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Immerstar, a still evolving 25 years old VR research facility

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Figure 1: The two immersive spaces of Immerstar: Immermove (left) and Immersia (right)

ABSTRACT

The two platforms Immersia and Immermove offer an immersive collaborative space called ImmerStar, intended for the scientific and industrial community, for international research projects. Immersia is a 3D virtual reality platform which, thanks to its exceptional dimensions, offers an environment for experimentation, particularly in the context of real-time and multi-modal interaction (vision, sound, haptics, brain-computer interface) between humans and virtual models. Immermove is a technological platform dedicated to motion capture, extended by a virtual reality space. It enables the precise capture of rapid movements (sports for example) or of a group of people, in order to study human behavior such as crowd-movement or sport gestures. This paper presents the history of the evolution of these two joint platforms, an overview of their technical specifications, associated research projects and perspective of evolutions.

Index Terms: Virtual reality, haptics, motion capture.

1 INTRODUCTION

The two platforms Immersia and Immermove offer an immersive collaborative space called ImmerStar¹, intended for the scientific and industrial community, for international research projects.

Immersia is a virtual reality platform with exceptional dimensions (10x3x3m wide), situated on the university campus of Beaulieu in Rennes. It provides a large environment for experimentation, particularly in the context of real-time and multi-modal interaction (vision, sound, haptics, brain-computer interface) between humans and virtual models.

Immermove is a technological platform dedicated to motion capture, extended by a virtual reality space. Installed at ENS Rennes on the Ker Lann campus in Bruz, it enables the precise capture of rapid movements (e.g. sports) or of a group of people, in order to study human behavior such as crowd-movement or sport gestures.

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The characteristics and functionalities of the two platforms are driven by the research activity of a large hub of VR and AR researchers, which comprises more than 150 individuals organised into four main research teams, Seamless, Virtus, Combo and Rainbow², tackling a wide range of research linked with VR and AR, such as avatars, haptics, biomechanics, robotics, human perception, human-computer interaction, neuroscience or rehabilitation.

2 HISTORICAL OVERVIEW

As the 1990s drew to a close, Bruno Arnaldi, Georges Dumont and their team from the IRISA/Inria research centre had already been studying virtual reality for approximately a decade when they first became aware of a specific platform for this research at a university in the USA. The establishment of a similar platform in Rennes was initiated through the implementation of a research project, which subsequently garnered support from the research centre. This initiative underwent a period of sustained development, under the aforementioned research centre's oversight. The inaugural version of the platform, in 1999, was equipped with a semi-cylindrical screen, utilising tri-tube projectors (Fig. 2). Subsequent enhancements were implemented to the Immersia platform, with the objective of ensuring that the equipment remained at the forefront of technological advancement. This strategy was employed to preserve the quality and competitiveness of the research conducted in Rennes in the domain of virtual reality.



Figure 2: Creation of the reality space Immersia in 1999

¹<http://immerstar.irisa.fr/>

²<https://www.inria.fr/en/{seamless|virtus|combo|rainbow}>

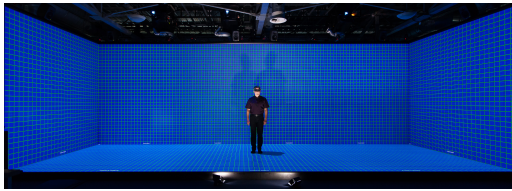


Figure 3: The four-sides immersive structure of Immersia created in 2011

In 2011, the platform was relocated to a new, larger room, thereby enabling the study of user movements. The facility is equipped one floor screen, and three glass screens, the largest of which measures 10 metres in width (Fig. 3).

From 2011 to 2015, Immersia has been a key node of the European Infrastructure Research project Visionair [9], hosting several international experimental projects on various topics such as distant collaboration [5], haptics [13], sport training [12, 3], perception [7, 6, 2, 14] (Fig. 4).

Since 2013, Immersia has been headed up by a committee made up of representatives from the CNRS, the ENS Rennes, Inria, INSA Rennes, the University of Rennes 1 and, starting from 2015, the University of Rennes 2.

In 2015, Immersia has been linked to the new platform Immermove, a motion capture platform, which has been extended through the addition of a virtual reality system (Fig. 5). This platform is capable of capturing rapid movements (in sport for example) or groups of people in precise detail, the goal being to analyse movements of crowds and individuals.

In 2016, an additional (3rd) face was added to the Immermove platform, and the Vicon tracking system was extended with new cameras (Fig.1, left).

In 2017, WQXGA laser projectors were installed in Immersia as well as a new tracking system and a new cluster of computers, improving the quality, homogeneity and latency of the platform.

In 2018, Immersia's functionalities have been extended through the addition of an haptic system covering the entire volume of the immersive space, allowing various configurations from single haptic device usage to dual haptic devices usage with either one or two users (Fig.6, right). In addition, a motion platform designed to introduce motion feedback in powered wheelchair simulations has also been incorporated (Fig.6, left).

In 2020, Immerstar participated to the creation of a new French National Research Infrastructure, Continuum³ [8], which gathers 30 visualisation, simulation, and interaction facilities in the broad country.

A team of eight individuals, of which six are permanent employees, two scientists, and six engineers, is currently responsible for the operation of the two Immerstar platforms. Notably, all team members are also affiliated with the research teams associated with the platforms, with the aim of promoting their experimental activities and facilitating their involvement in new projects.

3 TECHNICAL OVERVIEW

3.1 Immersia

The main immersive place is made up of four screens (a front, two sides and a ground). Dimensions are 9.6 m wide, 2.9 m deep and 3.1 m height (Fig. 3). Images are provided by a visual reproduction system that combines, 14 Barco F90-4K13 projectors powered by 7 HP Z820 with 2x7 Nvidia quadro P6000, through glass screens for front and side screens and rendered on the acrylic ground. An Optitrack localization system, constituted of 12 cameras, enables real

³<https://www.lri.fr/mbl/CONTINUUM/plateformes.html>

objects to be located within the whole environment and enables full body tracking. Sound rendering is provided by a Yamaha processor, linked either to Genelec speakers with 10.2 format sound or audio headsets (with 5.1 virtual format sound, or binaural sound), controlled by the user's position. The platform integrates a double Scale-one haptic system covering the entire space, one of which can carry the user. The rendering software mainly uses Unity and MiddleVR, but other rendering software such as OpenScene-Graph, Covise, Collaviz, OpenSG or OpenMASK were also already successfully installed and used in Immersia. The immersia platform is also equipped with different VR/MR headsets (HTC Vive, Hololens, Oculus), stereoscopic displays (ZSpace, active stereoscopic screens) and interaction devices (leap motions, kinect, myo, Light Shadows SENSO,...). 2 Virtuouse 6D35-45 haptic devices allow to add haptic feedback within experiments. A 50m2 room was added to Immersia in 2024, named Immerlab, to serve as an experimental space dedicated to HMDs.

3.2 Immermove

Immermove Platform is composed of a complete gymnasium with a floor area of 30 x 20 m² and a ceiling height of 8 m, with motion capture facilities based on 47 infrared cameras (23 Qualiysis Oqus 7 and 20 Vicon MX, Vantagen and Tseries), two force plates (120cm x 60cm), 16 channels wireless EMG sensors, and a large immersive room (12x4x4m) with stereoscopic vision, high-quality body tracking, spatialized sound and a software solution based on Unity and MiddleVR to host external standard softwares and applications.

Images of the immersive space are provided by 5 Christie Mirage 4K 3D projectors. It includes a tracking system constituted of 12 Vicon Bonita cameras, with one Apex for interactions, active stereoscopy with RF Volfonti ActiveEyes, surround sound 5.1, and rendering software based on Unity with MiddleVR.

4 RESEARCH PROJECTS

The research in Immersia focuses on perception and interaction in virtual reality, while Immermove research is dedicated to motion studies in virtual reality. The complementary functionalities provided in this room allow to capture motion on a stadium (half of a basketball field) and to allow interaction, mainly for sport performance studies, between real and virtual human (Fig.7).

Since their creation, the two platforms have been involved in major national and international research projects, on very different application domains such as collaboration (Collaviz) medical training (S3PM, Sunset), archaeology (Introspect), health (Adapt), sport (Revea), crowd simulation (Percolation), physical simulation (Imagin), avatars,...

They are both currently involved in national flagship projects in research and education, such as the aforementioned Equipex+ Continuum, but also the EUR Digisport project⁴ dedicated to digital sport science and elite sport training, PEPR eSEMBLE⁵, a national research programme that brings together scientists from all disciplines to address current issues in digital collaboration and propose long-term socio-technical models for collaboration and secure, interoperable, multi-organisational collaboration platforms that promote trust and digital well-being, and DemoES AIR⁶, which aims to develop innovative solutions for enriching and multiplying educational interactions using digital technology, and in particular immersive technologies.

The platforms are also currently involved in European projects such as GuestXR⁷, exploring haptic social virtual environments, and Sharespace⁸, exploring social virtual environments through

⁴<https://digisport.univ-rennes.fr/>

⁵<https://www.pepr-ensemble.fr/>

⁶<https://projet-air.univ-rennes.fr/presentation>

⁷<https://guestxr.eu/>

⁸<https://sharespace.eu/>



Figure 4: Visionair projects in Immerisa: Remote collaboration between Immersia and UCL Cave [5](top, left), virtual training to olympic shooting [12](top, right), obstacle avoidance [14](bottom, left), biomechanical study with haptic [13](bottom, right)

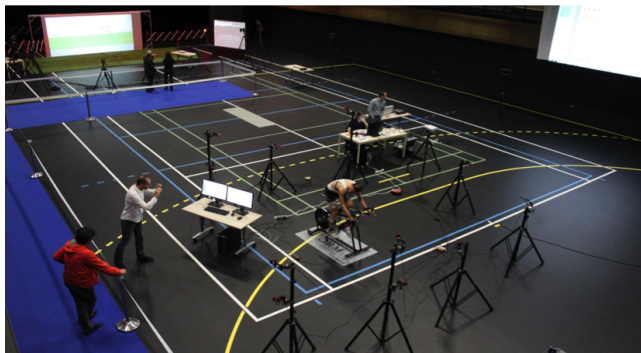


Figure 5: Creation of the Immermove platform in 2015



Figure 6: Left: Wheelchair simulator for the INTEREG Adapt project in Immersia, Right: The haptic system in Immersia

collaborative sport. Finally, the platforms serve also as a support for interdisciplinary research (Fig.8), e.g. in mathematics [11], art[10], archaeology[4] and cultural heritage[1] (Fig.8).

5 PERSPECTIVES

The two platforms are undergoing continuous development, with major improvements scheduled for implementation in 2025 through the Continuum project.

Immersia will integrate new projectors and computing capacities in Q2, enabling dual perspective viewing within the immersive environment. Additionally, it will host an Infinadeck omnidirectional treadmill. In Q3, Immermove will expand its immersive space with a fourth side and new projectors. New mocap capacities are deployed with the acquisition of new Xsens inertial motion tracking setups, in addition to the ones used by the research teams.

Both platforms are considering the deployment of new software development platforms due to the new licence politics of Unity.

In addition, the two platforms are getting involved in new research projects on art, health, digital twins, sport, and avatars, that will foster their continuous development.

6 CONCLUSION

The Immerstar platform, initiated in 1999, is now a major research facility in the domain of virtual reality. It gathers two platforms, Immersia and Immermove, each with distinct research activity. Immersia is dedicated to research on perception and interaction, while Immermove is dedicated to research on human motion.

The activity of the two platforms is supported by the presence of a major research centre in the field of VR and AR, with 4 research teams working on research problems in this field, with a staff of more than 150 people.

The two platforms are continuing to evolve, with major changes planned for 2025. New research projects will also help to develop the activity of the 2 platforms.

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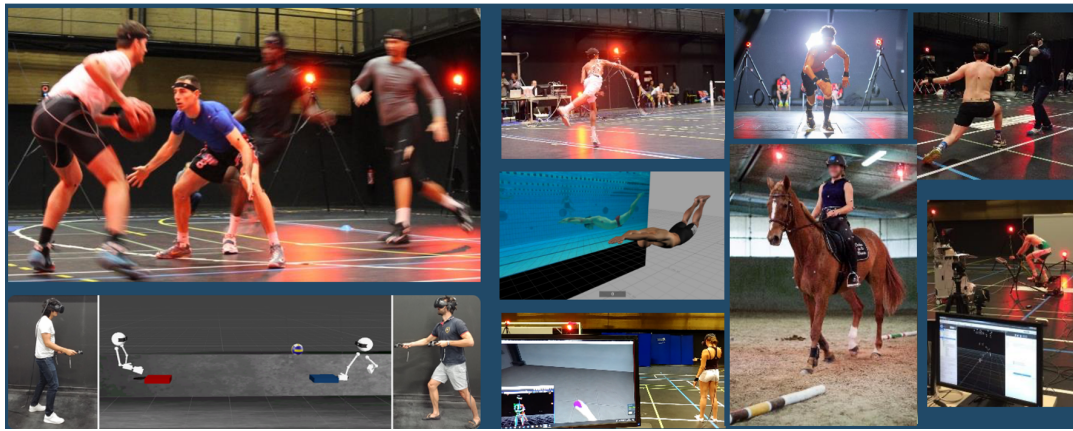


Figure 7: Various motion captures of sports carried out through the mocap Immermove equipments



Figure 8: Interdisciplinary projects in Immersia : exploring non Euclidean geometries (left), artistic performance (top, right), cultural heritage (bottom, right)

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