (as shown in Figure 4(b)). The integration of sensor information serves two purposes: (1) It increases the degree of immersion experienced by the patient. (2) It can be used as a therapeutic medium to focus the patient's attention on his body signals. This allows him to become aware of his own sensitive physiological reactions and thus can help to calm himself [12]. Overall, the design of the supervision monitor is plain and functional. GUI elements are sized, placed and colored to be quickly operated also in stressful situations.

Fig. 2: Top-left: Stream of the patient's view. Top-center: The patient's heart rate and perceived fear level. Top-right: Adjustment of global parameters. Bottom: VE map with the patient depicted in pink. Pins represent configurable stimuli.

Fig. 3: The control window of a fire stimulus and its preview in the context of the floor map.

III. Conclusion

Based on a comprehensive review on VRET literature and seminal existing applications, we have systematically extended the state-of-the-art in terms of interactive supervision, visual feedback and patient immersion. To this end, we presented an intuitive and goal-oriented supervision monitor that serves as the therapist's interface to observe and control the course of a therapy-supporting VRET session. The monitor integrates various supportive technologies such as the real-time stream of the patient's view, his contextual tracking in the VE, integration of additional sensory information for both the player and the supervisor (e.g. the pulse tracker), the ability to directly adjust global system parameters and concrete stimuli, and to log therapy-critical events. Based on our results, empirical studies have to be conducted as next step to reinforce the effectiveness of aforementioned concepts in practice.

(a) Footsteps. (b) Virtual fitness watch.

Fig. 4: Visualization techniques in VR for (a) the navigation system (b) and the heart rate.

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