PRIME-VR2 - H2020 Project
Personalised recovery through a multi-user environment

March 2021 - Issue #05

NEWSLETTER

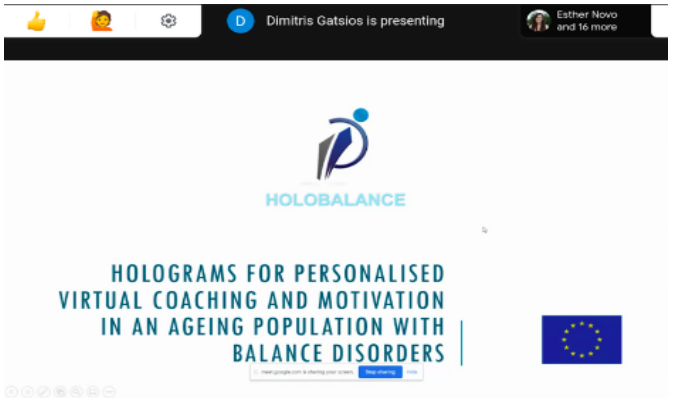
VR for Rehabilitation

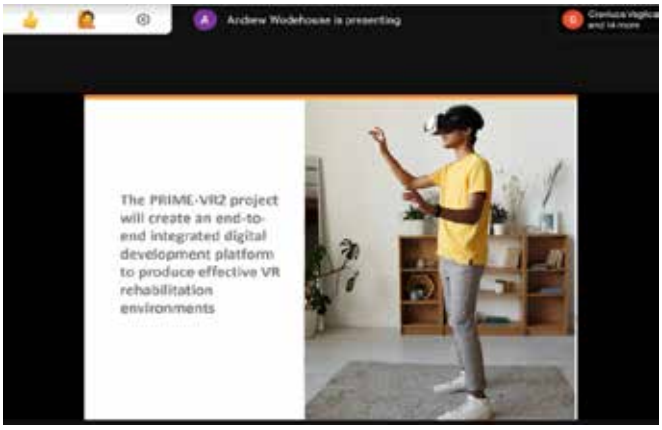
PRIME-VR2 Two major achievements

In the last period, the PRIME-VR2 team has achieved two major results. Ten serious games have been designed and prototyped to allow the Living Labs to preliminary evaluate their effectiveness, usability issues, and acceptance with a selected group of patients. The second achievement consists of the initial elicitation prototype of the controller, which allows the team to gain insights into the specifics of the three rehabilitation cases.

The Virtual Reality Helix Event

The first annual Helix Event was took place as an online Workshop for Health and Technology Sister Projects.





To mitigate the effects of Covid-19 on PRIME-VR2 dissemination activities, it was decided that the first annual Helix Event will be organised virtually in the form of an Online Workshop for Health and Technology Sister Projects. Organised by Crowdhelix and supported by PRIME-VR2 partners, the event was designed to promote knowledge sharing and collaboration between health and technology EU funded projects.

Attendees had the opportunity to share their expertise and broaden their knowledge in an event that hosted delegates from 7 European projects. In the first part of the event, all participants were offered the chance to provide an overview of their projects and to present their work. Time was also allocated for the attendees to discuss and ask questions after each presentation. A brief Virtual Reality Helix presentation was also included in the first part of the event. The participants were shown around the Crowdhelix Platform and were explained the advantages of the Virtual Reality Helix.

The second part of the event was marked by the thematic parallel sessions. The themes for these sessions were chosen to help the participants overcome common challenges and find ways of mutual development in the future:

1. Understanding high-quality User Experience in VR based rehab - Clinician, patient point of view - facilitated by Philip Farrugia
2. Looking forward - future collaborations - facilitated by Monica Bordegoni

The workshop concluded with fruitful discussions on the two mentioned themes. During this time, the attendees managed to identify and discuss a few areas of possible future collaboration which we are currently planning on taking forward.

Milestone 4: Demonstrating 10 scenario games

The Platform implementation team has worked on the 3 pivotal parts: Kerubiel is responsible for implementing the technology powering the Web Platform and supporting platforms, Capitola for the design and implementation of the Software Development Kit, and finally Flying Squirrel Games for game design and development.

While developing the Web Platform, we worked closely with members from other work packages, used questionnaires, interviews, and several focus group meetings to explore all the functionality that could be needed and required for the patients, the therapists and other related users. It was extremely important to create a system based on the available requirements, in which patients and therapists can receive information about the process of their development. From the implementation we can clearly see that it provides an excellent opportunity to monitor patient's progress. Leaderboards, achievements and the recording of patient centric metrics from the games through the SDK ensure that the rehabilitation process is a useful, fun, traceable and informative experience.
With regard to the SDK, the requirements identified by therapists include the ability to track a patient's rehabilitative progress and the ability to support a patient during a session. Secondly, an analysis was carried out on the various patients' capabilities. Following this, we derived a toolset to support a range of motor and visual impairments, and identified the relevant input measurements required to track a patient's rehabilitative progress.

We also built desktop tools that allow a therapist to support a patient during a gameplay session, including a supportive installer to distribute and streamline the installation process of games. We built various components of the SDK, including abilities to calibrate input, manage achievements and calculate scores, that support a developer to set up a game environment and connect to functionalities provided by the web API. All components and integration have been well documented and are accompanied with the SDK and technical examples.

In any VR game, setting the right environment is critical to the user experience. We concluded that the best way to determine what environments would be appropriate for this type of experience was to actively collaborate with the Living Labs and their patients. The process started off with a series of brainstorming sessions, from which patient factors such as: age, typical interests and physical aptitude helped narrow down from an initial list of potential environments. A total of 10 environments were shortlisted and expanded upon with concept art, write ups on possible activities (games) that the player would be able to do and then finally built-in proof of concept 3D with visuals closely resembling the original artwork. A variety of visual styles was employed across these concepts, ranging from: stylized (low polygon, cartoony) to realistic depictions of the 3D world.

These environments were then made fully navigable in VR and later integrated with the SDK into the backend such that the framework could be tested with real world fictional patient and therapist data. These environments are now fully integrated with the VRHAB-IT and are currently being demonstrated in the Living Labs in Malta and Cyprus (in VR and video forms) to shortlist the environments preferred by the sample patients themselves. At the time of writing, the Malta Living Lab chose the Sports Arena as their preferred environment, and is now identifying potential games, activities and exercises suitable to be held in this area.

The basic working Controller - Challenges

The goals and aspirations for the PRIME-VR2 controller

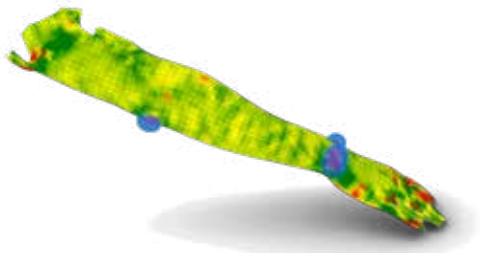
The ultimate goal of the physical hardware that we are developing as part of the PRIME-VR2, VR-HABIT system is to provide an engaging and effective means to perform physical therapy. We are aiming to develop a controller that authentically replicates the tangible experience of therapies that are currently recommended and prescribed by clinicians and allows them to be performed in the context of a VR experience, embedding them in a rich, immersive, audio-visual world.

In terms of the controller as a physical object we are looking for the controller to be an integrated, compact design avoiding the bulk of some orthotic and assistive devices on the market; bristling with buckles, straps, clamps and points of adjustment. The look and feel of this device will complement the existing VR headsets on the market that they will be paired with, avoiding feelings of being medicalised in the users.

How can this be applied to the development of the PRIME-VR2 controller?

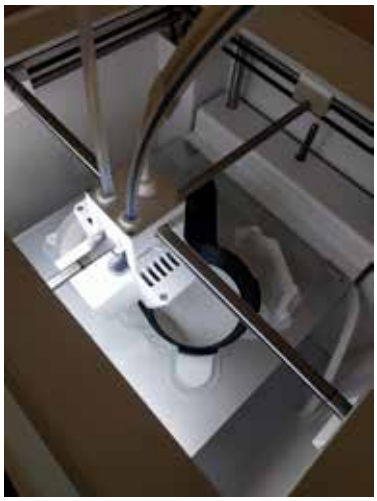
In developing a product which is so intimately linked to the anthropometry and biomechanics of the user, not only the sizing of components will vary but also the way in which they move, their centres of rotation, the loads and moments associated with a given exercise. By taking as input the 3D scans of the user's arm, we can identify the key elements of the controller which benefit from personalisation. Using additive manufacturing then allows us to cost effectively deliver a controller which fits that individual perfectly with little or no need for adjustment.

Exploring the possibilities of varying material properties through 3D printed elements allows us to potentially pack greater functionality into the controller that might otherwise have needed complex assemblies of distinct components to achieve the same results.



What advantages does Additive Manufacturing (AM) offer?

We are exploring taking advantage of the latest in additive manufacturing technologies here to offer bespoke elements in the controller hardware to ensure that fit, comfort and function are perfect for every user. Additive manufacturing offers a number of advantages which are of interest here, there is no initial capital cost in tooling as with injection moulding, one-off pieces become feasible and cost effective. Complex forms are also possible with a freedom not seen in other manufacturing processes, with the possibility to even vary material properties across a single component, moving from hard, rigid areas to soft and compliant features.



Algorithmic approach

Given that we are dealing with users across a wide range of pathologies and ages, there may be a great deal of variation in the inputs to the generation of a given controller. The algorithmic approach we have adopted aims to manage this complexity, identifying the key features of the arm and its biomechanics that are required as input and capturing the design intent as an algorithm that we can be sure produces a valid output.

Challenges

There are many technical challenges that we have already faced and many of course yet to be confronted in this highly innovative development. However, as with any collaborative, cross-disciplinary project, the key challenge is finding a common language to discuss and share perspectives and knowledge. In setting out to deliver a tangible VR controller that can deliver an authentic and effective replication of an existing physical therapy it is vital that the design team listen to the clinician and their patients' lived experiences and expertise. Every stage of this project proves to be a learning experience and we are looking forward to getting prototypes into the hands of users in the coming months to get more in-depth feedback to inform the development.

The basic working Controller - Elicitation prototype

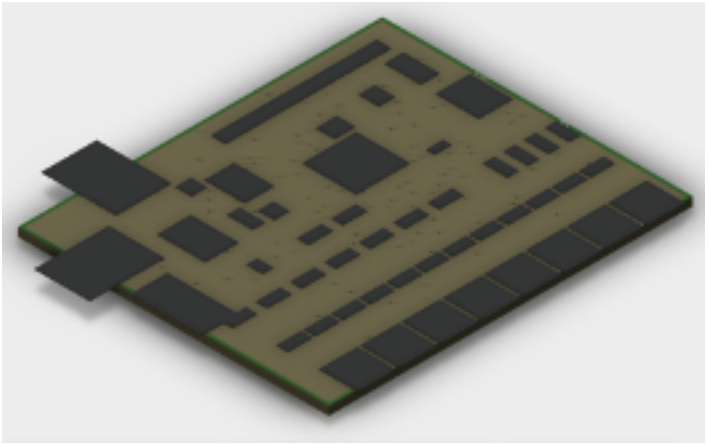
Elicitation prototype

The initial elicitation prototypes we are developing help us to understand the specific requirements for each case of patient rehabilitation and VR rehabilitation controller. These prototypes inform the hardware and software aspects of the controller and environment developed in PRIME-VR2. They are particularly useful to gain insights into the specifics of the three rehabilitation cases in the scope of the project.

Core electronics module

The electronics consists of different modules which utilize different types of sensors and a core module. The core electronics module will be responsible for receiving data from various sensors and sending this data to the computer system via Bluetooth connection. The sensors recognise therapeutic interactions. In particular, the sensors capture the users' gestures via the bespoke controller and transforms them as an input data for the VR rehabilitation system.

The core electronics module is entirely a custom device that serves the requirements of the rehabilitation cases in PRIME-VR2.



MEET THE TEAM: UNIVERSITY COLLEGE LONDON

University College London (UCL) is based in Bloomsbury at the heart of London. It is well known for its multi-disciplinary nature with leading departments across science, engineering, medicine and the arts. It consistently ranks as one of the top research universities in the world (ranked 10th in the QS World Rankings 2021).

The Department of Computer Science at UCL is the top computer science department in the UK as rated in the most recent UK Research Excellence Framework. The Virtual Environments and Computer Graphics group is a leading group for graphics and interfaces research, with an established and consistent presence at the main graphics venues, including SIGGRAPH, VR, CHI and CVPR/ICCV/ECCV conferences. It is world-renowned for its work from core systems development through to novel user experiments.

UCL's principal roles in PRIME-VR2 are in the development of validation mechanisms within the VR platform software for user assessment. Current work focusses on mechanisms for task-assistance and their effect on user progress, embodiment and sense of accomplishment. We are particularly interested in how users respond to embodiment, given that their sensorimotor contingencies are being changed by the interfaces. UCL is working closely with the Living Labs partners in Prime-VR2 to ensure that the mechanisms deployed form part of a coherent design strategy for user interaction with the VR platform games.

Anthony Steed

Anthony Steed is Head of the Virtual Environments and Computer Graphics group in the Department of Computer Science at University College London. He has over 25 years' experience in developing virtual reality and other forms of novel user interface.

David Swapp

David Swapp is a senior research fellow in the Virtual Environments and Computer Graphics group, and manager of UCL's Immersive Virtual Reality Laboratory. His chief interest is in mapping human perceptual capabilities to limited sensory displays.

Felix Thiel

Felix Thiel is a second-year PhD student at UCL's virtual reality lab. His current work is mainly focused on ways to make virtual reality more accessible for physically impaired players.

MEET THE TEAM: LOUD1DESIGN

Loud1Design Ltd. is a product design engineering consultancy based in Glasgow, Scotland offering new product development support directly to clients or integrating into other larger development teams looking for our focussed capabilities in form and geometry. L1D has been operating for 9 years as a design consultancy across a wide range of sectors ranging from medical products through toys to renewable energy and architectural technology. L1D has served many clients, large and small, from international companies such as Lego and Arup, to local SME innovators.

A key driver in L1D's work is the generation of parametric and algorithmic models that allow a solution space to be explored, optimised or customised to individuals. These models seek to capture the design intent fully, allowing explorations that always remain valid within the design constraints. The PRIME-VR2 project therefore naturally aligns with the development of L1D's practice and capabilities which we are continually developing.

L1D's systematic approach to design will be key in the development of bespoke controller housings and interfaces. These will be algorithmically developed to satisfy the ergonomic and biomechanical requirements captured in the biometric measurements to be undertaken of end users. The resulting controller housing designs will be tailored to appropriate additive manufacturing technologies using L1D's knowledge and experience of these tools in commercial product design and development projects. L1D is also involved in the integration of these housings with the internal controller electronics in close collaboration with other partners in the PRIME-VR2 team.

Brian Loudon

Brian is the director and owner of L1D and has 20 years of experience as a product design engineer consultant. Brian's experience in product design and engineering has included concept design work through to mathematical modelling and more detailed CAD and engineering work in preparation for production level information.

Robbie Bellshaw

Robbie has joined the team in this key phase in the development of the controller hardware. Robbie is bringing his inventive and thorough approach to bear on the mechanical design of key elements. Robbie is a multi-discipline designer and engineer, with 20 years' experience in developing, managing and delivering complex projects across a broad range of industries and themes.

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NEXT ISSUE: June '21

In the next issue, we will talk about ethics issues and report the preliminary results of the users' tests. We will write the contribution of some young researchers working on the project. We will report on the Tutorial Videos of the Training Building Programm and introduce other two partners.

NEXT EVENTS

In 2021 PRIME-VR2 is planning on working closely together with the internationally well-known event VR-Days. This year, the 3-day event will take place from 17 - 19 November, as a hybrid virtual and physical event. Last year the event was completely online, after many years of being a physical event hosted in Amsterdam. Hopefully, all partners will be able to attend the event, to contribute to the workshops open for PRIME-VR2 members and other attendees of the VR-Days.

CHECK THE WEBSITE REGULARLY FOR MORE NEWS, DOWNLOADABLE CONTENT AND INFORMATION!

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This Project is being co-ordinated by:

UNIVERSITÀ DI PISA