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Abstract

This article proposes a tool to support the psychotherapist in the process of treating spider phobia through a system that combines both software and hardware elements to present immersive virtual reality environments to the treated patient. To create the feeling of immersion, environments and models created in Unity are used in conjunction with the patient's movement tracked through the Kinect motion sensor. For the development of the system, the psychotherapeutic treatment method of systematic desensitization is used, so that the patient can overcome his fear and present non-phobic interactions with spiders. The process of developing the system and redacting this document was supported and supervised by a psychologist specialized in the treatment of phobias. Finally, tests were performed to obtain feedback from specialists and potential patients with a medium degree of phobia, in which the results were very positive and satisfactory.

Keywords (separated by '-'): Spider phobia - Systematic desensitization - Virtual reality - Unity 3D - Kinect

Alternative Treatment of Psychological Disorders Such as Spider Phobia Through Virtual Reality Environments

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Abstract. This article proposes a tool to support the psychotherapist in the process of treating spider phobia through a system that combines both software and hardware elements to present immersive virtual reality environments to the treated patient. To create the feeling of immersion, environments and models created in Unity are used in conjunction with the patient's movement tracked through the Kinect motion sensor. For the development of the system, the psychotherapeutic treatment method of systematic desensitization is used, so that the patient can overcome his fear and present non-phobic interactions with spiders. The process of developing the system and redacting this document was supported and supervised by a psychologist specialized in the treatment of phobias. Finally, tests were performed to obtain feedback from specialists and potential patients with a medium degree of phobia, in which the results were very positive and satisfactory. AQ1

Keywords: Spider phobia · Systematic desensitization · Virtual reality Unity 3D · Kinect

1 Introduction

The knowledge of phobias themselves is very old, in the time of the Egyptians there were already scrolls that referred to the cirps hippocraticum with reference to excessive or irrational fears [1], nowadays phobias are known as the persistent fear which is unleashed in the presence of a specific object or situation [2]. In the 17th century it was Boissier who described the fear of heights, calling it hysterical vertigo now called acrophobia, and it was Morei who first classified phobias and other neuroses [1]. Phobic disorders are characterized by physiological, behavioral, and cognitive symptoms that are present and interact with each other in each of the anxious episodes presented by phobic subjects [3].

Studies with adults have found that the average age of onset of specific phobias is 9.7 years. However, at an early age there is a great deal of therapeutic neglect, because there is a tendency to confuse specific phobias with childhood fears that are transient and play an adaptive role [4, 5]. Phobia is without a doubt the most frequently found in psychopathology in relation to insects, this phobia called entomophobia is found within specific phobias, according to the American Psychiatric Association, in its classification

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of Mental Disorders DSM-IV. However, only 17% of patients with this phobia visit a psychiatrist [6].

Many people have a fear of spiders, although it is often controllable and will rarely actively avoid the possibility of encountering these animals. Several studies have been conducted on arachnophobia, one of which is Seligman's for example, who suggested that simple phobias are a response to stimuli that in the course of evolution have represented a real danger to mankind. This theory could explain entomophobia, or more specifically spider phobia [6]. A person becomes spider phobic due to a traumatic event or negative thoughts disclosed by close people, it is an anxiety disorder that gradually increases if not controlled [7].

The first appearance of virtual reality in Clinical Psychology focused on the treatment of acrophobia [8], in which the patient overcame his fear of heights after being exposed to virtual reality environments that put him in acrophobic situations. The use of this technology implies that one can have simulations of reality instead of the patient's imagination or procedures such as role-playing, giving the therapist full control over events [9], this gave way to further researches.

The advantages that virtual reality has over real exposure are important, many of the visual stimuli for the treatment of phobias can be expensive, virtual reality gives complete control of events to the therapist, which guarantees the safety of the patient; however, it also has its disadvantages, *e.g.* it does not completely replace reality because the patient will sooner or later be exposed to a real situation in order to complete his or her recovery, in addition to the fact that there are certain patients unable to fully fuse with virtual reality environments [10, 11].

Psychologists and researchers in the field of virtual reality have paid special attention to the treatment of phobias and other anxiety disorders, publishing several studies on the subject; the most relevant are [8, 12–14] in which various phobias are treated, *e.g.* acrophobia, dentist phobia, even using mobile devices for the treatment of dog phobia, however, there is other research that focuses especially on the treatment of spider phobia, which concludes that, despite some improvements to conventional treatments such as protocols and standardization, the difference between live exposure versus the use of virtual reality is not significant [15–19].

2 System Structure

The virtual reality system proposed for the treatment of spider phobia is designed to allow the user to interact easily with the system; the use of both input and output hardware devices allows the user to interact immersively with the system. The block diagram shown in Fig. 1 details the structure of the proposed system through a series of steps that it follows to achieve its objective.

The patient's interaction with the motion detection device provides real-time treatment for the patient, making rehabilitation more interactive and immersive, introducing the user to virtual reality environments created with the goal of overcoming the user's fear of spiders. On the other hand, as it is a virtual environment, the patient can leave when he feels that his fear is uncontrollable and he can no longer control himself, which increases the feeling of personal control at the moment of rehabilitation.

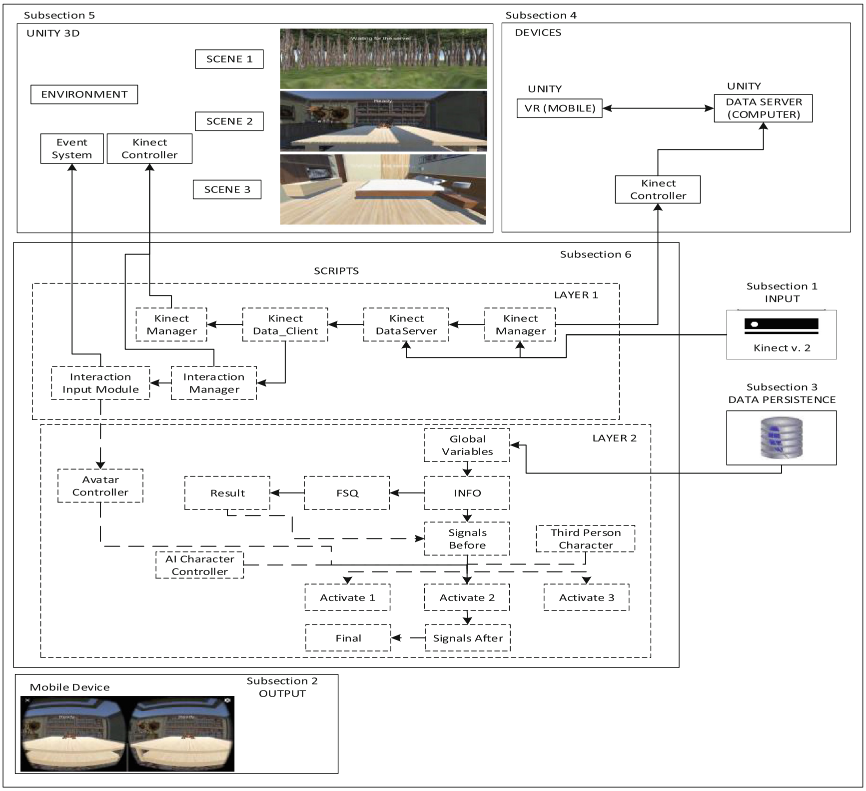


Fig. 1. Block diagram of the rehabilitation system

Likewise, by minimizing the effects and risks of live exposure and being something new for the patient, it significantly reduces therapeutic abandonment.

Figure 1 presents input, output, and data processing devices, as well as necessary scripts, logical objects, and a data persistence engine through which the proposed system becomes functional; the interaction of the variety of elements listed above recreates an immersive environment which is presented to the patient for the rehabilitation process. The patient's interaction with the entire system will give the sense of realism that is desired for successful rehabilitation. Application development can be subdivided into six subsections, (1) Input device, (2) Output device, (3) Persistence engine, (4) DataServer (Computer), (5) Processing interface (Mobile) and (6) Scripts.

Subsections 1–3. The proposed system has as its functional basis the detection of movements through the Kinect sensor as an input device [20, 21], for which through specific scripts, the data provided by the tool is interpreted in order to track the patient's movements to avatar animations within the treatment scene. As an output device we consider virtual reality glasses in order to give the patient a greater immersion in the rehabilitation process. Please note that the mobile device must be a smartphone and have Android 6.0 operating system or higher, while the virtual reality glasses will only need to be adjusted to the size of the mobile device. SQLite is used for the persistence engine, which is a database that does not represent a greater workload in the system compared to other engines.

Subsections 4–5. In these subsections there is the product of the development, on the one hand, there is the DataServer and on the other hand, there is the treatment interface. These subsections have a wireless communication between them, as can be seen in Fig. 2. The DataServer receives data from the patient's movement from the Kinect sensor, and sends it through the wireless network to the cell phone, which has the functional system installed. In the mobile the patient and the specialist interact actively with the software, at the same time, the software installed in the mobile has a direct connection with the database engine, which gives the required persistence.

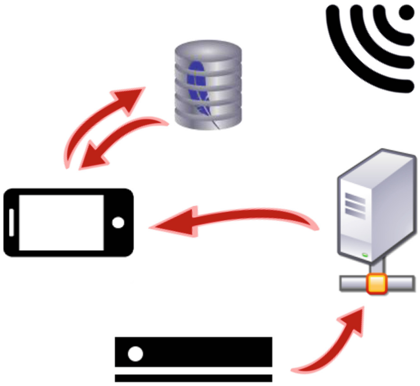


Fig. 2. Communication between devices

Subsection 6. This subsection is the main part of the system as it contains all the logic applied for its development. This in turn is divided into two essential parts, (i) Layer 1, which aims at device connectivity and data interpretation, while (ii) Layer 2 will prioritize system functionality and data persistence.

(i) Layer 1. In this layer is found the Script that interconnects the devices wirelessly, taking as parameters the IP's of each equipment. The Kinect Data Server located on the server side (computer) determines the IP of the server and makes it visible to the server side so that there is a dynamic connection between the mobile phone and the computer. The Kinect Manager script located on both server and client, is the one that receives the patient's movements through the Kinect sensor, interprets them and makes them understandable for the Unity video game engine. Finally, there is the Avatar Controller, which allows the app to collect data from previous scripts, and based on this data, obtain and replicate the patient's movements and give motion to the avatar that's inside the environment.

(ii) This layer is responsible for the main functionality of the system, as it contains all the treatment logic, where the patient will have to go through virtual reality environments which depending on the patient have three different levels of intensity. These environments differ in: (a) *Comfort*. Which is the level of comfort provided by the environment in question, (b) *Realism*. It is the level of detail of the spider model, this feature enhances the therapeutic process through the modification of the 3D model, and in (c) *Animations*. Which are the type of movements the model has inside the virtual environment [22].

3 Virtual Interface

The system is developed in three different sections: (1) Interaction with the user, (2) Interaction with the specialist and, finally, (3) Virtual interaction with the patient.

3.1 User Interaction

This section focuses on the patient, a login process is presented so that the software stores each user and remembers all the results associated with it, both those obtained in the questionnaire and those provided to the system by the doctor during each session. Also, a questionnaire (FSQ) is presented which will inform both the specialist and the system about the level of phobia that the patient possesses, therefore, an interaction of the patient's hands with the buttons placed in the environment is needed, so that they can select the answer of their preference see Fig. 3.

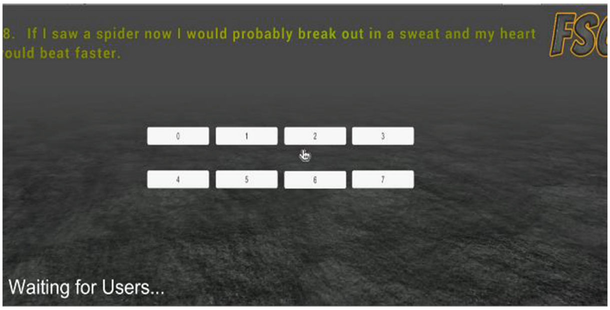


Fig. 3. Question number 18 from a bank of questions belonging to the FSQ, through which the patient's degree of phobia is obtained.

By completing the questionnaire, the system is able to present the scenario that best suits the patient depending on their degree of phobia. This avoids unnecessary interaction of the specialist with the system.

3.2 Specialist Interaction

This section is based on the interaction of the specialist with the system, it is about the input of certain variables that are needed in each session to follow the patient during his treatment, see Fig. 4.

Fig. 4. Data entry forms for the specialist, before and after the treatment session. On the left, input of the date of the current session and the patient's heart rate; on the right, input of the patient's fear level, presence level and heart rate prior to the session.

The variables to be measured are a selection of the variables presented in previous research [23, 24], which are listed below:

- Self-Reported Measures
  Here the state of the patient is used, the subjective units of disturbance scale (SUDs) will be used, where 0 is no disturbance or neutral and 10 is the maximum disturbance that the patient can imagine, with this range the patient must, after 10 to 40 s of exposure, rate the level of fear he feels of the spider, and after 20 to 50 s, rate the level of presence he feels about the spider. The level of fear is the anxiety the patient feels while the level of presence is if the patient feels the spider nearby after seeing it.
- Fear of Spiders Questionnaire
  The questionnaire will be taken from the patient before and after the treatment, the questionnaire was taken from FSQ (Fear of Spiders Questionnaire) [25].
  The FSQ consists of 18 questions each with answers on a scale of 0 to 7 where 0 is not at all and 7 is totally. The patient is asked to evaluate within this scale the similarity of his or her reaction to such situation with the reaction of the question.
- Behavioral Measures
  As for behavioral measurements, the heart rate measured with a sphygmomanometer before and immediately after the treatment will be used, in this way, the values obtained can be compared and the impact of the treatment on the patient can be observed session by session [26].

3.3 Virtual Interaction

The proposed system has several virtual reality environments which are used as a treatment for patient phobia, through interaction with the most realistic 3D spider models possible, the patient should learn with the guidance of the specialist and the system to face the fear. For this purpose, it is taken into account that there are currently several methods for the treatment of phobias, one of which is systematic desensitization, which is based on the psychological principle that the body cannot be in a state of relaxation and anxiety at the same time, therefore, the patient should be taught how to relax in a situation of anxiety, and gradually become used to remain relaxed in front of the object responsible for the phobia.

Therefore, this research is based on what has been explained above and this concept is used to create virtual reality environments that allow this method to be applied. The system will have its functionality in treatments with constant and programmed sessions, in order for the rehabilitation to be a success.

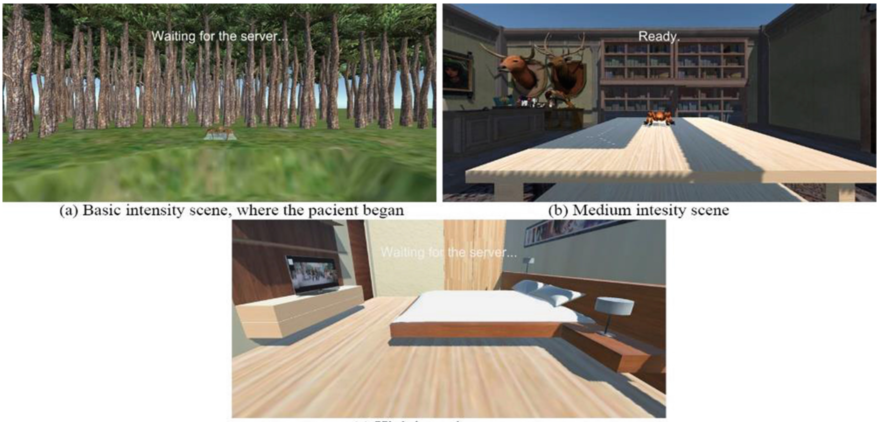
4 Use Case

The results of the system developed as an alternative treatment for psychological disorders such as spider phobia are presented in this section. During the process, a group of patients with a high degree of spider phobia is treated, and a test subject is chosen to collect the results of this research. Next, the patient's treatment process is highlighted. First, the entire environment is prepared to proceed with the treatment. In order for the application to have its full functionality and be able to retrieve data from patient movement, an instance is required within a Data Server computer.

From the data retrieved from the Kinect sensor and sent through the local network where the server and client are connected by the Data Server, the application works at full capacity, at the beginning it displays a menu, which has the options of registering and logging in with a user. Once logged in the system displays some important information about the patient, see Fig. 5.

Fig. 5. Shows the information retrieved from the database for the user, in this interface the most relevant data of the patient is shown, such as user name, FSQ scores and the options to follow from that point onwards. On the left, information on the test subject, presented in the first instances of his or her treatment; on the right, the result of the patient's FSQ on the first day of treatment.

The patient's treatment is specified according to his degree of phobia, for this purpose the system has a spider fear questionnaire, which consists of 18 questions, with which a total is obtained and the patient is classified according to his level of fear, in this case, the patient presented a degree of phobia of 90, categorizing him as a highly phobic person [27]. There are 3 treatment levels within the system, see Fig. 6. In this case, the treatment starts with the most basic scene possible. Continuing with the treatment, the specialist enters the date of the session along with the patient's pre-treatment heart rate for future comparisons. The patient then interacts directly with the virtual environment guided by the therapist, thus the virtual part of the treatment begins.



(a) Basic intensity scene, where the pacient began (b) Medium intesity scene

(c) High intensity scene

Fig. 6. Scenes divided by treatment levels.

The first scene is used as a basis for treatment because it does not constitute a major threat to the patient, in this scene the spider waits quietly for the patient, and at a certain distance begins to follow him. The following scene increases in difficulty for the phobic person as in this case the spider attacks the patient when he gets too close, see Fig. 7. Finally, the most difficult scene is the one where the patient has no idea where the threat comes from, so the alert status is higher, at the same time the number of spiders is higher.

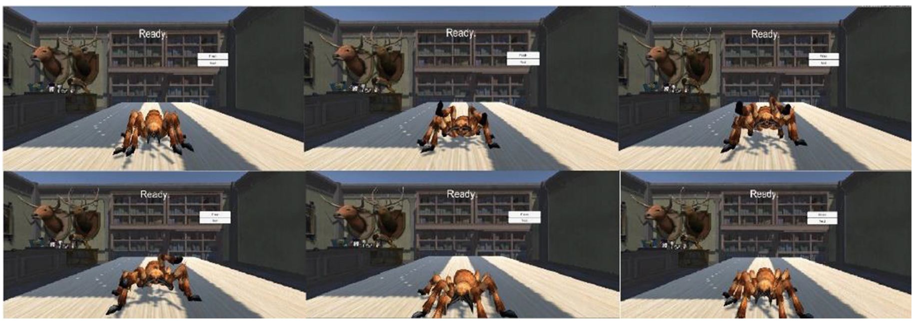


Fig. 7. Sequence of images of the attack animation within scenario number 2

Once the session is over, the specialist re-enters the vital signs and other variables considered, and the system returns a history of the patient's data and all the results.

5 Analysis and Conclusions

The proposed tool is oriented towards the diagnosis of specific phobia CIE10 F40.2 (Spider Phobia), the therapeutic process consists of two phases, the preparatory phase, in which emotional control techniques such as relaxation, breathing, safe place, among others, are applied to the patient with the objective of making the patient feel as calm and comfortable as possible. Once this phase is over and the emotional state that the therapist requires has been achieved, the next phase proceeds to the use of the proposed system, focusing clearly on the rehabilitation of the patient.

The psychotherapeutic treatment is enhanced by the ease with which realism can be managed through the modification of the 3D model of the spider and the environment in general, in addition, the tool helps to reduce therapeutic abandonment through important factors within the treatment such as the increased sense of personal control, the novelty of the rehabilitation technique and the safety it provides by minimizing the effects of live exposure.

The proposed system was tested with a group of 10 patients with a medium degree of phobia and 3 specialists including the supervising research psychologist. In order to obtain feedback from the system, a bank of questions was prepared for both patients (Qp) and specialists (Qs) see Table 1, which are answered on a scale of 0 to 10 where 0 is disagreement and 10 is agreement (Fig. 8). AQ2

Table 1. Questions for patients and the specialist to obtain feedback on the proposed system

	Questions
Qp1	I am familiar with the handling of devices that facilitate the immersion in virtual environments.
Qp2	Handling virtual environments is relatively easy.
Qp3	The execution of the interface is simple and intuitive.
Qp4	The limitations given by external noise (light, depth) are imperceptible.
Qp5	The equipment used does not cause any discomfort.
Qs1	Patients are enthusiastic about these types of rehabilitation options.
Qs2	The system facilitates obtaining information on the progress of the patient's treatment.
Qs3	The increasing complexity of tasks accelerate the recovery of the patient.
Qs4	The system is robust enough to determine slight missteps in the sequences.
Qs5	The system can be easily implemented in institutions dealing with this phobia.

Fig. 8. Feedback results

Consequently, the proposed system is proven to be user-friendly and proves to provide a very useful tool for the therapist when treating arachnophobia. These positive and satisfactory results demonstrate the feasibility of implementing this tool in an institution or clinic that deals with this type of phobia.

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