

Master Thesis



F3

Faculty of Electrical Engineering
Department of Computer Graphics and Interaction

SIMR

**Simulating the phenomena of altered
states of consciousness using virtual
reality**

Jakub Hlusička

2021–2022

Supervisor: Ing. Josef Kortan

Diplomová práce



F3

Fakulta elektrotechnická
Katedra počítačové grafiky a interakce

SIMR

**Simulace fenoménů pozměněných stavů
vědomí pomocí virtuální reality**

Jakub Hlusička

2021–2022

Školitel: Ing. Josef Kortan

Abstract

TODO

Acknowledgements

TODO thank sci-hub

– Jakub Hlusička

Contents

1	Introduction	1
1.1	Problem Statement	2
1.2	Motivation	2
1.2.1	Art and Media	2
1.2.2	Education	2
1.2.3	Research and Psychotherapy	2
1.2.4	Understanding of the Human Mind	3
1.3	Related Work	3
1.4	Contributions	3
2	Background	4
2.1	Altered States of Consciousness	5
2.1.1	Definition	5
2.1.2	Aspects	5
2.2	Replications	5
2.2.1	Replications suitable for Virtual Reality	5
2.3	Psychometric Evaluation Methods	5
3	Implementation	6
3.1	Design of the Application	7
3.1.1	Safety	7
3.1.2	Virtual Scene Creation	7
3.1.3	Experiment Automation	7
3.2	Implementation of Replications	7
3.2.1	Spatial Effects	7
3.2.2	Non-Spatial Effects	7
3.3	Complex Replication	7
3.3.1	Execution Order	7
3.3.2	Biosensor Influence on Replication Parameters	7
4	Evaluation	8
4.1	Methodology	9
4.2	Analysis	9
5	Conclusion	10
5.1	Discussion	11

5.2	Notable Issues Encountered During Development	11
5.3	Future Work	11
	Bibliography	12

1

|

Introduction

Contents

1.1	Problem Statement	2
1.2	Motivation	2
1.2.1	Art and Media	2
1.2.2	Education	2
1.2.3	Research and Psychotherapy	2
1.2.4	Understanding of the Human Mind	3
1.3	Related Work	3
1.4	Contributions	3

1.1 Problem Statement

This thesis is focused on the development of a virtual reality (VR) application that simulates select aspects of altered states of consciousness (ASCs; further defined in 2.1.1) typically induced by classical psychedelics such as LSD and psilocybin/psilocin. We focus primarily on the recreation of the ASCs' effects on sensory perception using an analytical approach.

1.2 Motivation

Due to their high degree of immersion, VR systems, with head-mounted displays (HMDs) in particular, offer a unique opportunity for recreating certain aspects of ASCs.

1.2.1 Art and Media

ASCs of various forms have had a significant influence on art for millenia. Earliest signs of inductions of ASCs via neurotropic substances have been found possibly as early as 60,000 BC (Guerra-Doce 2015). ASCs continue to be depicted in or influence contemporary popular media.

An analysis and a recreation of certain aspects of ASCs may serve as a reference point for recreating those aspects of ASCs in popular media.

1.2.2 Education

While experiencing a simulation of an ASC is unlikely to be fully representative of the ASC the simulation is modelled after, we propose that the simulation may be significantly less inductive of difficult experiences colloquially known as "bad trips".

This may be a viable alternative form of experiencing certain aspects of ASCs, while the possession or consumption of mind-altering substances is illegal in most countries. The resulting VR application may serve as an educational tool about ASCs which would not require as controlled of an environment as is required in psychedelic-assisted psychotherapy.

1.2.3 Research and Psychotherapy

Aday, Davoli, and Bloesch (2020) make an interesting observation, that psychedelics and VR are utilized in tandem to enhance the experience of recreational users. Moreover, the authors claim that VR could also be used to optimize and tailor the therapeutic setting during psychedelic sessions.

Most importantly, however, the authors state, that:

[...] VR may be a useful tool for preparing hallucinogen-naïve participants in clinical trials for the sensory distortions experienced in psychedelic states.

Nonetheless, as mentioned previously, care should be taken to ensure that users experiencing the simulation are informed about the simulation not being fully representative of the **ASC** it is modelled after. While a **VR** simulation may be suitable for simulating sensory effects of **ASCs**, other effects, such as the effects on cognition, may be much more difficult, if not impossible, to directly replicate via **VR** technologies alone. If uninformed, users may gain a false impression about the **ASC**.

1.2.4 Understanding of the Human Mind

Finally, without any immediate application, the study of the effects of **ASCs** may help contribute to our understanding of the human mind. Particularly, for instance, analyzing the invariant effects of classical psychedelics on sensory perception may improve our understanding of the visual cortex and the way it functions. Further research involving perceptual phenomena and pharmacodynamics of psychedelics and their mechanisms of action may contribute to our understanding of the significance of certain receptors in processing visual or other sensory information.

1.3 Related Work

1.4 Contributions

We develop a **VR** application for **HMDs** that simulates select aspects of **ASCs**. We perform a study in which we measure the influence of the created **VR** application on the human mind. This measurement is done via the 11-factor altered states of consciousness questionnaire (**11-ASC**; Studerus, Gamma, and Vollenweider (2010)), that is used in clinical studies of psychedelic drugs.

2 | Background

Contents

2.1	Altered States of Consciousness	5
2.1.1	Definition	5
2.1.2	Aspects	5
2.2	Replications	5
2.2.1	Replications suitable for Virtual Reality	5
2.3	Psychometric Evaluation Methods	5

2.1 Altered States of Consciousness

2.1.1 Definition

2.1.2 Aspects

2.2 Replications

2.2.1 Replications suitable for Virtual Reality

2.3 Psychometric Evaluation Methods

3 | Implementation

Contents

- 3.1 Design of the Application 7
 - 3.1.1 Safety 7
 - 3.1.2 Virtual Scene Creation 7
 - 3.1.3 Experiment Automation 7
- 3.2 Implementation of Replications 7
 - 3.2.1 Spatial Effects 7
 - 3.2.2 Non-Spatial Effects 7
- 3.3 Complex Replication 7
 - 3.3.1 Execution Order 7
 - 3.3.2 Biosensor Influence on Replication Parameters 7

3.1 Design of the Application

3.1.1 Safety

3.1.2 Virtual Scene Creation

3.1.3 Experiment Automation

3.2 Implementation of Replications

3.2.1 Spatial Effects

Depth Perception Distortion

Waviness or "Breathing" of Objects

3.2.2 Non-Spatial Effects

Visual Acuity Enhancement

Hue Shifting

Tracers

3.3 Complex Replication

3.3.1 Execution Order

3.3.2 Biosensor Influence on Replication Parameters

4 | Evaluation

Contents

4.1	Methodology	9
4.2	Analysis	9

4.1 Methodology

4.2 Analysis

5 | Conclusion

Contents

5.1	Discussion	11
5.2	Notable Issues Encountered During Development	11
5.3	Future Work	11

5.1 Discussion

5.2 Notable Issues Encountered During Development

5.3 Future Work

List of Acronyms

11-ASC 11-factor altered states of consciousness questionnaire

ASC altered state of consciousness

HMD head-mounted display

VR virtual reality

Bibliography

- Aday, Jacob S, Christopher C Davoli, and Emily K Bloesch. 2020. "Psychedelics and virtual reality: parallels and applications." *Therapeutic Advances in Psychopharmacology* 10:2045125320948356.
- Guerra-Doce, Elisa. 2015. "Psychoactive substances in prehistoric times: examining the archaeological evidence." *Time and Mind* 8 (1): 91–112.
- Studerus, Erich, Alex Gamma, and Franz X Vollenweider. 2010. "Psychometric evaluation of the altered states of consciousness rating scale (OAV)." *PloS one* 5 (8): e12412.