PRoF Award abstract – Call 2018

Deadline for submission: Thursday March 1st 2018 (12 o'clock noon)
Please send to: PRoF-Award@uzgent.be.

Manibus Virtualis Mobili (M-VR-M)

1. Research Outline

Acronym	M-VR-M.
Project name in English	Manibus Virtualis Mobili
Pitch (1 sentence)	Development and validation of a low cost modular 3D motion sensing rehabilitation system
Executive summary (max. 10 lines)	
Within the context of the E-health initiative of Ministry of Health and Social Affairs in Belgium there is a push to reduce the length of stay in hospitals. So healthcare activities, prevention and rehabilitation, are moving to "the living room". Also patients are stimulated to take own responsibility in staying healthy or doing an accurate protocol when they are not healthy. This implicates the use of accurate mobile tracking devices in the home situation by means of telerehabilitation. Recently it has been proven that telerehabilitation in cardiac therapy is cost effective. Patients also stayed longer in healthy condition at home. For physical rehabilitation purpose the use of trackers and virtual reality (VR) seems to be a perfect match. The trackers provide accurate, distant, data for the rehabilitation expert whilst the virtual environment provides challenging exercises for the patient himself. By developing a mobile, low cost, 3D motion sensing system rehabilitation can take place at home under supervision of a distant expert rehabilitation team.	

2. Cause and context of the research

At first we were only interested in using innovative techniques to treat our on house rehabilitation population. We wanted to expand the amount of time that our patients can do exercises because the more you exercises the more likely it is that your rehabilitation will have a positive outcome. This principle has been proven in a neuroplasticity context in literature. But how can we accomplish that goal with limited resources (therapists and budget)?

We did a literature research with topics as Artificial Intelligence (AI), Internet of Things (IoT), quantified self (e.g. wearables, big data), rehabilitation robotics, Augmented and Virtual reality (AR/VR), 3D-printing, gamification and telerehabilitation. Some of the applications we found were still in the embryonic stage (e.g. AI) and others were too expensive (e. g. rehabilitation robotics). Nevertheless a couple were ready to get exploration in a clinical environment. In 2015 we started to explore the possibilities of using 3D printing in a rehabilitation context (see also PRoF Award 2016) and in 2017 we started to use VR in our rehabilitation activities.

Especially with VR we have a broad range of rehabilitation possibilities. In the first place we focus on physical rehabilitation but there are also clinical applications for neurocognitive rehabilitation (e.g. attention and concentration), treatment of pain (e.g. burn injuries), education (e.g. prepare children for surgery) and so on.

Our final intent is to extend the amount of rehabilitation activities in the acute (acute hospitalization), subacute (rehabilitation unit) and chronic phase (home, private practice). Therefore we want to develop a low cost VR mobile VR application which offers the patient challenging rehabilitation activities.

3. Innovation results achieved

We explored the marked of virtual reality and augmented reality applications for rehabilitation in 2016. We visited several sites with VR/AR systems in Belgium as well in the Netherlands. We explored large setups (e.g. Projector Based, Virtual Doom, The Cave at BARCO), moderate setups (e.g. Driving simulator IMOB Diepenbeek) as well as rather small setups (e.g. HTC Vive, Occulus Rift and Microsoft Mixed Reality).

We experienced great enthusiasm from the therapists as well as the patients in using these innovative ways of treatment. Nevertheless there were stumbling stones;

For the large setups we need a lot of space and budget. These setups are not mobile. Same major issues for the moderate setups. The smaller setups did meet our requirements best. Limitations here were mostly; rather expensive, not mobile and safety issues because of the use of cabling.

Our main criteria at that time were: VR/AR setup, combination with motion sensors, low cost, mobile, accurate registration/transmission of data and flexibility in software adaptation.

By chance we found a small company InMotionVR (https://www.inmotionvr.com/) which had a preproduction setup in which they combine a head mounted display (HMD), a smartphone and a tablet PC; the Corpus VR. Corpus VR is a therapy platform for physio- and neurotherapy that can be used as a therapy for physical rehabilitation, pain relief and treating physical anxiety disorders. As a platform, accessible through an app, Corpus VR holds a variety of therapeutic exercises for neck and shoulders. At that time it fitted best our requirements.

After months of field testing we came to the conclusion that the setup is really good but that the amount of available activities was the limiting factor for our patient populations. You can do a lot of activities with moving your head but in this setup you can not integrate arm and hand movement in the VR rehabilitation program. This was for us a major shortcoming. Also the games itself could be made more attractive for our population.

For both problems we found partners in the Netherlands who were interested in the further development of the Corpus VR setup. For the game aspect we partnered we Fantazm and for the development of hand/arm sensors we found a partner in Adjuvo. We started in 2017 with the further development of the Corpus VR. We want to be

marked ready end august 2020. Following is an image representing the prototype we want to have ready end of 2018 so we can do field testing in 2019.

We expect a growing market share of 2% in 2021 (Netherlands/Belgium) up to 15% in 2025. On European scale a market share of 2% is expected in 2023, 7% in 2025.

4. Link to the PRoF values

There is a growing body of evidence that illustrates how enriched virtual environments may be used as a therapeutic training tool in which many principles of motor control and motor learning can be incorporated to provide a learning experience tailored to individual clients. The flexibility of the computer environment allows the clinician to target specific motor control deficits and to provide meaningful feedback that encourages motor learning based on motor control principles of movement organization.

Both off-the-shelf and customized technologies applied to motor rehabilitation concluded that a range of VR technologies provide therapeutic interventions within a functional, purposeful, and motivating context (Weiss PL, 2009).

Training in a virtual environment shows significantly greater improvements in global cognitive functioning, attention and executive functions when comparing VR to conventional therapy (Faria, Andrade, Soares, & Bermudez i Badia, 2016). Nevertheless it has been shown that younger populations are more eager to use VR than elderly.

Using the mobile M-VR-M setup it is possible to start with rehabilitation in an early stage. Literature has shown that early, goal-directed mobilisation improved not only patient mobilization but also shortened the length of stay in an intensive care unit. Furthermore it also improved the patients functional capacity/mobility at discharge (Iwashyna & Hodgson, 2016).

Using low cost VR setup, like the M-VR-M, makes telerehabilitation more feasible. Training at home offers the comfort that one can do his/her exercises when they see fit. No need to go to a rehabilitation facility on a daily bases makes it less stressful for people as they don't have to worry on getting there on time, finding a parking space, being stuck in traffic (Dobbs, et al., 2017).

It is also comforting for patients to know that there is distant follow-up from the experts at the rehabilitation center. They can intervene when necessary by adjusting the difficulty level of the exercises, the amount of repetitions needed or the overall doze of therapy. By monitoring the exercises the decision can be made to re-admit the patient. It is our intention however to keep the patient as fit as possible in the best environment, their home.

By keeping the cost low it is not only possible to setup a cheap renting system for the patients. Smaller hospitals and rehabilitation facilities can also benefit as the M-VR-M setups get in their price range. At last also for private practitioners (physiotherapist) the M-VR-M can be affordable

5. Applicable IPR rules

There are none

6. Information on the partners

- UZ-Ghent – Physical Rehabilitation and Medicine: Lode Sabbe – Head occupational therapist (lode.sabbe@uzgent.be)
- Fantazm – Game design: Gert-Jan Brok – founder (g.brok@fantazm.com)
- InMotion VR – Corpus VR: Kiki Coppelmans – founder (kiki@inmotionvr.com)
- Adjuvo – Spin-off TU Delft: Johannes Luijten (info@senseglove.com)

1 Bibliografie

Dobbs, B., Shaw, M., Kasshau, M., Frontario, A., Krupp, L., & Charvet, L. (2017). Telerehabilitation using Remotely-Supervised Transcranial Direct Current Stimulation (RS-tDCS) Enhances the Benefit of At-Home Cognitive Training in Multiple Sclerosis (P4.335). *Neurology*, 88,16.

Faria, A., Andrade, A., Soares, L., & Bermudez i Badia, S. (2016). Benefits of virtual reality based cognitive rehabilitation through simulated activities of daily living: a randomized controlled trial with stroke patients. *Journal of NeuroEngineering and Rehabilitation*, 13:96.

Iwashyna, T. J., & Hodgson, C. L. (2016). Early mobilisation in ICU is far more than just exercise. *The Lancet*, Volume 388, Issue 10052, 1–7, 1351-1352.

Weiss PL, S. H. (2009). Video capture virtual reality: a decade of rehabilitation assessment and intervention. *Phys Ther Rev* ., 14:307–321.

'The goal of rehabilitation, to assist people to lead meaningful, fulfilling lives, is a tremendous undertaking, one that cannot be accomplished without a true, collaborative effort'

...

'If we can save the lives of people with an insult to the brain, we owe it to them to make sure their saved life is worth living' (Cicerone, 2009).

Note:

If your project is selected as laureate for the Award Symposium, a powerpoint presentation that reflects the project as suggested will be required (in advance), including a future plan how the funding will be used.

If your project is selected as the winner of the Award, you will be invited to present the results achieved thanks to the award during the Award Symposium of the next year.

Addendum: Contact information

Lode Sabbe

Head occupational therapist UZ Ghent

Corneel Heymanslaan 10

9000 Ghent

0032 9/332 42 15

0032 477/39 26 11