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Systems Neuroscience
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Closed Loop Virtual Reality for the Treatment of Phobias

Bachelor Thesis

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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 6, 2018

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Abstract

Virtual reality is a high-end user-computer interface that involves real-time simulation and interactions through multiple sensorial channels[1]. Virtual reality devices have been used for years in industry and healthcare, where researchers have been trying to develop and implement virtual reality in ways that could assist approaching and training various situations.
With the advent of commercial virtual reality technology Head-Mounted-Displays (HMD) provide easier access to a vast field of possible applications. Including medical research using virtual realty to diagnose and treat diseases, allowing not only professionals but rather the patients to interact with a virtual environment.
A striking example can be found in the field of psychotherapy. The treatment of psychological conditions such as acrophobia can be a challenging task considering traditional therapy involves exposing the patient to a hostile situation.
As part of a study, which is set to evaluate the effectiveness of virtual reality guided exposure therapy in comparison to the established in-vivo therapy, the goal of this thesis is to provide a closed loop virtual reality fit to treat acrophobia.
On that account we created a virtual environment which is appropriate for treating different degrees of acrophobia and designed a setup capable of adapting to the users needs. We demonstrate that a well tailored virtual reality can provide a safe and controlled environment without compromising on the quality of the therapy.

[1]Burdea, G.C. and Coiffet, P. [1]

Zusammenfassung

translation of abstract

Acknowledgments

Contents

1 Introduction

In this chapter, we will give a introduction to the field of specific phobias and the associated therapy concept. The first part will contain fundamentals on phobias, exposure therapy and the effects of fear on the human body. Furthermore we will elaborate on biosignals containing information expressing these effects.
In the second part, we will

1.1 Motivation

Suffering from a specific phobia such as acrophobia can be a huge interference with daily life. Those affected are often experiencing a slow progressing self-limitation fueled by their fear resulting in a declining quality of life. For people afflicted with acrophobia a therapy can therefor be life-changing.
Typically a therapy is designed to help patients face their fears and practice coping strategies resulting in reducing the fear altogether. A traditional exposure therapy can be tainted with risks though. Major disadvantages being the amount of effort involved and dangers that come with giving therapy in extreme locations.
Virtual reality guided exposure therapy offers the possibility to treat patients in a controlled environment and eliminate the risk of injury. Furthermore virtual reality assisted treatment represents a safer and cost-efficient alternative that has great potential in improving phobia treatment based on its flexibility.
For example a in-vivo therapy consists of many different steps based on the initial extent of a patients fear and requires just as many individual stimulating situations. On the contrary one well designed virtual setup can easily adapt to all therapy stages and therefor be more convenient.

1.2 Theoretical Background

1.2.1 Acrophobia

definition of fear and specific phobias,prevalence, evolutionary purpose(fight or flight),connection fear to stress

1.2.2 Stress

definition of stress, ways of stress perception (eustress and distress)

1.2.3 Galvanic Skin Response

short explanation, influences(autonomic nervous system), role as method to register physiological correlates of mental states like stress

- illustration of a typical gsr signal and explanation of its components (graph, peaks etc.)

- how and where is gsr usually measured? why there?

1.2.4 Exposure Therapy

what is exposure therapy?
when is it used?
how is it done?
what is needed for it to be successful?
how effective is it?

1.3 General

1.3.1 State of the Art

1.3.2 Recent Advances in Research

1.4 Problem Analysis and Goals

- analyse the problem with current models of exposure therapy - show that my approach is different and how - why my approach is better and makes sense - goal is a safe and effective therapy option for acrophobia

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

Table A.1: Surgical needle sizes in Gauge[1]

Size [G]	Diameter [mm]	Colour code
10	3.4	brown-olive
11	3.0	yellow-green
12	2.7	lightgray
13	2.4	purple
14	2.1	lightgreen
15	1.8	blue-gray
16	1.6	white
17	1.4	violet
18	1.2	pink
19	1.1	ivory
20	0.9	yellow

[1] see [2]

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Bibliography

[1] Burdea, G.C. and Coiffet, P. *Virtual Reality Technology*. Number Bd. 1 in Virtual Reality Technology. Wiley, 2003. ISBN 9780471360896. URL https://books.google.de/books?id=0xWgPZbcz4AC.

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