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A Preliminary Study on the Use of an Adaptive Display for the Treatment of Emotional Disorders

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ABSTRACT

A preliminary study on the use of an adaptive display for treating emotional disorders is presented. The purpose of this study is twofold: to obtain a virtual environment that adapts to the emotional states of the user at each moment and to analyze the possibility of using it for the treatment of emotional disorders. Until now, different types of adaptive displays have been developed and studied, some of which try to react to affect states of the user (Reynolds et al., 2004). The novelty of our system lies in the use of the adaptive display for the treatment of emotional disorders.

Keywords: *adaptive displays, virtual space, transformation of virtual environments, emotional disorders.*

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1. Introduction

1.1 Adaptive displays

An adaptive display can be defined as a device that autonomously adjusts its presentation and actions to better match the immediate goals and abilities of the user. The system has to monitor several variables, such as user status, tasks and context. The possibilities depend on the capabilities of the technology that carries the display.

Rothrock et al. (2002) identified two types of adaptability depending on the tasks that the user must perform in the system: interaction and knowledge content. If the user's purpose is to execute and control tasks using the system, interaction adaptability would

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be required. In this case, a perceptual adaptation is usually made. On the other hand, if the user's purpose is to acquire knowledge, the focus would be on content adaptability. This knowledge content adaptability can be used in web browsing, learning activities and so on. The system would elicit information from the user and continually update the information that is shown based on patterns of interaction.

In recent years, interest in adaptive displays has greatly increased, as it is a technology that can be applied in many different areas. A lot of research has focused on the technical aspects such as improving resolutions and detail of the displays. Other research has focused on cognitive aspects such as analyzing the problem of information overload and the observer's ability to process the information that is shown.

A few studies are centred on the perceptual adaptation of the user. Schowengerdt et al. (2004) have recently built several prototype displays that can vary the focus of objects which are at different distances in a displayed scene. The purpose of the authors was to couple accommodation and vergence in a stereoscopic display to better simulate natural viewing conditions.

Other special kinds of adaptive displays are gaze-contingent. These devices attempt to balance the amount of information displayed with the visual information processing capacity of the observer (Duchowski et al., 2004). Depending on the user's focus of attention, content is shown in different ways using different display processing means. Eye tracking can be used to follow the user's eye movements in real time.

While Duchowsky and many others focus on spatial adaptivity, other authors focus on temporal adaptivity. The sampling in these studies is not only denser but also more frequent. Watson et al. (2004) have developed a display that emphasizes older samples in static settings and new samples in dynamic settings. This offers new possibilities for adaptation to the user state (not only where it is needed, but also when it is needed). Watson's prototype also included eye tracking to respond interactively to changes in the user's viewpoint.

Other adaptive displays emphasize content. Their goal is to minimalize the flood of information towards the user, taking into account the user's speciphic needs and capabilities as well as the technical features of the system. There are different levels of meaning that are integrated within human information processing (Duke, 2004), and it is important to identify these levels in order to adapt the delivery of graphics and information to the user.

Cai (2004) describes a case study of video stream monitoring for traffic safety. Since it is impossible to display all the video streams from all the buses in a metropolitan

area, a selection must be made in order to broadcast a set of channels that falls within the capacity of the bandwidth for the operator. Narayan et al. (2004) describe a system that assists users in locating and navigating data sources in a repository of information. Once again, the emphasis is on facilitating information search and knowledge discovery. Beal (2004) describes the use of an intelligent tutoring software program that dynamically adapts the instructional information that is shown to a student, depending on the student's cognitive strengths, motivation and attention.

Currently, there are research groups that are developing new kinds of sensors and algorithms that can detect information related to affect. This could be the basis of a new kind of display that adapts to affect (Reynolds et al., 2004).

The research that we present in this paper has been performed within the EMMA (Engaging Media for Mental Health Applications) Project, IST-2001-39192 (Alcañiz et al., 2003). It is representative of this latest category of adaptive displays. We have developed a virtual reality application whose contents and aspects change dynamically depending on the emotions of the user. It can be described as an adaptive display that reacts to affect. This environment is designed to be used in psychological therapy.

1.2 Treatment rationale

During the last century, there has been excellent progress made in the field of psychological treatments and "empirically validated" treatments are now available (Task Force on Promotion and Dissemination of Psychological Procedures, 1995). The cognitive model has greatly contributed to the development of these treatments. However, this approach cannot control all the changing human processes. This is due to theoretical limitations. There are discrepancies between the linear rationale of the cognitive theories, and the complexity of the therapy. It is difficult to change certain personal beliefs, and the importance of emotions has not been taken into account. Miller (1956) pointed out that cognitivists were victims of their own success; they traded the construction of a metaphor of the meaning for a human mind model based on a computer.

Nowadays, more attention is being paid to the importance of the emotional aspects in therapy, specifically emotion control problems. Recently, an entire issue of the *Journal of Clinical Psychology* (2001, vol. 57(2)) was dedicated to this topic. This issue states that emotion and its control is emerging as a topic of central relevance in understanding psychological problems and their treatment (Paivio & Greenberg, 2001).

For example, Paivio and Laurent (2001) consider that a great challenge for clinicians is to address emotion control problems that prevent many patients from processing traumatic experiences. Wiser and Arnow (2001) point out that emotion is a key factor in the process of change and that it is an important source of information. For this reason, the awareness of emotional experience is considered as necessary for effective emotion control and adaptive functioning for positive emotions as well as for negative emotions.

The aim of this work is to test some of these developments in cognitive psychology. That is, to focus on meaning and emotion as central subjects in psychological research. To do this, we have designed and tested virtual reality strategies that structure effectively the treatment procedures described by these theoretical approaches. We propose going beyond changing the observable behaviour or changing the central cognitive contents that influence the individual functioning. Our goal is to modify cognitive processes and structures and to activate and modify basic emotional patterns.

2. Description of the virtual environment

2.1 Clinical aspects

The application has been designed to help in the treatment of post-traumatic stress disorder, adjustment disorder, and bereavement. In all these situations, people have suffered a traumatic experience (e.g. the loss of a loved one, loss of a job, divorce, rape, etc.). To accomplish our therapeutic goals, a series of emotional objects can be used and personalized so that they are meaningful to the user and contain the fundamental elements that the person must confront. The objective is to obtain a physical representation of personal meanings and the emotions that are related to those meanings and to study how this strategy helps the person to change. The set of personal experiences that is created can be used to activate, correct, structure and restructure those previous experiences. By using them as cognitive-emotional structures, the therapist can help the patient to structure a new way of processing and integrating past, present and future experiences.

2.2 General description of the different tools

In the first stages of the therapy, the patient learns how to navigate and interact with the system by practicing in a neutral environment.

The treatment environment is a special place where patients can feel free to express their emotions and where emotions are going to have an effect on everything that surrounds them. A series of tools are used in each session. They are always available in the environment and are selected based on the therapist's instructions. For example, if the patient is asked to relive an experience while speaking to the therapist, the virtual environment will reproduce these feelings in different forms (such as a dark forest with no exit). Another tool provided by the system is "the living book", which has been designed so that the person can reflect feelings and experiences in it. It contains images, objects and other elements that are also present in the virtual environment. The objective is to represent the most important moments, people and situations in the person's life. Anything that is meaningful for the patient can be incorporated in the system: photos, drawings, phrases, videos...

Both the therapist and the patient are physically present in a room. The patient visualizes the virtual environment in a retro-projected screen. The virtual environment contains a circular room, so the environment outside the room can be visualized from the inside. The user can navigate both inside the virtual room and outside it (Figure 1).

Fig. 1: Image of the room from the outside.

The patient can select different objects that can appear in different places of the environment in order to personalize it. The therapist can control the contents that the user views from another computer, and can make the environment change in real time; for example, a beach can be changed to a snow-covered town. The therapist can also create different effects in the environment such as rain, snow, earthquakes...

In this section, we describe in greater detail the kind of actions that can be performed by the patient and the therapist.

2.3 Personalization by the patient

The environment includes different systems that interact to allow the patient to express ideas through different items. The characteristics and positions of these items can be modified in real time.

2.3.1 Object selection

The first customization that the user can make in the environment is the selection of different objects and elements that can be added to the environment in real time.

A database with different elements can be created for each patient. A graphical element, the database screen (Figure 2), provides access to the different categories of objects that can be held and used in the system: sound, video, images, three-dimensional objects and colours.

Fig. 2: The database screen. The object category is shown in the image. The user can select other categories by pressing the correct tab.

Each category is composed of an array of icons that represents objects that are present in the database. When the patient selects them, they are copied to a temporary storage tool called the inventory tool, from where the elements can be copied to different places in the virtual room.

In order to identify the parts of the virtual room where objects can be copied, there are special objects, called “object holders”, which are distributed throughout the room. The objects that are in the inventory can be copied into these holders. The effect created is different depending on the object that is copied. If it is a three-dimensional object, it is viewed above the object holder (Figure 3). If it is a sound, it will be heard when the user approaches the object holder. If it is a video, it will be viewed on a small screen above the object holder when the user approaches it. If it is an image, it will be viewed in a

small screen above the object holder. An object holder can serve as a mixing tool to combine several elements to form a new more complex element. This is achieved when different elements from different categories are copied to the same object holder; thus, an object holder can simultaneously show a 3D object, a video and an image; the associated sound can be heard when the patient approaches it. Also, if a colour element is copied to an object holder that already has a 3D object, a coloured light will be applied to the object. The size of the different elements that are shown in an object holder can be controlled by the patient.

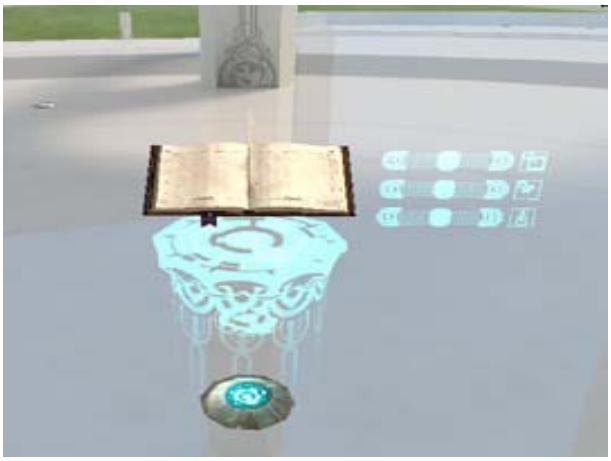

Fig. 3: An environment object holder that contains a book. The book is viewed above the object holder.

The elements in the object holders can be moved by copying them to the inventory. This makes them disappear from their current location. Then, they can be copied in other object holders of the virtual room.

Besides object holders, there are other special elements that are used inside the virtual room. The most important one is the living book (Figure 4).

Fig. 4: The living book. The title can be read on the upper left corner of the first page. There are different slots for placing different objects.

The representation of this element is a book that contains pages that represent different chapters. A title for each chapter can be introduced by using a virtual keyboard. The living book is the instrument that the patient uses put in order and keep all the contents that have been analyzed with the therapist during the session. Initially, the living book is empty. The user can select the elements that will be introduced in each of the chapters directly from the database screen or from an object holder. The elements are copied temporarily to the inventory tool, and from there to the different positions that are available on each page of the living book. The elements are represented in the living book by means of an icon. Once the elements have been copied in the book, their order can be changed at any point during the session.

Finally, there is another special element that is used to eliminate objects, the drain (Figure 5). It is used to destroy the objects that are no longer needed. The interaction with the drain is similar to the ones that we have described above. When the user drops an element from the inventory to the drain, the element is deleted from the inventory and can no longer be used.

Fig. 5: The drain. This is the graphical representation of the object used to destroy elements.

2.3.2 Emotional discharge system

The emotional discharge system (Figure 6) provides a space that allows the patient to modify and manipulate the characteristics of the virtual environment and the objects that are placed in it in accordance with emotions.

Fig. 6: The discharge area. It is composed of three special object holders that allow the user to modify the objects that are placed above them.

The discharge system has been implemented as three special object holders that are on the balcony of the virtual room. Patients can modify the shape and the aspect of the objects that are placed on them with their voices (shouting in a louder or softer way depending on their emotional state). The size of the objects placed in those special object holders is modified according to the loudness of the input sound. More than one object holder can be active at the same time. In this case, the aspect of all the objects placed over them will change simultaneously.

2.4 Personalization by the therapist.

The therapist accompanies the patient during the session and can have an important role in the customization of the environment.

A special interface has been prepared to allow the therapist to control several aspects of the appearance of the outer part of the virtual room. The application that controls this runs on a different computer from the one with the virtual environment. The commands that the therapist introduces are sent using TCP/IP to the environment computer, and the appearance of the environment changes depending on the command that the computer has received.

There are five different pre-defined aspects (Figure 7): a desert, an island, a threatening forest, a snow-covered town and meadows.

Fig. 7: The different aspects of the virtual environment: the meadows, the desert, the island, the snow-covered town and the threatening forest.

The environments are related to different emotions. For example, the desert can be related to rage. The island can be shown when the therapist wants to induce relaxation in the patient. The threatening forest can be related to anxiety. The snow-covered town can be used during the session when the patient is remembering a sad situation in his / her life. The meadows can be used to induce happiness in the patient. However, the specific use that is given to each environment depends on the context of the session and can be selected by the therapist in real time.

Apart from this large-scale control (changing the entire aspect of the outer part of the virtual environment) the therapist can also make small-scale changes. Different effects can be applied to the environment (Figure 8): a rainbow can appear; it can start to rain or to snow; an earthquake can be generated; the hour of the day (and the corresponding illumination) can change...

Fig. 8: Sad environment with a storm, rain, and snow. The therapist can control the appearance of these effects at the relevant moments.

All these effects can be launched from the same interface, and the therapist can control both the appearance and disappearance of the effect, as well as the intensity with which the effect is shown.

The following video shows changes that can occur during a real session using the virtual environment.

Video 1: http://www.psychnology.org/Images/rey_video.avi

3. Conclusions

We have developed a virtual environment that can be used in psychological treatments. It acts as an adaptive display that varies the contents that are presented depending on the emotions of the user at each moment. With this new technical approach, different environments can be created to help the therapist treat different kinds of psychological problems.

The principal contribution of this work (from the technical point of view) is the possibility to dynamically change the aspect of the virtual environment. This opens up a new area and new possibilities not only in the field of psychological disorders, but also in many other sectors such as industry, architecture and medicine.

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