# Exploratory Design and Evaluation of a User Interface for Virtual Reality Exposure Therapy

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**Abstract.** Virtual reality exposure therapy is slowly becoming a viable option for therapists. For virtual reality systems to be used in the daily practice of therapists, their usability needs to be taken into consideration. This paper describes the current state-of-the-art in interfaces for these systems, and describes several proposals for improving the design of these systems. An exploratory evaluation is performed to assess the merits of aspects of the proposed user interface.

## 1. Introduction

Already a great number of studies have shown virtual reality to be effective in the treatment of phobias such as acrophobia [1][2][3][4], claustrophobia [5], arachnophobia [6], agoraphobia [7] and fear of flying [8][9]. Slowly, Virtual Reality Exposure Therapy (VRET) is becoming a viable and acceptable option for therapists. When compared to current standard in vivo therapy, VRET can be less expensive, less intimidating for the patient and can provide the therapist with greater control of the stimuli with which the patient is confronted.

Currently, most research has been focused on proving the effectiveness of VRET. However, for VRET to become accepted in the daily practice of the therapist, the system should be easy to use for both therapist and patient. Our research is focused on improving the usability of VRET. For this, we have looked at the user interfaces of current VRET systems, and have made an analysis of the user interaction during virtual reality therapy sessions to identify possibilities for enhancing the user interface. This article describes our exploratory research into options for improving the user interface design of such systems.

## 2. Current VRET systems

An investigation into the user interfaces of existing systems for VRET, based on a web-based questionnaire and personal inquiry at the several suppliers of these systems, shows that these interfaces are quite similar and of a simple design. Table 1 shows an overview of the systems included in this research.

Without exception, these systems use a Head Mounted Display (HMD) to immerse the patient in the Virtual Environment (VE). The exact same view that is provided for the patient is also shown on a standard monitor for the therapist. In five of the seven systems, the therapist could alter certain elements of the VE during the exposure by keystrokes on the keyboard. In three systems, the therapist could also control the viewpoint of the patient, often by use of a joystick or similar input device.

The patient could look around in the world by use of a tracking device attached to the HMD. In case the VE consisted of a driving simulation, the patient was provided with appropriate steering controls. In some cases, the user was provided with a tracked device to interact with objects in the VE.

Table 1: Overview of commercially available systems for treatment of phobias

| *Name System* | *URL website* | *Phobias (other disorders)* | |
|---|---|---|---|
| Hanyang University | bme.hanyang.ac.kr/vr | Acrophobia<br>Fear of driving | Fear of speaking<br>Agoraphobia |
| Virtually Better | www.virtuallybetter.com | Acrophobia<br>Fear of flying<br>Fear of speaking<br>Agoraphobia | Fear of thunderstorms<br>(Post traumatic stress disorder for Vietnam veterans) |
| VRHealth | www.vrhealth.com | Claustrophobia<br>(Panic disorders) | (Eating disorders) |
| Previ | www.previsl.com | Fear of Flying<br>Claustrophobia | (Eating disorders) |
| DriVR | www.driVR.com | Fear of Driving | |
| VRT-2002 | science.kennesaw.edu/~mnorth/vrt1/vrt1.html | Acrophobia<br>Fear of flying<br>Agoraphobia | (Obsessive Compulsive disorders)<br>(Attention Deficit Disorders) |
| CYBERmed | www.insight.co.at | Fear of flying | |

To investigate the usability of these systems in more detail we created a virtual reality testbed configuration [10] with which different types of user interfaces can be tested. The testbed was configured to offer a user interface similar to the interfaces found in the systems described above. A usability study and a task analysis were made based on the observations of several therapists using this system in treatment of acrophobia [11].

The task analysis showed that by far the most frequent activity during VRET is determining the fear level of the patient by the therapist. Further usability analysis also showed that therapists have to memorize several arbitrary keyboard commands to control the VE, thus increasing the memory load and training time for the therapist on each VE. Another problem was that the therapist's view of the VE was restricted to the view of the patient, which was determined by the looking direction of the patient. Combined with the fact that the patient could also move him/herself within a limited range in the VE through use of the headtracking this made navigating the patient through the VE sometimes difficult for the therapist.

## 3. Proposed user interface

Research has indicated that interaction can increase the sense of presence [12]. Presence is seen by some as a key element in VRET. To enhance the sense of presence, patients are provided with a means to navigate themselves through the VE. For this, we used a technique based on the position of the HMD. If the patient stepped out of the middle of his or her moving space, (s)he would automatically start to move in that direction in the VE with a constant velocity. This motion would stop either when the patient stepped back, or when the patient collided with an obstacle (e.g. a wall) in the VE.

In the reviewed systems there was no specific screen for the therapist. Because the same image was projected both in the HMD and on the monitor, extra information for the therapist could not be included because this would also show in the HMD. Using our testbed we created a separate screen for the therapist by including a second computer that could communicate over the network with the virtual reality station generating the stereoscopic images for the HMD.

Based on the findings of our aforementioned study, we designed a user interface specifically for the therapist. Figure 1 shows an overview of the screen presented to the therapist. Through use of the familiar Window Icon Mouse Pointer (WIMP) metaphor the therapist could control the various parts of the graphical user interface. The two three-dimensional views in the middle of the screen displayed the VE from the viewpoint of the patient (top) and from a second, external viewpoint (bottom). Furthermore, patient name and session-number could be stored with additional treatment data and a clock was provided to keep track of session time.

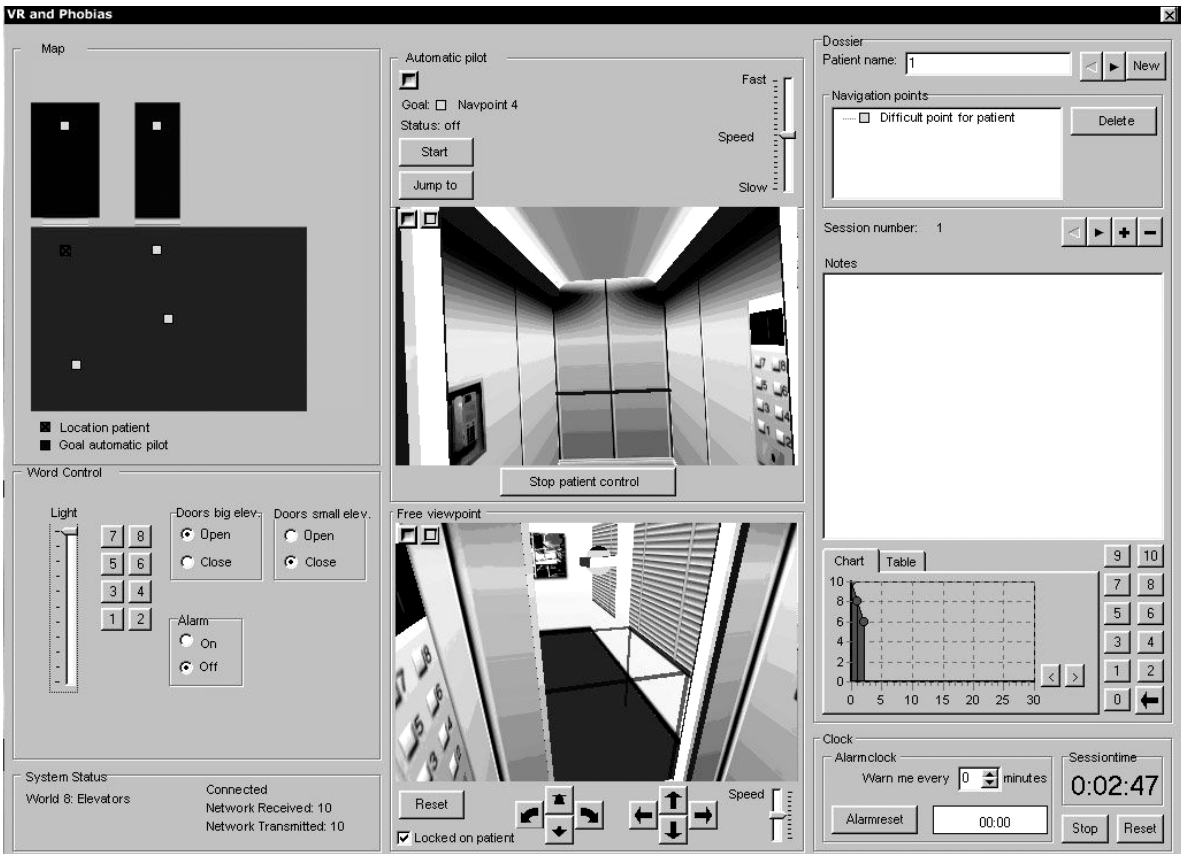

Figure 1: Overview of the proposed user interface for the therapist

### *3.1 SUDs recording*

During therapy, patients are often asked to report their current level of anxiety on a scale from zero to ten, where zero means not anxious at all and ten indicates the highest level of fear the patient can imagine. Such Subjective Units of Discomfort (SUDs) are used by therapist to determine amongst others whether the fear has diminished during the exposure treatment.

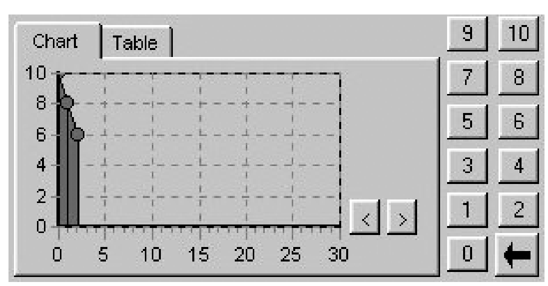

Figure 2: Tool for keeping track of SUDs

Figure 2 show the tool designed to keep track of these SUDs. By clicking on one of the numbers the SUD as well as the time is recorded and displayed either on a chart or in the form of a table. The back arrow could be clicked to erase the last SUD notation.

*3.2 Automatic pilot*

Even though the patient could also move him/herself through the VE, the therapist was also provided with several controls to manipulate the patient's location. One way was through use of the automatic pilot that could be programmed by dropping a token □ representing a location in the VE on the widget of the autopilot panel displayed in figure 3. By pressing the 'start' button the patient would gradually be moved to the location at the speed set with the speed control. By pressing 'jump to' the patient would immediately be teleported to that location. The location tokens could be picked up from the two-dimensional map of the VE and could be stored and retrieved from the patient dossier so the therapist could later return with a patient to a specific situation.

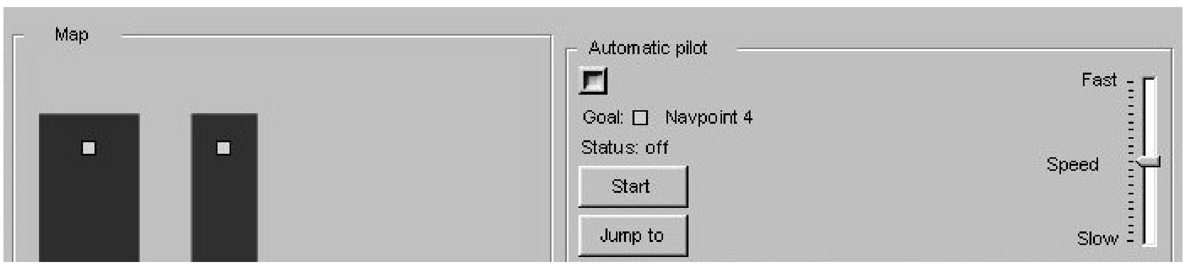

Figure 3: A part of the two-dimension map (left) and the control for the automatic pilot (right)

*3.3 Free viewpoint*

To solve the navigation problems experienced by some therapists, an external viewpoint was provided as shown in figure 4. This viewpoint was by default locked on the patient, showing the viewpoint of the patient in the shape of a head wearing an HMD.

In reality a railing surrounded the patient, and this railing was also represented in the external view. This not only enabled the therapist to determine where the patient was standing within the railing without looking up, but it also made it possible for the therapist to determine when a virtual railing corresponded to the real railing, thus creating the illusion that the patient could physically touch the virtual railing.

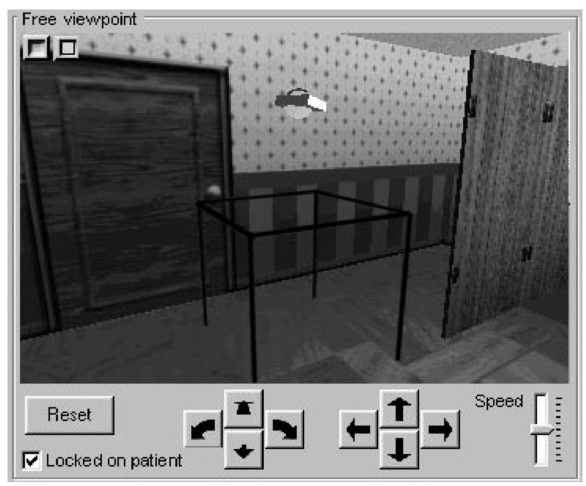

Figure 4: Extra viewpoint displaying the VE as well as a representation of the HMD and the railing surrounding the patient in reality

Controls to alter the viewing direction were also provided, configured according to guidelines set for these types of interfaces [13].

## 4. Method

A user interface was designed to represent the current state-of-the-art as described in section 2. This user interface (UI1) and the proposed new design (UI2) were used for exposure therapy on 27 students diagnosed as having a reasonable amount of acrophobia or claustrophobia. The therapy was performed by six students of the clinical psychology department trained in phobia treatment. For acrophobia treatment our VEs of a construction site, firestairs and rooftop terrace were used in combination with UI1. For claustrophobia treatment a virtual elevator, closet and narrow hallway were used in combination with UI2.

Questionnaires for both 'patients' and 'therapists' were used to acquire insight into the overall system usability and the usability of specific elements of the user interface. The patients were also required to fill in the Igroup Presence Questionnaire [14]. Additionally, the therapists were interviewed based on videorecordings of the treatment sessions.

Figure 5: The test environment with a patient standing in the railing wearing the HMD, and a therapist behind the controls.

## 5. Results

In all, 3 students performing the therapy were interviewed. Two of these preferred UI2 to UI1. The other student indicated that her preference for UI1 was primarily based on the fact that the acrophobia worlds provided better possibilities for the exposure therapy; it was possible to increase the fear for the patient more gradually and to a higher extent. Interestingly, this student did rate UI2 much higher on our questionnaire with questions regarding sense of control during the session, ease of use of the system and whether it was subjectively pleasing to use the system. The other students rated both user interfaces equally.

Analysis of the questionnaires and interviews indicated that several elements of the proposed design were found helpful in the therapy. The SUDs registration tool was most popular, receiving 5 out of 5 points both for being used frequently and for easy of use.

The students indicated that the automatic pilot was hardly used at all. This was because the patient could navigate him/herself through the virtual environment. The students reported the autopilot to be moderately easy to use, and that they could achieve their goals with the automatic pilot. Storing certain locations for later use with that patient was never used because patients were never exposed to the same VE twice.

The external viewpoint was considered useful (average 4 out of 5 points). Users commented that the viewpoint increased their overview of the situation, reduced the need to look at the patient directly and facilitated moving the patients in tight spots. However, none of the students ever used the controls to change the viewpoint. The main reason given for this was that the controls were too complicated.

The fact that the patients could navigate themselves in UI2 was evaluated positively by the therapists (average 4 out of 5 points). Due to an error in filling in the questionnaires, only 4 of the patients treated with UI1 actually filled in the usability questionnaire, compared to 14 using UI2. Nevertheless, a one-way-ANOVA showed scores to be significantly lower (p=.008) for UI2 in response to the question whether the interventions of the therapists in the controls were considered to be annoying. Also interesting is that subjects using UI2 scored almost significantly higher on questions regarding how much they looked around in the VE (p=.058) and the ease with which they could do this (p=.087).

The presence experienced by the patients, as measured with the IPQ, did not differ significantly between conditions.

## 6. Conclusions

The fact that the different types of user interfaces were used for treatment of different phobias made comparison between the systems difficult. As expected, responses showed usability to be not only a function of the type of user interface but also of the design of the VE itself. However, qualitative insight was gained into the contribution of several user interface design elements to system usability. The tool for recording SUDs as well as the external viewpoint were evaluated positively in terms of their usability. It is also clear that the controls for changing the external viewpoints need to be simplified before therapists will use them.

The patient's navigation control was considered to enhance usability, both for therapists and patients. However, this type of interaction had no measurable effect on the sense of presence that the patients experienced.

The study reported here is, of course, only of an exploratory nature. Future experiments are planned to provide more quantitative insight in the way in which the usability of VRET systems can be improved.

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