

Virtual Reality System Specifications for Pain Management therapy

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Abstract— Virtual Reality (VR) systems are used to distract patients from their current condition and immerse them in a virtual world where they are able to do many virtual activities while receiving their treatment. It was observed that VR systems improve the patient state of mind thereby improving their immune system. In this paper we study the role of VR in improving pain threshold for chemotherapy and burn patients. Unfortunately not all patients are able to use VR equipments, for example burn patients are unable to use VR head mounts and gloves. To design a VR software and hardware that could be used for every patient is close to impossible. In this paper we introduce the benefits and challenges of using VR systems as an added therapy to reduce pain sensation; we also give the general technical requirements for such system.

Keywords— *pain management; complementary therapy. virtual reality;*

I. INTRODUCTION

Complementary therapy refers to the practices, systematic and comprehensive concepts of health and disease, diagnostic and therapeutic procedures, in medical treatment, which differ from the conventional treatments [9,14]. A complementary therapy is used in panic

attacks, quit smoking, weight loss, pain management, and performance anxiety.

VR is considered one of the promising methods as a complementary therapy. This technique is used to employ the power of the mind; VR therapy empowers the human imagination to gain a positive influence. In the field of medical complementary treatment, VR is considered to be one of the best technologies for distraction used by psychologists. It could be used before, during or after the traditional therapy, according to patient's situation and diseases, for pain management [1]. Hoffman et al [1], used pain Stimuli on healthy volunteers. The results of functional magnetic resonance imaging showed large increases in activity in several regions of the brain that are known to be involved in the perception of pain., but, when the volunteers were involved in a virtual- reality environment during the stimuli, the pain-related activity drawn.

II. PERFORMANCE CRITERIA

VR performance evaluation is obtained by measuring level of pain for patients after each VR session which is called a "Measure of Assessing Pain", this is a global measure of ten degrees which help patient care provider assesses pain according to different patients. The scale starts at 0 (no pain) to 10 (pain in the worst case) for patient self assessment. Face and behavioral scales can be used to express patient's pain Figure1 [12].

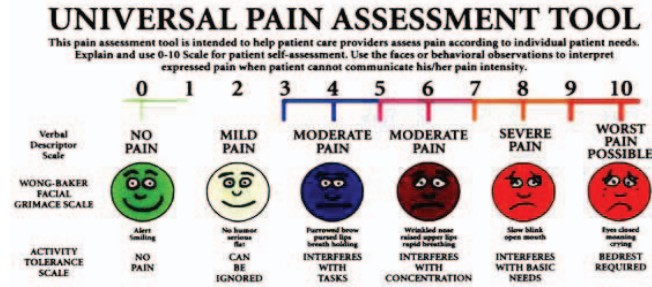


Figure1:Pain Assessment Scale [12,14]

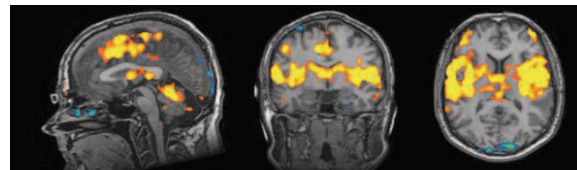
The results of virtual reality pain distraction have been strong and consistent results, and the results obtained by Hoffman with his team at HTLAB have been independently replicated by burn centers in other countries. The higher the quality of VR system and software, the stronger the analgesia effect would be [1]. For example, in one laboratory study conducted by Hoffman, 1 out of 3 participants showed clinically meaningful reductions in pain during VR. That's fairly impressive.

In that same double blind study, 2 out of 3 subjects randomly assigned to receive a wide field of view VR helmet showed clinically meaningful reductions in pain as shown in Figure 2.

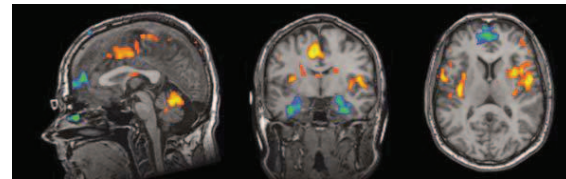
Breast cancer patients spend many hours in clinic treatment, while receiving chemotherapy, which leads to exhaustion and sometimes depression. It has been observed that the use of virtual reality greatly helps in reducing the perception of time [4], as shown in Figure 3.

III. CHALLENGES

Many burn patients found it uncomfortable to wear a VR HMD on their head, and this was especially true for patients with severe burns on their head or face.



a). No Virtual Reality system is applied.



b). Virtual Reality session is applied, with a significant reduction in Pain signals

Figure 2: Pain Related Brain Activity [1].

Furthermore, even if patients don't have serious burns on their head or face, the conventional

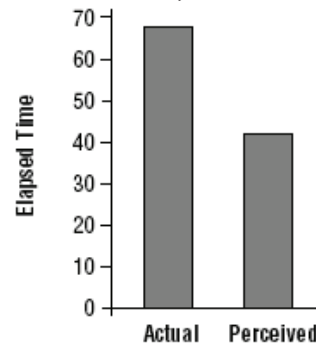


Figure3: Perception of Time (in minutes) While Using VR[4]

high technology VR HMD tends to weigh nearly 2 lbs. So, just the weight itself can become uncomfortable. For sterility reasons, keeping the helmet scrapped in disposable plastic, were also time consuming. This need prompted the design and implementation of a goggle holder that is more comfortable for burn patients. The robot-like arm holds the goggles near the patients' head, so they don't have to wear the VR helmet on their injured heads. That was an important breakthrough that has made virtual reality goggles easier to use [13,14].

Another Challenge is that many burn patients receive their painful medical procedures while sitting soaking in a bathtub, and/or while having water sprayed onto them. This water makes it dangerous to wear a conventional VR HMD, so caregiver must avoid using VR during wound care in the scrub tank. . Hoffman has designed and built a special VR HMD that uses light, no electricity, so patients could wear the helmet while sitting in a bathtub of water [13].

There are a number of challenges related to technical reasons. Modeling of the 3D objects, defining their behavior and interaction manner, defining object texture and other properties such as degree of reflectance, shininess, and connect all of these with the environment. These processes are time consuming, and make VR systems an expensive alternative [2].

IV. VR SYSTEM CHARACTERISTICS

VR technology has a number of characteristic which can enhance the effectiveness of VR as a distraction technique; hence increase its power in alleviating pain. [8]. Table 1 shows an example of needed quality Hardware and Software to make the VR experience a realistic one. In reference [15]. A rich list of available VR vendors and consultancies is added.

V. CONCLUSION

It has been found that the distraction technique was one of the best psychotherapy methods, while it has the ability to attract patient's attention convenient activities. Imagery therapy is a kind of distraction technique, which can relieve physical symptoms such as pain, fatigue, and distress, as well as psychological symptoms such as uncomfortable feelings.

Virtual reality is considered to be one of the successful imagery as well as complementary methods that helps patients to cope with their pain. it's defined as a way to immersed mind and body into a computer-generated environment in a naturalistic fashion. Virtual reality is interactive, and it engages several senses simultaneously [7]. These characteristics made virtual reality to be one of the best distraction techniques comparing with other complementary therapy such as humor and relaxation therapy. Pain requires attention VR attracts the attention away from a pain and leaves less attention available to process pain.

Virtual reality in the medical field suffers from various drawback including technical limitations. Virtual world development is complicated and expensive process. Also, in term of usage, there are some difficulties. Virtual reality may cause some side effects on patients such as , disorientation, dizziness and nausea [2].

Although, numerous case studies have been conducted, but still there is a lack of good quality, long-scale study on the effectiveness of virtual reality as a complementary therapy [6].

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Table1: An example of quality VR components for realism

Equipment/software	Benefit	Additional Specifications	Commercial Example
Head Mounted VR Viewer	The ability of VR'S HMD to view the environment as a natural or real environment. It allows the user to look around, walk around, or even fly in the virtual environment.	Light weight Easley cleaned	xSight from Sensics makes high-performance virtual reality goggles that are offered in various price and performance ranges.
Rendering Engine	The powerful rendering of objects enhances the perception of depth and the sense of space.	The Irrlicht Engine is an open source high performance realtime 3D engine	tOG-3d developed as an OpenGL graphics engine capable of rendering the most demanding 2d and 3d images in both SD and HD.
VR Objects	The virtual environment relates to the people size properly and provides realistic interaction through the use of gloves and other devices which allow to control, operate, and manipulate it.	Very detailed objects in both geometry as well as surface properties (e.g. hair, fur, textured and smooth surfaces, etc.)	tOG-3d developed as an OpenGL graphics engine capable of rendering the most demanding 2d and 3d images in both SD and HD.
Other VR assistive devices	The auditory, haptic, and other non-visual technologies could enhance the full immersion in the virtual world.	<ul style="list-style-type: none"> VR Gloves with 6 degrees of tracking Real-Time interaction with objects in a VR environment, 3D audio performance 	P5 Gloves from vrealities company

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