中國機械工程學刊第四十一卷第二期第 131~140 頁(民國一百零九年)
Journal of the Chinese Society of Mechanical Engineers, Vol.41, No.2, pp 131~140 (2020)

Behavioral Therapy for Phobias Using Immersive Virtual Reality Technology

Amy J. C. Trappey [a,*], Charles V. Trappey [b], Chia-Ming Chang [c], Usharani Hareesh Govindarajan [d], Xyuan-Yu Shih [e], I-An Su [e] and Nishant Gupta [f]

Keywords： Clinical virtual reality, Behavioral therapy, Immersive system framework, Arachnophobia.

ABSTRACT

Mental disorders are difficult to diagnose and treat. Global economic growth, changing social organizations, and urban conditions affect mental health resulting in increased costs, limited benefits, and fewer facilities for behavioral treatment. Virtual reality-based behavioral treatments for mental illness offer benefits to supplement conventional therapies. Virtual Reality Treatment (VRT) let patients confront phobias using a virtual environment with a therapist. A therapist observes and coaches the patient through increasingly difficult levels of confrontation to desensitize patient phobias. This research presents a generic framework and discusses the related behavioral therapy.

A VRT for confronting fear of spiders is the case used for the technology development and data collection processes which establish the basis for future clinical trials and analysis.

The preliminary trial of the arachnophobia VRT platform with eight scenario levels has produced accurate bio-feedback results. The system demonstrates promise for rapid VRT application development for clinical behavioral psychotherapy.

Paper Received June, 2019. Revised September, 2019, Accepted October, 2019, Author for Correspondence: Amy J. C. Trappey

[a,] Distinguished Professor in the Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Hsinchu, Taiwan 300. Corresponding email: trappey@ie.nthu.edu.tw*

[b] Department of Management Science, National Chiao Tung University, Hsinchu, Taiwan 30010.

[c] Clinical psychiatrist and research faculty in the Psychiatry Department, Chang Gong Memorial Hospital, Taiwan 33305.

[d] Assistant Professor in the Sino US Global Logistics Institute, Antai College of Economics and Management, Shanghai Jiao Tong University, Shanghai, China 200030.

[e] Graduate students studying in the Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Taiwan 300.

[f] Graduate student from the Institute of Informatics and Communication, University of Delhi, India and 2019 summer intern student under Prof. Amy Trappey's supervision at National Tsing Hua University.

INTRODUCTION

Virtual Reality (VR) creates immersion in a three-dimensional virtual environment while incorporating sound and motion with a sense of presence. The level of immersion varies based on the rendered information in virtual space. Information presented in terms of a full 360° space is called a fully immersive system. Information providing less than 360° space is called semi-immersive or non-immersive systems (Baños et al., 2004). The virtual environment from a user's vantage includes three-dimensional (3D) vision, stereo sound, and dynamic control of the viewed environment (Chen et al. 2007, Hsu & Weng 2011). The peripheral equipment to create the environment requires Head Mounted Displays (HMD), room scaling, and handheld display controllers. The peripheral devices and algorithms to measure and track sensory information and to deliver effective immersion (Brinkman et al. 2009). VR systems dynamically update the view based on the user's interest and control. This is achieved using head or eye movement tracking technology embedded in the HMD and the hand-held controller. CAVE systems are an alternate implementation for HMD based VR systems that consist of an arrangement of stereoscopic projector components exceeding two dimensions. CAVE systems support multi-user interactions and are frequently used for collaborative game playing (Mestre 2017). CAVE based implementations are used for other task-specific applications such as flight simulators where the entire crew is collectively trained. The high cost and floor space constraints are bottlenecks for these types of systems. Since HMD systems have miniature displays that are worn, they require less floor space. Recent designs re-purpose mobile phone screens as the mini displays in the

HMD. The increased acceptance and lower costs of new designs have raised user expectations and increased demand for VR applications.

Good mental health represents emotional, psychological, and social well-being, living a natural and productive life with the absence of mental illness. Mental health is a key component of wellness across age demographics. A phobia is a condition of irrational fear for situations that pose no danger. Example phobias include acrophobia; a fear of heights, agoraphobia; fear of public places, and claustrophobia; fear of closed-in places. People with phobias, especially those initially caused by trauma and extreme stress may experience re-occurring anxiety and panic attacks. The most popular treatment for phobias worldwide is a form of psychotherapy, called Cognitive Behavioral Therapy (CBT) (Toyoda et al., 2018). CBT is an enhanced version of exposure therapy that involves gradual and repeated exposure to a specific phobia combined with other techniques and medication. Psychotherapy is an costly activity that varies with geographic locations. A standard session (45-55 minutes) of psychotherapy in the USA costs between $80 and $120. The recurring cost of treatment sessions along with a shortage of trained therapists is affecting the healthcare industry. Estimates show that the number of patients who actually received treatments is far fewer than the number of untreated patients in every country (Demyttenaere et al., 2004). Virtual Reality Treatment (VRT) is a technology-based behavioral treatment which augments the behavioral exposure therapy the patients receive. Using VRT, a patient is immersed in a virtual environment that simulates the feared situations or locations in ways that may not be safe in real life (e.g., fear of driving over a bridge). There is strong evidence that VRT is effective for treating several types of phobias and symptoms of anxiety (Maskey et al., 2019; Ding & Dai 2018).

The investment required for developing the base scenes, scenarios and equipment for 360° virtual imaging behavioral treatment environments exceeds conventional methods. Therefore, many clinicians resist research and development of VRT unless the effectiveness is demonstrably better, faster, and cost-effective over time (Lin et al. 2007). Prior patent research on 360° imaging technology highlighted technologies that are lowering the cost and development of VRT and forecasts increasing applications for testing and development (Dunn et al. 2019). This research presents a VRT design and development process for arachnophobia (fear of spiders). The research sets the foundation for comparing the effectiveness of VRT versus conventional behavioral therapies for treating different types of phobias. The following sections cover the related literature, details of the experimental design, the development process, the data collection plan, and the findings from the initial testing of VRT for arachnophobia.

Immersive technologies consist of a collection of hardware and software components that enable a user in the physical world to connect with the digital world with a sense of immersion. Virtual Reality (VR),Augmented Mixed Reality (AMR), and Brain Computer Interfaces (BCI) are immersive technology components that have the potential for delivering an enhanced and lifelike 3D experience (Govindarajan et al., 2018). The application of immersive technologies in clinical applications augments virtual treatment. This section presents a review of the state of art of immersive applications in psychotherapy related clinical applications.

Publications from the Institute of Electrical and Electronics Engineers (IEEE) Xplore, Association for Computing Machinery (ACM), and the Web of Science (WoS) are searched using keywords with feedback refinement. The search resulted in the identification of key publications that provided keywords representing the current state of virtual reality therapy applied to symptoms of mental disorders as shown in Figure 1.

The review presents virtual reality treatments for phobias and addiction. Phobias address generic or specific conditions. A specific phobia causes anxiety about a particular situation. Exposure to the specific situation leads to anxiety which may be followed by panic attacks. Specific phobias are numerous and include fear of heights (acrophobia) (Haworth et al., 2012; Schafer et al., 2015; Shunnag & Reader, 2016), being in closed spaces (claustrophobia) (Christofi & Michael, 2016; Bruce & Regenbrecht, 2009), falling (Giotakos et al., 2007), spider (arachnophobia) (Haworth et al., 2012; Eustace et al., 2013) and driving (Claudio et al., 2015; Taheri et al., 2016). Generic phobias include social anxiety (Walkom, 2016; Wu, 2019) and stress (Repetto et al., 2013; Rothbaum, 2010). People with addictions have an intense focus on using certain substances (e.g., alcoholics) (Uthayasangar & Wimalaratne, 2013). Anxiety-related to physical or behavioral changes such as Post Traumatic Stress Disorder (PTSD) forms a more specific phobia diagnosis.

VRT for children having bedtime anxiety presents imaginary monsters in a virtual environment with varying levels of scariness to help children become familiar with their fear of the dark (Thanh et al. 2017). The research findings contribute to the area of child psychology and are deployed over the Google cardboard ecosystem to increase access to children in developing countries (Ding & Dai 2018). VRT exposure sessions for the fear of flying with a focus on the role of the therapist have been published (Govindarajan et al. 2019). The research presents a therapist's observations over 14 sessions that show therapist-initiated errors. The research suggests improvements through the automatic generation of flying scenarios rather than therapist generated

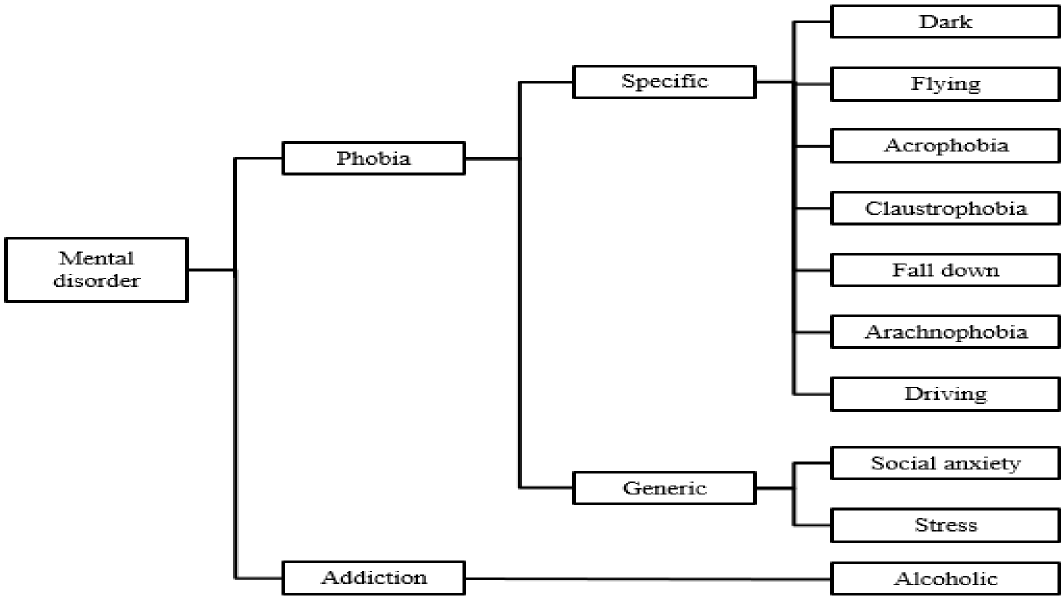


Fig. 1. Virtual therapy application used in the treatment symptoms of mental disorders.

narrations. An initial study using virtual avatars as a treatment instrument for acrophobia was explored (Mestre 2017). The research used an oculus rift ecosystem and demonstrates the effectiveness of a virtual avatar in VRT using a sample size of 42 subjects. This research provides a means to test a wider range of insects to evaluate the effective treatment of entomophobia.

VIRTUAL TREATMENT DESIGN

This section presents the design methodology used in the construction of the VRT research. Figure 2 presents the organization and flow for the VRT treatment. A pre-session questionnaire collects comprehensive patient information

The treatment begins with a welcome screen and presents relevant disclaimer information. Head movement-based gaze interaction allows for natural head movement during the VRT session. The patient looks at the buttons displayed onscreen to move forward. A timer-based control is implemented to prevent accidental gaze-based movement across scenes.

The VRT has eight exposure levels for treatment as shown in Figure 3. The patient can increase or decrease the exposure level based on gaze interaction as guided by the psychotherapist.

360° imaging is used to capture a variety of living spaces such as a living room, kitchen, dining area, bathroom, and elevator. Virtual objects such as spiders (crawling, jumping) and spider webs are superimposed on the 360° image to present a realistic experience (Figure 4).

The crane spider which is a native to Asia is characterized by long legs and a small body and is commonly feared across Asia. The crane spider (Figure 5) is programmed with behavior traits such as fast running and jumping animations. A control for an emergency stop is built in to exit the VRT in case of sudden panic. Various data points are collected during the exposure session. The completion of eight levels is the first stage of accomplishment.

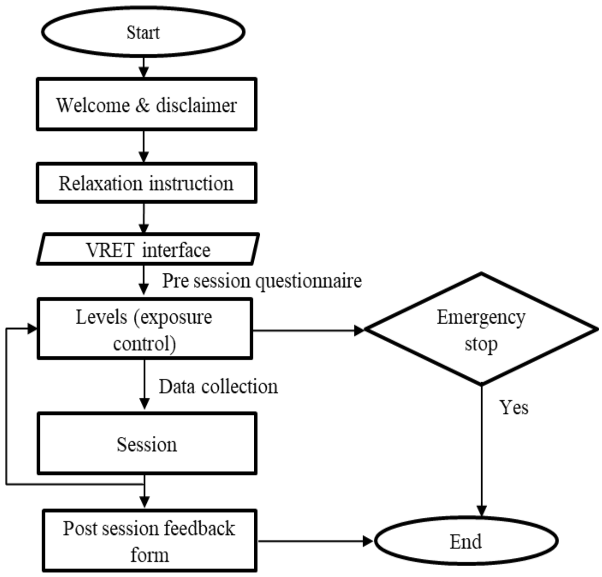


Fig. 2. Virtual treatment design.

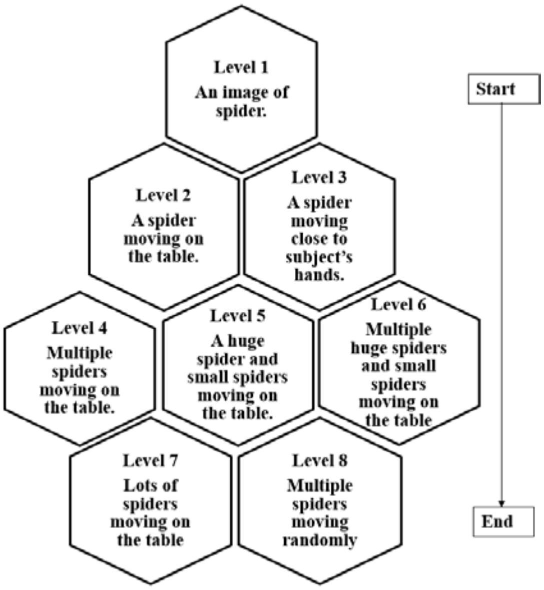


Fig. 3. Virtual exposure levels.

Fig. 4. 360° living space capture.

Figure 6 presents a snapshot of the level eight exposure where a spider from the group crawls toward the patient's virtual hands and the psychologists advises the patient to slowly remove their hands from the table and back away. Any contact with a spider should be avoided and patients must learn that sudden movements can cause the spider to jump at the patient. The safe proximity of a spider to a human varies by species and a cane spider is safe within three feet. A spider approaching as illustrated requires the patient to slowly but calmly move their hands back, slowly get up, and move away. A post-session questionnaire collects session information and acts as an additional feedback form for self-improvement.

Fig. 5. Asian crane spider rendering.

Fig. 6. Level 8 exposure snapshot, subject's hands placed on the keyboard to overcome fear.

INFRASTRUCTURE

Implementation requires the integration of hardware and software to create the underlying infrastructure. Infrastructure selection is based on considerations such as feasibility, availability, and scaling. The selection is chosen from technology appliances that fit clinical requirements.

A. Hardware

Key hardware components used as critical infrastructure are the HTC Vive Pro for VR interactions and Insta One X imaging technology.

(1) HTC Vive Pro

The HTC Vive Pro is the latest iteration of the HTC and Valve corporation for VR. The kit headset includes VR interactions, two base stations for movement tracking, and two motion controllers for virtual world interaction. The headset provides room scaling as a prerequisite configuration for tracking user movement in 3D space with high accuracy. The Vive pro connects to the Nvidia 1080 Ti graphics processing unit for lag-free virtual environment rendering.

(2) Insta One X

Virtual imaging using 360° capture aids rapid scene creation. Insta One X and the bundled One X studio are used for converting and editing 360° imaging. The raw format capture for video is in a proprietary "insv" format that requires conversion to generic ".mp4" and ".jpg" formats for import and application.

B. Software

Key software components used to integrate the above hardware are presented in the following section.

(1) Unity

The unity development platform is selected for the building the project for its compatibility with HTC Vive Pro, steam launcher, and other ecosystems for future distributions. The Unity platform implements an asset (reusable graphical elements) workflow that helps to reuse from a host of standard asserts or buy from the assert store.

The editor functionality features external tool integration and workflow (flow of design constructs) customization. Further, Microsoft C# is used as the programming language for script functionality development (actions for virtual objects).

(2) Blender

Blender is an open-source 3D computer graphics software toolset used for creating required animations. Since unity is not a specialized platform for clinical experiment design many virtual objects (unavailable as an asset) need to be created and rendered during implementation. Blender is used to create prefabs for such virtual objects that can be imported on to unity development.

(3) Steam

Steam is a distribution platform used to connect the unity engine and HTC Vive Pro. Steam integration enables multi-system project distribution and centralized update management.

(4) SQLite

SQLite is an open-source database management system. The research work with the SQLite to collect Arduino data directly from the serial port and store the data into the SQLite database using Python programming script.

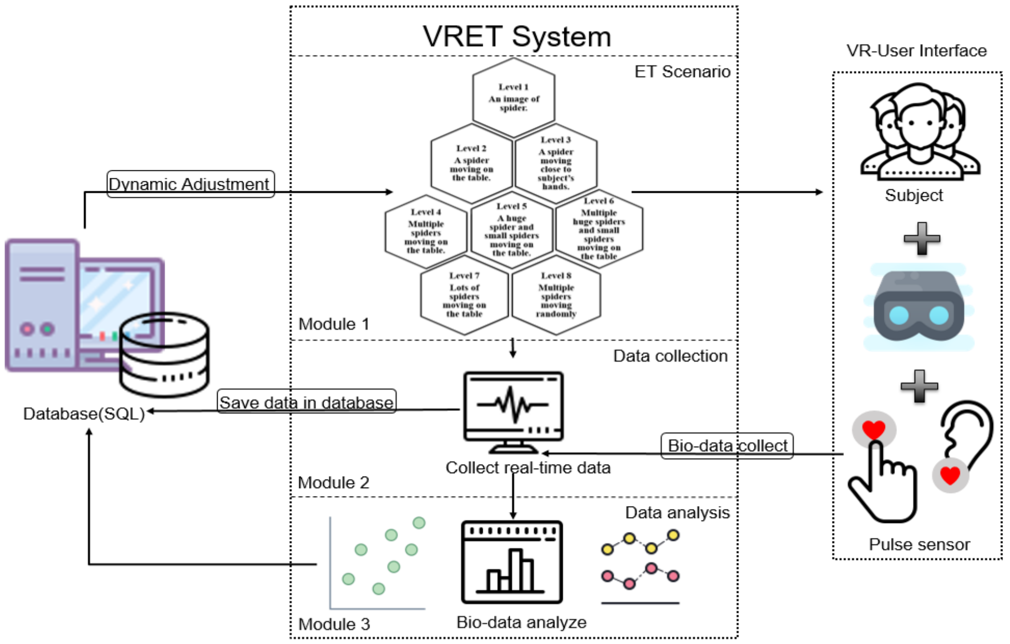


Fig. 7. Overview research framework and system architecture.

SYSTEM FRAMEWORK

A generic behavioral therapy system framework is presented in Figure 7. The presented framework combines three core modules: Exposure Therapy (ET) scenario module, data collection module, and data analysis module. The ET scenario module generates virtual scenarios for the patient (subject) and displays in the VR headset. A dual sensor is used to capture physical and psychological bio-data (Arduino pulse sensor, Unity XR head tracking) during exposure in real-time. The data collected include subjects heart rate, head position, and the frequency of spiders moving direction. The obtained data are independent variables that are saved in the internal SQL database by the data collection module. The data analysis module collates the captured information and performs dynamic analysis to carry out real-time subject bio-data based exposure parameter adjustments. The presented arachnophobia case consists of eight levels (Fig. 3.). The parameters that dynamically change in each level are the number of spiders, whether the spider is walking, and the frequency of spiders moving in a random direction.

An automatic reduction in exposure level or emergency stop based on a subject's heart rate is implemented in the framework. Additionally, the subject's physiological data is collected during the changes in these dynamic parameters for additional post-exposure session evaluation and feedback.

DATA COLLECTION OVERVIEW

Data collection in conventional psychotherapy sessions has relied on self-report measures. These mechanisms suffer from bias such as social desirability, exaggeration, and embarrassment in revealing private information. Four stages of data collection are used for the clinical trials. Heart rate tracking using an Arduino Pulse Sensor module is integrated into unity for continuous data collection. Further, head movement tracking along with clinical standard questionnaires used by previous research studies measure this virtual therapy's effectiveness (Craske et al., 2013). Self-report measures are required to measure whether the patient is becoming more or less biased with the exposures.

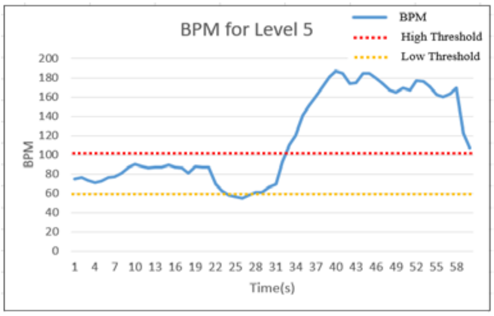
The Arduino Pulse Sensor is an experimental device that allows one to measure heart rate in real-time. The method of this heart rate sensor is essentially a photoplethysmography, which is non-invasive technology that converts analog fluctuation in voltage into digital signals. The Pulse Sensor is open-source hardware and very convenient for secondary development (Liu & Fan, 2017). Head movement tracking during the clinical trial uses Unity XR which has a set of built-in functions. The output generates features of movement in a three-dimensional space for identification of user reactions to specific exposure situations. Additionally, the frequency of the spiders movement and direction is a parameter used to analyze whether the subject's heart rate or head movement is related to this parameter. The data of the head tracking movement is collected. HMD X represents the subject moving forward and backward, HMD Y represents the subject moving right and left, and HMD Z represents the subject moving up and down. Eq. (1), is able to calculate the two points in Three-Dimensional Space. The distance between two points P_1=(x_1,y_1,z_1) and P_2=(x_2,y_2,z_2) in XYZ-space is given by the formula.

$$d(P_1,P_2) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_1 - z_2)^2} \quad (1)$$

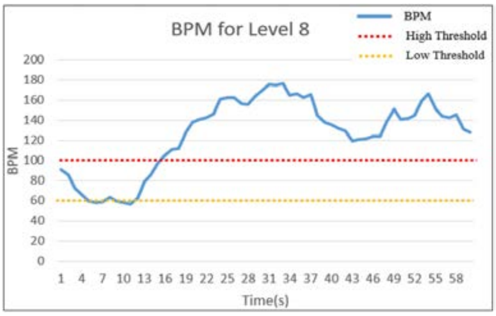
In the experiment, two subjects were tested, namely subject A and subject B respectively. Subject A was set to be afraid of spiders and subject B was not afraid of spiders. The fear of the subjects is observed by their heartbeat and head movement change at each level. During the test, the subject is asked to hold the hands on the X bottom and space bar on keyboard. If you can't bear the fear during the test, you can press the X bottom immediately to stop the level. If you want to go to the next level, then you can press space bar. The average test time of one level is about 30 seconds. The initial experimental results show that the subjects' heartbeat and head movement change frequently at level 5 and level 8. The following discussions therefore focus on level 5 and level 8.

In Figure 8 (a), a huge spider and several small spiders are crawling on the table. When the spider walks towards the subject on the table, the subject's heartbeat is significantly increase. We ask the subject the reasons which cause the subject to feel nervous. The key reason is that when the huge spider walks towards the subject, the subject can see the appearance of the spider clearly, which creates a feeling of nausea. Head movements showed little changes in Figure 8 (c). The reason why the subject's head movement fluctuated slightly during the test is because the subject's vision follows the spider.

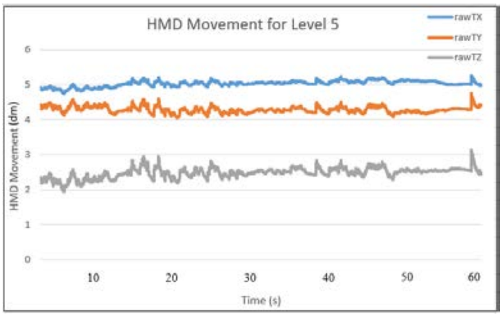
In Figure 8 (b), the heartbeats of the subject fluctuated significantly. The reason for the subject's increased fear is caused by the spider is walking at different speeds in the scene which makes it difficult for the subject to predict the movement and direction of the spider. In Figure 8 (d), near the end of the test, we observed that the subject's head moved downward. The observed change of subject A was about 0.179 meters. In the scene for level 8, the spider jumps towards the subject. Therefore, the subject bows the head and makes a dodging action accompanied by an increase in the subject's heartbeat.



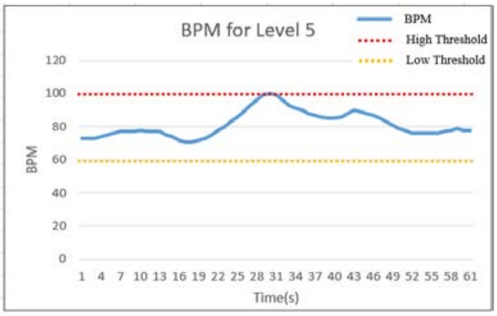
(a)The pulse rate tracking data for level 5.



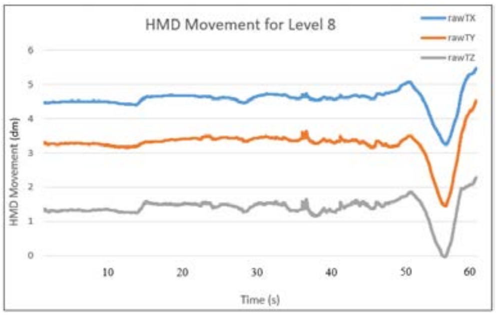
(b)The pulse rate tracking data for level 8.



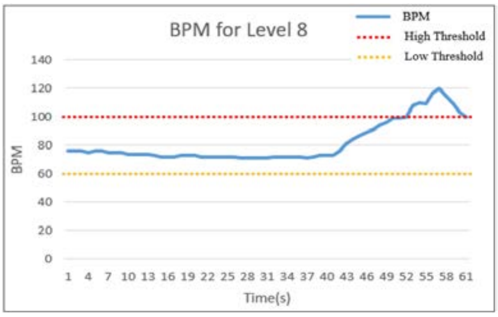
(c)The head movement tracking for level 5.



(a)The pulse rate tracking data for level 5.



(d)The head movement tracking for level 8.

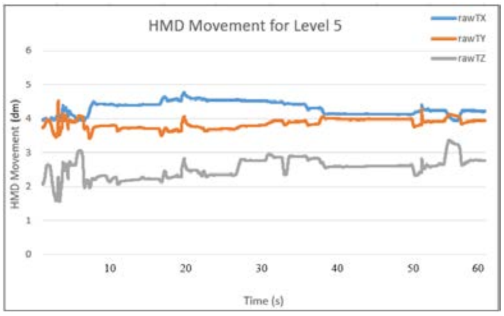


(b)The pulse rate tracking data for level 8.

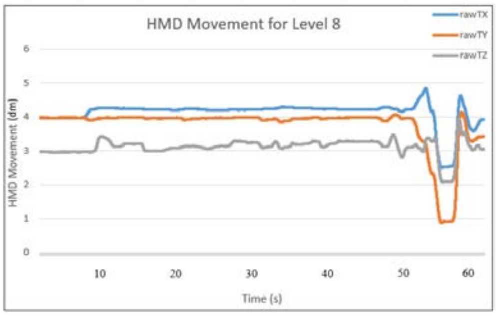
Fig. 8. Subject A data tracking of pulse rates and head movement coordinates for VRT levels 5 and 8.

In Figure 9 (a), after 30 seconds, the heartbeat of subject B rises from 70 bpm to 100 bpm, indicating that when the spider approached the hand, subject B's fear increased but less so than subject A. From Figure 9 (c), the data for head movement changes during the test indicate that the subject looked down at the spider at that time.

In Figure 9 (b), the heartbeats of subject B are about 70 bpm during the start of the test. We assume that the exposure components of fears are relevant to the previous level. Also, level 8 mixes all the parameters from the previous level, and the subject may have adapted to the level. However, the heartbeats began to increase after 40 seconds, and even reached 120 bpm. Therefore, subject B has a fear of the spider when it unexpectedly jumps towards the subject. From Figure 9 (c), we observed that the subject also made a dodging action, the observed change of subject B was about 0.162 meters.



(c)The head movement tracking for level 5.



(d) The head movement tracking for level 8.

Fig. 9. Subject B data tracking of pulse rates and head movement coordinates for VRT levels 5 and 8.

We learned from the experimental data that the two subjects both have fears of unexpected movements of the spider. However, the reasons underlying the fear is different subjects, such as when the big spider walks towards the subject. The speed of the spiders and the distance from the subjects to the spiders are also important parameters that affect the fear of the subject. The heartbeats of subjects who are afraid of the spider are more significant than those who aren't afraid of spiders. Therefore, a pretest is needed to test fear of spiders before the therapy session. If the heartbeats of the subjects are significantly abnormal, the experiment will be terminated immediately.

These initial observations incentivize the development of a clinical trial plan. The patients will be divided into experimental and control groups by a clinical trial committee. Data collection will be collected by research assistant psychologists who are blind to the treatment allocation. The collected data follows clinical guidelines and are analyzed by the research group. The obtained skewed continuous data are normalized before parametric analyses. The research uses SQLite to collect real-time data and charts to show the response of the subjects at different levels. Through data collection and analysis, the levels and parameters can be changed in response to the subject's fear and underlying reasons for the fear.

CONCLUSIONS

In this experiment, we use virtual reality exposure therapy to treat spider phobia. The experiment is divided into different levels, gradually increasing the subject's fear or reducing the fear to avoid risk and achieve a better effect. The experiment currently uses HTC Vive and a simple physical sensor (Arduino pulse sensor) to analyze the physical situations of subjects. In addition, real-time data from the subjects track how fear impacts the patient's responses and better enable the levels of fear to be altered. The levels are designed to force the subject to receive a complete treatment by holding hands on the keyboard, but the experiment can be terminated whenever the subject can't bear the fear to greatly reduce the risk of VR-based treatment. During the experiment, we can observe and collect data in real-time, such as observing the subject's heartbeat to identify reasons causing the fear of each subject. By analyzing the data immediately, we can help the subjects overcome fear more accurately. In the next treatment, we can adjust parameters to make the level more effective to help each subject decrease their spider phobia. Development costs and limited immersive psychotherapy specific application support are the current research shortcomings. However, 360° immersive imaging technology applied in this research offers cost benefits for accelerated scene creation.

In the future, the pulse sensor can be changed to a more precise instrument and the patient's physiological data can be obtained for more aspects to evaluate the accuracy and effectiveness of the data collected. We will invite more patients for our VRT system and collect more clinical trail data. The research promotes interdisciplinary collaborative engagements between National Tsing Hua University and Chang Gong University Medical School. We hope that the presented virtual treatment design, development, and clinical trial data collection process will incentivize psychotherapists towards the further application of clinical VRT.

ACKNOWLEDGMENT

This research is partially supported by the joint research grant of National Tsing Hua University and Chang Gong Memorial Hospital and the individual research grants of Ministry of Science and Technology, Taiwan (Grant numbers: MOST-107-2221-E-007-071,-107-2410-H-009-023, and -108-2811-E-007-505).

REFERENCES

Baños, R. M., Botella, C., Alcañiz, M., Liaño, V., Guerrero, B. & Rey, B. "Immersion and emotion: their impact on the sense of presence." CyberPsychology & Behavior, 7(6), 734-741, (2004).

Brinkman, W. P., Sandino, G. & Mast, C., Field observations of therapists conducting virtual reality exposure treatment for the fear of flying. Ecce 2009 - European Conference on Cognitive Ergonomics: Designing Beyond the Product-Understanding Activity and User Experience in Ubiquitous Environments. L. Norros, H. Koskinen, L. Salo and P. Savioja, 258, 169-176, (2009).

Bruce, M. & Regenbrecht, H., "A virtual reality claustrophobia therapy system - implementation and test." IEEE Virtual Reality Conference, Lafayette, LA, 179-182, (2009).

Chen, C. K., Chen, F. J. & Huang, C. J., "Study of interactive bike simulator in application of virtual reality." Journal of the Chinese Society of Mechanical Engineers, 28(6), 633-640, (2007).

Christofi, M. & D. Michael-Grigoriou, "Virtual environments design assessment for the treatment of claustrophobia." 2016 22nd International Conference on Virtual System & Multimedia (VSMM), Kuala Lumpur, 1-8, 63-70, (2016).

Claudio, A. P., Carmo, M. B. & Gomes, I. L., "Sense of presence inside a feared (virtual) tunnel." Institute of Electrical and Electronics Engineers, (2015).

Craske, M., Wittchen, U., Bogels, S., Stein, M., Andrews, G., Lebeu, R. & American Psychiatric Association, "Severity measure for generalized anxiety disorder–Adult." Diagnostic and Statistical Manual, 5(3), (2013).

Demyttenaere, K., Bruffaerts, R., Posada-Villa, J., Gasquet, I., Kovess, V., Lepine, J. & Kikkawa, T., "Prevalence, severity, and unmet need for treatment of mental disorders in the World Health Organization world mental health surveys." The Journal of the American Medical Association, 291 (21), 2581-2590, (2004).

Ding, X. & Dai, L. I., "Virtual reality-based exposure therapy for anxiety disorders: A meta-analysis for randomized controlled trials." Chinese Mental Health Journal, 32(3), 191-199, (2018).

Dunn, A., Patterson, J., Biega, C. F., Grishchenko, A., Luna, J., Stanek, J. R. & Strouse, R., "A novel clinician-orchestrated virtual reality platform for distraction during pediatric intravenous procedures in children with hemophilia: Randomized controlled trial." JMIR Serious Games, 7(1), e10902, (2019).

Eustace, N., Head-Mears, J. & Duenser, A., "Exploratory development and evaluation of user interfaces for exposure therapy treatment." Australian Computer-Human Interaction Conference, (2013).

Giotakos, O., Tsirgogianni, K. & Tamanas, L., "A virtual reality exposure therapy (VRET) scenario for the reduction of fear of falling and balance rehabilitation training of elder adults with hip fracture history." Institute of Electrical and Electronics Engineers, (2007).

Govindarajan, U. H., Trappey, A. J. & Trappey, C. V., "Immersive technology for human-centric cyberphysical systems in complex manufacturing processes: a comprehensive overview of the global patent profile using collective intelligence." Complexity, (2018).

Govindarajan, U. H., Trappey, A. J. & Trappey, C. V., "360° technology as a gateway for immersive psychotherapy applications: An intelligent patent mining analysis." 15th International Conference on Data Science, Nevada, USA, 215-218, (2019).

Haworth, M. B., Baljko, M. & Faloutsos, P., "PhoVR: a virtual reality system to treat phobias." ACM SIGGRAPH International Conference, (2012).

Hsu, K. S. & Weng, F. T., "Design and analysis of human interface device for tele-presence system." Journal of the Chinese Society of Mechanical Engineers, 32(3), 235-242, (2011).

Lin, C. Y., Hsu, C. C. & Chuang, T.Y., "The development of a car-driving training system for sci patients." Journal of the Chinese Society of Mechanical Engineers, 28(1), 111-116, (2007).

Liu, S. C. & Fan, C. W., "Pulse sensor system based on arduino data acquiring device." Journal of Chinese Trend and Forward, 13(2), 61-79, (2017).

Maskey, M., Rodgers, J., Ingham, B., Freeston, M., Evans, G., Labus, M. & Parr, J. R., "Using virtual reality environments to augment cognitive behavioral therapy for fears and phobias in autistic adults." Autism in Adulthood, 1(2), 134-145, (2019).

Mestre, D. R., "CAVE versus head-mounted displays: ongoing thoughts." Electronic Imaging, Society for Imaging Science and Technology, 17(3), 31-35, (2017).

Repetto, C., Gaggioli, A., Pallavicini, F. & Cipresso, P., "Virtual reality and mobile phones in the treatment of generalized anxiety disorders: a phase-2 clinical trial." Personal and Ubiquitous Computing, 17(2), 253-260, (2013).

Rothbaum Bo, Rizzo AS & Difede J., "Virtual reality exposure therapy for combat-related posttraumatic stress disorder." US National Library of Medicine National Institutes of Health, (2010).

Schafer, P., Koller, M. & Diemer, J., "Development and evaluation of a virtual reality-system with integrated tracking of extremities under the aspect of acrophobia." Institute of Electrical and Electronics Engineers, (2015).

Shunnaq, S. & Reader, M., "VirtualPhobia: A model for virtual therapy of phobias." Institute of Electrical and Electronics Engineers, 59-63, (2016).

Taheri, S. M., Matsushita, K. & Sasaki,M., "Virtual reality driving simulation for measuring driver behavior and characteristics." Journal of Transportation Technologies, 7(2), 123-132, (2017).

Thanh, V. D. H., Pui, O. & Constable, M., "Room VR: A VR therapy game for children who fear the dark." SIGGRAPH Asia, (2017).

Toyoda, E., You, B., Thatcher, B., Siddagunta, C. P. & Donovan, J., "Is cognitive behavioral therapy effective for treating anxiety disorders in adolescents and children?" Evidence-Based Practice, 21(3), 8-9, (2018).

Uthayasangar, R. & Wimalaratne, P., "Towards virtual therapy for alcoholic depression." Institute of Electrical and Electronics Engineers, (2013).

Walkom, G., "Virtual reality exposure therapy: To benefit those who stutter and treat social anxiety." Institute of Electrical and Electronics Engineers, (2016).

Wu, S. R., "A study on the learning effect of virtual reality for a self-protection program on sexual harassment in autistic teens." Journal of Chinese Society of Mechanical Engineers, 25(1), 1-29, (2019)

以沈浸式虛擬實境科技發展恐懼症行為療程平台

張瑞芬
國立清華大學工業工程與工程管理學系

張力元
國立交通大學管理科學系

張家銘
林口長庚醫院精神科

Usharani Hareesh Govindarajan（何玄）
上海交通大學

施宣酉 蘇怡安
國立清華大學工業工程與工程管理學系

Nishant Gupta
University of Delhi, India

摘要

本研究透過虛擬實境心理治療（VRT），讓心理醫師指導患者實施各層級的恐懼症療程。本研究提出 VRT 與 Bio-sensor 結合之沈浸式平台開發技術，以蜘蛛恐懼症 VRT 實驗設計為例，藉平台實作示範、測試者即時生理數據收集、分析，展現 VRT 沈浸式整合技術平台模組與實驗。依初步蜘蛛恐懼症 VRT 平台在不同情境設計 (Levels 1~8)中產出之生理資訊追蹤結果，充分證實 VRT 對各類恐懼症快速開發與臨床療程的應用潛力。