VITALabs - A Multi-Stage Platform for the Evaluation of Virtual Therapies

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ABSTRACT

In this paper we introduce the multi-stage platform VITALabs, which consists of three coherent virtual reality (VR) labs for case and field studies as well as clinical trials to evaluate novel forms of virtual therapies. The focus of this interdisciplinary project is the creation of a user-friendly and real-world research and interactive environment with the topic of diagnostics and therapy in the future with medico-therapeutic context. The project provides a platform for other scientists, doctors, therapists and patients.

1 INTRODUCTION

The development and evaluation of novel user-centered innovative virtual forms of therapy in everyday life in practice often lacks a generalized platform and physical space for long term studies. Furthermore, while regulations and ethics approvals are essential and important for clinical research, sometimes those aspects hinder that patients get early access to novel technology or innovate forms of therapy. This is due to the fact that extensive trials, pre-evaluations, ethic approvals or medical certification are required beforehand. This is true specifically for a variety of therapeutic and health applications which can be helpful to a wide range of patients.

To deliver a platform, which allows to bring novel user-centered innovative virtual forms of therapy faster to patients, we develop the VITALabs as interdisciplinary partnership with expertise in the construction, installation, operation and maintenance of VR systems as well as medical domain experts for different clinical pictures (e.g. neurological diseases such as Alzheimer, Dementia or Parkinson). Specifically, we propose three coherent lab types: (i) VITALab.First, (ii) VITALab.One and (iii) VITALab.Mobile. The purpose of those labs is to test, examine and constantly improve new forms of therapy using virtual reality in a multi-stage process. The focus of the labs is to create, research and continuously improve effective, efficient and user-friendly interactive therapy. The central topic is the diagnostics of the future forms of virtual therapy with the involvement of real patients.

The multi-stage installation of the labs ensures that new virtual forms of therapy are not used on the patient until the effectiveness of the applications has been proven in laboratory studies in the VITALab.First (see Figure 2). There, the feasibility of the newly developed forms and concepts of therapy will be examined with volunteers under the supervision of medical domain experts and therapists. Only if these studies have demonstrated positive therapeutic effects (without negative side effects such as cybersickness or fatigue), the new methods will be evaluated in clinical field studies in VITALab.One together with patients (see Figure 2). Successful new forms of therapy can be made available to the population in rural regions in a second phase with the VITALab.Mobile, which also offers a mobile lab for further field studies.

2 RELATED WORK

A wide range of applications evaluated the therapeutic and medical effects of VR and AR technologies on patients. For example, exposure therapy (ET) is a typical example of such applications and is a widely used method in the treatment of several psychological disorders, such as various forms of phobias and anxiety disorders [5]. In this context, VR can facilitate the therapy by providing a safe, controlled environment for VR exposure therapy (VRET). For example, exposing to a virtual airplane and virtual sense of flying for treating the fear of flying (e.g., [4, 9]) is much safer and less expensive compared to in vivo (i.e., real life) exposure. VR provides also a broader range of control over the course of treatment. For instance, to treat the fear of public speaking one can easily change the number of the virtual agents (VAs) representing the audience from one to 100 or change their behavior. Having the same conditions in real life requires hiring and training of an enormous amount of actors for every single experiment. In this context, prior studies [7] support the use of VR for provoking public speaking anxiety. In addition, VR has been used in the treatment of patients with neurological diseases such as Alzheimer, Dementia or Parkinson. For instance, Pompeu et al. [8] use games to promote cognitive training. Other approaches by Aruanno et al. [1] evaluate the effects of AR as therapeutic tool for people with the Alzheimer’s disease. Further studies suggest that VR significantly can help in the clinical context of treatment of depression [3] or stress-related disorders [2].

VITALabs provide a platform and physical space for this kind and newer applications with the goal to evaluate their effects in a controlled setting. The possibility to carry out Virtual Reality studies outside a laboratory was first pursued by Mottelson et al. [6]. With our VITALab.Mobile we will be able to present different VR/AR application for different patients depending on the therapeutic needs without interfering with their daily environment.

3 VITALabs

In the initial phase the three VITALabs will work with two projects to enable empirical research in the laboratory as well as in different locations in the field. The proposed labs VITALab.First and VITALab.One are similar labs to develop and study virtual medical forms of therapy that will enable researchers, developers and VR/AR projects to bring their technologies and applications to real life, and to test in clinical contexts. The focus of VITALab.Mobile is to give users the opportunity to test extensively and without much effort in their existing environment before deciding on a permanent installation in their hospital or nursing home. Furthermore, VITALab.Mobile increases visibility and results can be presented at trade fairs and congresses, and developed projects can be directly tested or applied.
3.1 VITALab.First

The VITALab.First is installed in a university laboratory for easy access for volunteers and scientists. The VITALab.First and VITALab.One consist of two similar laboratories. Each will address empirical studies with different research topics. The laboratory studies in VITALab.First are carried out mainly with healthy subjects to evaluate the following aspects:

- Investigation of the usability and user experience of the user interfaces for the novel types of virtual therapy.
- Evaluate the effects of novel VR/AR interaction forms and concepts on cybersickness and presence.
- Assess the accuracy and precision of new tracking approaches for virtual forms of therapy, e.g. Combination of optical sensors and wearables.
- Assessment and assurance of privacy and security concepts.

3.2 VITALab.One

In the VITALab.One patients come into contact with new innovative VR/AR applications (forms of therapy). This ensures that only those applications are tested in a clinical context, which have proven to have a real medical and therapeutic benefit to patients according to VITALab.First evaluations. The field studies in VITALab.One are carried out with patients and clients in the real medical therapeutic context (see Figure 1) to investigate and evaluate the following questions:

- Evaluation of the short-term and long-term effectiveness of novel virtual forms of therapy.
- Evaluation of the target group-dependent usability, user experience and acceptance of the new types of virtual therapy.
- Investigation of the effects of long-term use of VR/AR hardware (user change, hygiene, improper handling, etc.).

All experiments conducted in the two laboratories are reviewed by an Ethics Committee.

3.3 VITALab.Mobile

The realization of the VITALab.Mobile is done in a truck with a specially designed trailer, which is adapted to the needs of new virtual forms of therapy. The basic equipment of the lab includes VR therapy stations including green screen and tracking setup and a suitable sensor and wearables environment. Furthermore a graphics and computing server for displaying VR data and realizing simulation calculations and machine learning is available. The VITALab.Mobile can be booked for a limited period of time by clinics and nursing homes and will be guided by experts. The mobility of the VITALab is an important component and offers the following advantages:

- Taking into account the mobility of elderly or restrained persons, e.g. for larger facilities (hospitals, retirement homes, etc.). Thereby we enable the possibility to reach this group of people.
- Mobility enables empirical research in different places and improves the accessibility of study subjects.
- Facilitates networking with other research labs and interdisciplinary research. Furthermore it increases public visibility for this research since it can also be used for events and conferences.
- The mobility aspect also brings financial benefits to collaborative projects, as communication between the labs is facilitated and no fixed space is required.

The VITALab.Mobile provides an infrastructure in a mobile interactive scenario. As in VITALab.One, real patients are examined in a medico-therapeutic context. In addition to the points above, the central and overall goals are the development of mobile, intelligent and interactive VR/AR laboratories with the topic of diagnostics in the future. In doing so, the mobility of the lab makes it easier for patients and clients of other therapy groups to be integrated.
4 APPLICATIONS: BODY, MIND, MOVEMENT

The VITALabs work as a platform for other applications. Their focus is the implementation of motor and cognitive testing by the provision of VR/AR technology. Examples for these applications are:

- VR/AR exergames for the treatment of neurological diseases,
- validated test procedures (memory or memory tests with Gamification approaches),
- playful reaction tests using the AR / VR technologies to test the driving ability of older persons,
- VR/AR supported endurance training for elderly people with hypertonic.

We can think of many more applications that are suitable here. However one central element is also to provide the possibility of the analysis of the patients inside the labs. Therefore the labs are equipped with hardware to analyse patients movements by means of a body scanner (for example 3D scanners, tracking systems or motion capturing systems), smart textiles or suitable inertial sensors and the movement problems to be derived therefrom, e.g. the danger of falling.

In summary one can say that our proposed VITALabs will develop and investigate virtual therapies that enable VR/AR researchers, developers and projects to test their technologies and applications in real clinical settings.

REFERENCES


