Closed Loop Virtual Reality for the Treatment of Phobias

Bachelor Thesis

Systems Neuroscience & Neurotechnology Unit
Saarland University of Applied Sciences
Faculty of Engineering

Submitted by	:	Dominik Limbach
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First Supervisor	:	Prof. Dr. Dr. Daniel J. Strauss
Second Supervisor	:	Dr. Lars Haab

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Declaration

I hereby declare that I have authored this work independently, that I have not used other than the declared sources and resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources. This work has neither been submitted to any audit institution nor been published in its current form.

Saarbrücken, February 19, 2018

Dominik Limbach

Abstract

we want to find out if it is possible to design a fully automatic therapy system using vr and psycho physiological measurement. therefor we will test our virtual environment with a random group of subjects and measure ecg and gsr the goal of the conducted experiment is to show that our virtual reality is capable ob causing fear this will be done by evaluating the measured bio data

furthermore our virtual can be controlled by a therapist the therapist will be able to exercise control through a matlab program provided with real time visual data the therapist will be a substitute for the AI which will later be controlling the vr respectively to the measured data

the vr and the related pc will feed visual input to the subject this input is processed by the subject and he gives output information in the form of gsr and heart rate serving as input for our third system, the therapist (visual presentation of processed data) therapist can control vr —loop closed

Zusammenfassung

translation of abstract

Acknowledgments

Contents

1 Introduction

Virtual reality combines real-time computer graphics, body-tracking devices and high-resolution visual displays to create a computer-generated virtual environment. With their ability to immerse the user into a virtual mirror of the real world virtual environments are a powerful tool in clinical application, especially in the treatment of phobias (Riva, 2003).
Studies have shown anxiety disorders to be the most prevalent mental disorders (Kessler et al., 2005). Many consider exposure therapy the most effective form of treatment for specific phobias (DeRubeis and Crits-Cristoph,1998)(source). However that may be, considering the nature of certain phobias such as fear of heights, exposure therapy involves a genuine risk of injury. Performing therapy in a virtual environment therefore can be a promising alternative to in vivo exposure.
The efficacy of virtual reality exposure therapy (VRET) has already been demonstrated in the past. A study conducted on acrophobia compared two groups of student subjects. The first group received a graded VRET. The second group was a waiting-list control group. Results showed that VRET is more effective than no treatment (Rothbaum et al.,1995). VRET was also found to be as effective as exposure in vivo in a more recent work by Emmelkamp et al. (2002).
In addition to this using a virtual reality system can have a number of advantages over in vivo exposure. First and foremost being the ability to conduct therapy inside a controlled and secure environment like a therapist's office. This also implies therapy being less time consuming and provides considerable financial benefits (Cavanagh and Shapiro, 2004). The possibility of having therapy in a more private scenario also could mean it becoming a more attractive choice for patients that are too anxious or fear public embarrassment. A recent study exploring the acceptability of virtual reality exposure and in vivo exposure in subjects suffering from specific phobias supports this hypothesis. Seventy-six percent chose virtual reality over in vivo exposure. In addition to this the refusal rate of 3% for virtual reality exposure was substantially lower than 27% for in vivo exposure (Garcia-Palacios et al., 2007). Further epidemiological studies show a lifetime prevalence of 28.5% for vHI and 6.4% for acrophobia alone and only 11% of susceptible people consulting a doctor (Huppert et al., 2013; Kapfhammer et al.,2015).
These results suggest that virtual reality exposure could help increase the number of people who seek therapy for phobias and therefore needs to be established in everyday clinical work.
In recent years there has been a lot of research on virtual reality treatment for different phobias trying just that.

For example a controlled study by Rothbaum et al. on aerophobia (2000) as well as an open clinical trial post-traumatic stress disorder (2001) and a study on agoraphobia (Meyerbröker et al.,2011), all of which yielded positive results. There also have been studies on ways to control the virtual reality. In a pilot study, Levy et al. (2015) explored the possibility of a remote controlled virtual reality. After a trial session in a neutral virtual environment the patients received a total of six therapy sessions. The first three sessions were remote virtual reality exposure therapy (e-VRET) followed by three sessions in the presence of a therapist (p-VRET). The study showed that e-VRET not only is possible but produces results equal to p-VRET. This inevitably leads to the idea of an independent VRET. To our knowledge there has not yet been a form of VRET that does not depend on external control. A system able to adapt to the mental state of the patient throughout the entirety of therapy and therefore qualify for private use could help expanding the reach of exposure therapy even further.
Assessing the mental state of a patient is essential for the success of the therapy. A task which usually falls to the hands of the therapist and in most cases relies on a verbal communication between both parties. To ensure the quality of our therapy system we clearly have to provide some sort of substitute for this.
Past studies have shown a strong psychophysiological arousal in in vivo exposure for different specific phobias (Nesse et al.,1985; Alpers and Sell,2007). In a more recent work Diemer et al. (2015) also confirmed the physiological arousal during a virtual height challenge. The study examined phobics and healthy controls in terms of subjective and physiological fear reactions resulting in a significant increase of subjective fear, heart rate and skin conductance level. We base our hypothesis on these results and claim a virtual reality system that is able to react according to changes in heart rate and electrodermal activity can work independently.
The present thesis is prior to a study in cooperation with the psychiatry department of the University Clinic Saarland concerning VRET on acrophobia. Our goal is to prove that a closed loop virtual reality system able to operate on its own by relying only on real-time physiological data is possible. To do so we want to design a virtual reality system for the treatment of acrophobia that is sufficiently adaptable to various degrees of acrophobia. We will show the effectiveness of our system based on a subjective rating as well as heart rate and skin conductance measurements. Further we will deploy our virtual environment in an experimental setup featuring a control through multiple systems in a closed loop fashion. We will conduct an experiment simulating the effect of real-time physiology based decision making by using a remotely controlled virtual reality.

Research Question
- is the designed VE able to elicit fear (subjective)
- differences in hrv and scl in fixed paradigm and remote paradigm

1.1 Theoretical Background

1.1.1 Acrophobia

1.1.2 Stress

1.1.3 Electrodermal Activity

Electrodermal activity (EDA) is a collective term for changes in the electrical qualities of the skin. It covers active and passive properties, caused by skin functions and skin structure as well as organs, contained in the skin[1]. EDA is one of the most commonly used response systems in psychophysiological research. This is due to its relative ease if measurement and its sensitivity to psychophysiological states and processes. The following section will provide a overview of EDA, ranging from physical and psychological context to recording and quantification methods.

Anatomical and physiological basics:

1.1.4 Exposure Therapy

1.2 General

1.2.1 State of the Art

1.2.2 Recent Advances in Research

1.3 Problem Analysis and Goals

[1] see Thom and Boucsein [1]

2 Materials and Methods

2.1 Materials

mention the SNNU and the lab where the study takes place

2.1.1 Setup

- description of the therapy setup
- graphic 1, shows a patient inside the defined treatment area, wearing VR-Headset, the lighthouse system, eeg and gsr sensors, connection to the pc controlled by the physician

2.1.2 Procedure(Paradigm)

- how many subjects did participate?
- which tasks did the patients fullfill? (cross the bridge etc.)
- duration of the experiment

- description of the virtual environment, the procedure (baseline measurement,VRET in detail)
- pictures that show the VE in it's starting state as well as it's therapy state (descended floor)
- description of how the VR is controlled by the user(which parameters can be influenced)

2.2 Methods

- main objective is the measurement of gsr during the therapy and the evaluation of the gsr data concerning the stress of the patient during the therapy
- how is the gsr information processed and evaluated?

how is it presented to the user?
- description of how the VR is controlled by the user(which parameters can be influenced)
- graphic of control chain

3 Results

4 Discussion

5 Conclusions and Future Work

A Tables and Measurement Results

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Bibliography

[1] E. Thom and W. Boucsein. *Elektrodermale Aktivität: Grundlagen, Methoden und Anwendungen*. Springer Berlin Heidelberg, 2013. ISBN 9783662069684. URL https://books.google.de/books?id=_mrvBgAAQBAJ.