VITALab.Mobile - A Mobile Living Lab

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Figure 1: VR laboratory in a truck with a homely feeling.

ABSTRACT

VITALab.Mobile is a mobile VR/AR laboratory for case and field studies as well as clinical trials to evaluate novel forms of virtual therapies and scientific research. The laboratory is build into a truck, which can reach a variety of different user groups everywhere. 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 within a medico-therapeutic context. The project provides a platform for other scientists, doctors, therapists and patients.

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CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

virtual reality, augmented reality, truck, mobility, health, research, human computer interaction

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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 mid- and 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). The project is funded by the BMBF[1]. The VITALab.Mobile is one of three lab types proposed in the project VITALabs: (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. Additionally the VITALab.Mobile strives to collaborate with institutes, companies and projects from various fields to further VR research and visibility.

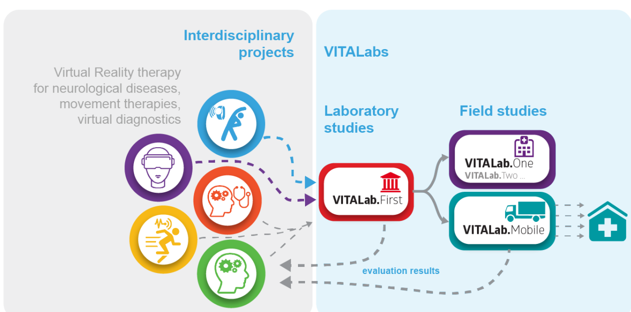

Figure 2: (Left) Illustrates new virtual forms of therapy that can be evaluated for effectiveness in the VITALabs. (Right) Applications will be pre-evaluated for medical and therapeutic compliance before tested on patient in hospitals and nursing homes (VITALab.One and VITALab.Mobile). VITALab.Mobile delivers the application including VR equipment directly to the 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. The demo showcases the possibilities of the VITALab.Mobile as one element of the VITALab concept and provides an exemplary VR application for coordination and memory training.

2 RELATED WORK

A wide range of applications evaluated the therapeutical 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 a 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 therapeutical needs without interfering with their daily environment.

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

[1]https://www.bmbf.de/

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, nursing homes or other scientific institutions and will be guided by experts. Our focus throughout the project is on providing an interdisciplinary research platform to promote new research ideas and industry collaborations and to adopt them for similar concepts in the future. 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 large-scale studies to be conducted across a wide range of study groups in different places.
- 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.

Planning

To build an optimal mobile laboratory into the trailer of a truck, we worked together with designers, medical staff and potential users to detect all requirements and possible problems. This is a vital step for the planning process to ensure the safety of all users and a wide-ranging field of application. We identified the following important aspects for the planning process: mobility, interaction space size, accessibility, air conditioning, storage space, interior design, electricity and lighting. We chose a trailer with 6m x 2 ,5m x 2,5m (L x W x H) in size to get a decent interaction area but to stay within the legal limits and best mobility for driving and parking. Electricity is provided by an outlet on the outside of the trailer, which is very commonly used for campers. It provides enough power for all necessary devices, like air conditioning, VR/AR hardware and lights. At the front of the trailer - close to the driver's cab - a large shelve will allow enough storage for equipment.

Trailers usually can be entered through a large loading ramp going up and down, which is located in the back. This doesn't provide a comfortable access to the interaction space and isn't safe, particularly for people with different kind of health problems. Instead of one large ramp, it is possible to enter the trailer by a staircase or a smaller loading ramp (see figure 3). Both have added railings to allow safe access.

Figure 3: Access to the trailer with stairs and a secured loading ramp for wheelchairs.

As the lab should be operational at any given time of the year, the temperature has to be manually adjustable. An air conditioning unit and a heater is a vital reqiurement to ensure an enjoyable stay in the trailer. Both devices work more efficiently when the room is enclosed. However it was never an option to close the outer doors of the truck, because it can cause unease or even claustophobia. During the design process it was decided to add a glass door to the entrance. The glas door creates an enclosed space, while allowing the natural light to enter. Additionally lights are added to the ceiling. The color of the lights are adjustable to create different athmospheres to the room, which can be an important element for different kind of studies.

Figure 4: The comfortable furnished truck, where people can be participate in studies.

With the beginning of 2020 multiple field studies are planned. We will be demonstrating an operational vehicle equipped with all necessary hardware. Users can test different VR applications inside of the truck.

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 hypertonie.

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.

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