



PRIME-VR2 - H2020 Project

Personalised recovery through a multi-user environment

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# NEWSLETTER

## VR for Rehabilitation



## PRIME-VR2 Final Newsletter

It is with great excitement that we announce the successful completion of the PRIME-VR2 project. This has been a journey filled with hard work, innovative thinking, and a dedication to making a positive impact in the field of rehabilitation. Throughout the project, we have pushed the boundaries of what is possible with virtual reality technology, and we are proud to say that the results have exceeded our expectations. The PRIME-VR2 project has provided us with a unique opportunity to bring together experts from a wide range of fields, including healthcare, technology, and rehabilitation, to collaborate and create something truly special. Today, we look forward to sharing our accomplishments with you and showcasing the innovative solutions we have developed.

# PRIME-VR2 User Experience Design for Virtual Rehabilitation (UX4VRehab)

The Department of Civil and Industrial Engineering of the University of Pisa hosted the [User Experience Design for Virtual Rehabilitation \(UX4VRehab\)](#) Conference as part of the H2020 PRIME-VR2 project on October 13-14, 2022. The Conference aimed to explore design methodologies and innovative solutions in the fields of 3D scanning of body anatomy, Additive Manufacturing, and Virtual Reality applied to the creation of user experiences and interactive custom devices for rehabilitation.

The UX4VRehab Conference was organised as a hybrid approach and registered 88 participants, 60 of which attended the event in presence. The conference included 15 oral paper presentations organised into three different tracks: “3D acquisition for medical applications”,



Fig. 1: Some participants of the UX4VRehab international conference during the track presentations

“Design and development of rehab devices”, and “Experiences and evaluation of VR rehab”.



Fig. 2: Best paper and best presentation awards

Two research works were awarded best paper and best presentation. All submitted papers went through a blind peer-review process and those accepted were published in the dedicated special issue (CADUED) of the Computer-Aided Design and Application international journal.

The Conference organised two workshops, where experts in the field proposed and discussed with the audience two relevant topics: “3D acquisition for customization” and “VR serious games for rehab”. During the workshops, the experts performed some interactive demonstrations showing the results of the project consisting of innovative bespoke 3D-printed controllers and the supporting IT platform for rehabilitation purposes.

Distinguished leaders in the field of VR and rehabilitation were invited as keynote speakers to illustrate current and future developments in VR technologies and related practices for rehabilitation. In particular, three main speakers took part in this two-day conference: Dr. David Wortley, vice president of the International Society of Digital Medicine, Lasse Tuominen, account executive at Varjo and Lucia Pannese, Imaginary’s CEO.

Finally, experts from the academic and industrial worlds met in a dedicated session to discuss issues related to technology transfer, commercialization of research results and the creation of spin-offs and start-ups. The conference concluded with an overview of Horizon Europe relevant calls for possible continuation of the project's research activities.

“We are very proud of the results achieved in the PRIME-VR2 project” - comments Sandro Barone, full professor of Design and Methods of Industrial Engineering at the University of Pisa and H2020 PRIME-VR2 project coordinator - having achieved the challenging initial goal of developing an innovative framework for the rehabilitation of upper limbs tailored to the needs and characteristics of each patient. The framework includes a system for the acquisition of the geometry, movements, and forces of patient’s upper limb. A data-driven approach has been developed to design a custom wearable controller. The patient can experience a Virtual Reality environment by wearing a VR headset and perform rehab exercises through serious games by using the controller”.



Fig. 3: Expert panel presentations about technology transfer, commercialization of research results and the creation of spin-offs

“One of the main problems related to rehabilitation - adds Armando Viviano Razionale, full professor of Design and Methods of Industrial Engineering at the University of Pisa and scientific coordinator of the project - is the high number of patients dropping out of rehabilitation, which can be due to various factors such as the repetitiveness of the exercises. The interactive virtual environments developed in the PRIME-VR2 project allow patients, with the assistance of medical staff, to perform the right movements to rehabilitate the limb in an engaging environment, and to achieve results more easily, with the consequent improvement in quality of life”.



Fig. 4: Attendees of the Conference experience the 3D scanning rig during the interactive workshop “3D acquisition for customization” run by the University of Pisa



Fig. 5: Demonstration of the VR games during the workshop “VR serious games for rehab” run by Flying Squirrel

# Project achievements

The overall aim of the PRIME-VR2 project was to deliver a development platform that integrates bespoke VR hardware and physically- and socially-optimised gaming to deliver enhanced VR experiences for rehabilitation purposes. This has been developed for three use cases, and has led to new standards of accessibility, control, feedback and engagement for patients. The specific project objectives that have been reached are the following:

- \* Development of a VR environment for rehabilitation exercises that allows users to play and compare progress to aid motivation in rehabilitation;
- \* Development of new approaches for non-invasive, accurate anatomical and mobility data collection that retains user dignity;
- \* Definition of an advanced biomechanical profile of the patient to develop bespoke VR controllers aligned with specific rehabilitation approaches;
- \* Implementation of a User Data Toolkit for the acquisition of the patient's physiological data;
- \* Implementation of a User Profile Toolkit to manage and visualize the acquired physiological data, together with proposals of which controller and therapy game is recommended for the patient;
- \* Implementation of a web platform offering a "platform loader tool" to download the serious games assigned by the therapist to the patients;
- \* Design of a basic controller prototype consisting of a core controller that can be equipped with three different modules to suit patient's requirements;
- \* Advanced manufacturing of bespoke controller housing structures that blend external physical requirements with internal actuation properties by using additive manufacturing technology;
- \* Verification tests and certification of the developed devices.

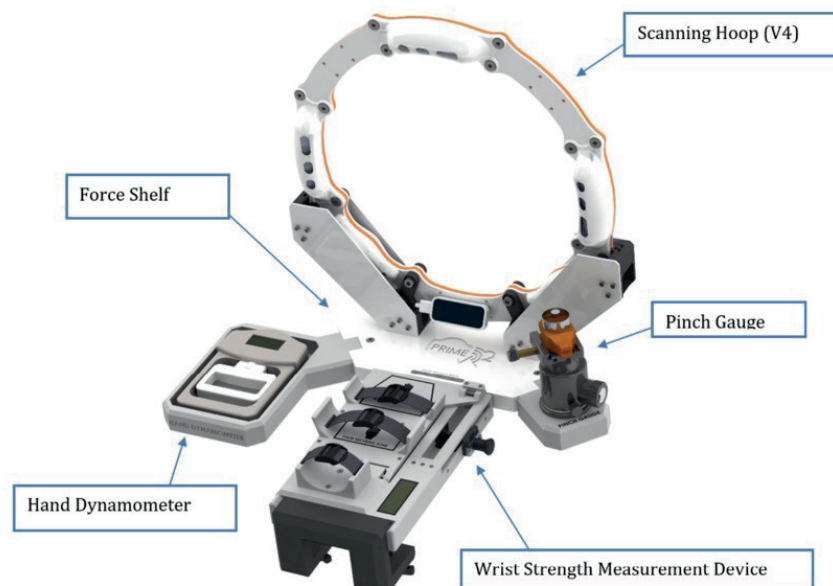


Fig. 6: Render of scanning rig fully assembled

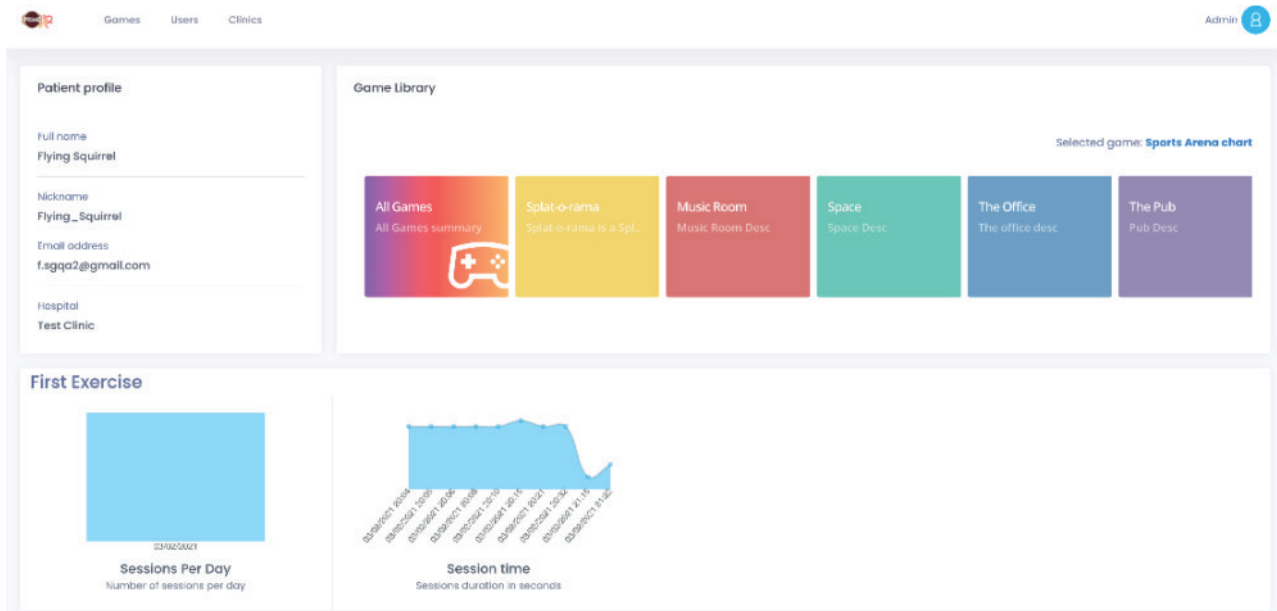


Fig. 7: Web platform to download serious games assigned by therapist to patients

The project has achieved all its objectives and milestones. The main results that the partners believe being exploitable are the framework for physiological data capture and patient's assessment; bespoke controller housing and interface design; and VR gaming environments for rehabilitation.

Two of the main innovations of the research project have been selected for patent application, namely the full controller generation framework (the VRHAB-IT) which includes the technology and process of biometric data collection, processing, controller generation, therapy building, implementation and progress tracking; and new concepts in auxetic structures, physical structures that can adapt and change depending on the needs of the surfaces required. These key patents have been filed at the European Patent Office during the project, and will continue to be developed towards market applications in the near future. Sixteen papers about the technological advances have been published by the partners in scientific journals and can be retrieved through the project web site.



Figure 9: CAD model of the bespoke controller.

Fig. 8: Screenshot of the VR serious game "Splat-o-rama" executed with the developed controller

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Fig. 9: CAD model of the bespoke controller

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PRIME-VR2 is on the [Virtual Reality Helix](#)



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