INCLUVERSO 5G: Designing and validating the technology for the Incluverse

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Figure 1: The three use cases developed in INCLUVERSO 5G will be integrated in the services that Fundación Juan XXIII provides to people with intellectual disability and other situations of psychosocial vulnerability: cognitive therapy (left), supervised apartments (center), professional training (right).

ABSTRACT

INCLUVERSO 5G is a research project targeted to develop XR and 5G telecommunications technologies that allow for immersive communication experiences applied to therapy, telepresence, and teletraining use cases. The project aims to apply these technologies to people with intellectual disability and other vulnerable psychosocial situations as a fundamental step towards the development of a fully inclusive Metaverse or *Incluverse*.

CCS CONCEPTS

• Human-centered computing \rightarrow User studies; Mixed / augmented reality; • Social and professional topics \rightarrow People with disabilities.

KEYWORDS

inclusive metaverse, extended reality, intellectual disabiliy, psychosocial vulnerability

CHI '23 Workshops, April 23--28, 2023, Hamburg, Germany

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ACM ISBN 978-1-4503-XXXX-X/18/06...\$15.00

https://doi.org/XXXXXXXXXXXXXX

ACM Reference Format:

Pablo Pérez, Diego González-Morín, Jaime Ruiz, Jesús Gutiérrez, Marta Orduna, Carlos Cortés, María Nava-Ruiz, and María Julia Sánchez-Silva. 2023. INCLUVERSO 5G: Designing and validating the technology for the Incluverse. In *CHI '23 Workshops: Towards an Inclusive and Accessible Metaverse, April 23–28, 2023, Hamburg, Germany.* ACM, New York, NY, USA, 3 pages. https://doi.org/XXXXXXXXXXXX

1 INTRODUCTION

The development of Extended Reality (XR) technologies represents a new milestone in the way people will communicate in the near future. XR systems will allow distant people to feel physically present in the same environment and interact as effectively as in a face-toface meeting. Consequently, new services, devices, and networks, including 5G and its evolution, need to adapt to meet the associated technological challenges. XR devices must be lighter and more ergonomic, which imposes energy consumption restrictions. The network must provide consistent quality of experience (QoE), lower latency, and symmetric bandwidth [8].

XR technologies are particularly suitable for therapeutic and educational use cases. They can help improve the inclusion of people in vulnerable psychosocial situations, such as people with intellectual disabilities, dependence, or neurocognitive impairment. For example, Virtual Reality (VR) can facilitate the development of music therapy and sensory stimulation [10]. Telepresence allows people in isolation or in lockdown situations to virtually visit people and places to which they do not have daily access [1]. Remote assistance based on XR allows caregivers, therapists, and family members to more effectively assist dependent individuals. The use

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of XR in training can improve the efficiency of training and therefore the employability of these individuals [11]. Lastly, internal user state and environment analysis can provide additional tools to improve the psychosocial capabilities of the people who use them, such as emotional regulation or information about the environment through augmented reality [2].

One of the most common problems faced by the development of AI and XR technologies is their bias towards certain user profiles [12]. Including diverse populations from the beginning of the research process ensures universal use and accelerates their acceptance by the population.

In this context, the INCLUVERSO 5G project aims to develop XR and 5G telecommunications technologies that allow for immersive communication experiences applied to therapy, telepresence, and teletraining use cases. The project aims to apply these technologies to people with intellectual disability and other vulnerable psychosocial situations as a fundamental step towards the development of a fully inclusive Metaverse or *Incluverse*.

2 THE PROJECT

INCLUVERSO $5G^1$ is a research project which will start at the second quarter of 2023 and last until mid 2025. It is led by Nokia Extended Reality Lab (XR Lab), in cooperation with Universidad Politécnica de Madrid (UPM) and Fundación Juan XXIII². The project will address three main challenges.

Firstly, accessible XR technologies are needed, including representation of users within the immersive scene [7], natural and intuitive interaction interfaces [3], virtual environments, telepresence technology [5], and digital biomarker technologies to improve user interaction and compensate for possible limitations associated with psychosocial vulnerability. The project will leverage and evolve the technological assets developed by Nokia XR Lab in collaboration with UPM [3, 5, 7].

Secondly, XR applications need to be deployed at field trial scale with sufficient Quality of Experience (QoE). This implies designing a proper edge cloud computing architecture to handle the computing requirements of the system, and deploying 5G network infrastructure to provide the required throughput and latency.

Finally, it is necessary to design XR technology while validating it in different use cases. In this sense, validation is part of a codesign process for XR technology to enable its application in real scenarios. Therefore, it is necessary to develop specific application cases, tools for their monitoring and validation, and tests of the different applications with real users in situations of psychosocial vulnerability to understand which technological options are most effective in supporting the inclusion of these groups. This co-design process will also allow the development of more inclusive XR technology that is easier to adopt by the general population. Fundación Juan XXII, which works with people with intellectual disabilities and other psychosocial vulnerabilities, will have a key role in this area.

Pérez et al.

3 USE CASES

The project will develop three use cases sequentially, with partially overlapping timelines to allow the gradual development and testing of the involved technologies. The use cases follow a logical order based on their technological complexity, level of control of the XR experiences, and potential scope of the developed technology.

The first use case is focused on behavioral and cognitive therapy for people with specific therapeutic needs, with highly controlled and systematic XR content to facilitate research in interaction and emotional regulation technologies.

The second use case is focused on telepresence for supported living facilities, enabling the development of XR technologies for communication between people, with professional support available for evaluation.

The third use case is focused on teletraining for job placement, aimed at people with intellectual disabilities, enabling the validation of all technologies developed in the project in a less controlled environment for general use.

3.1 Behavioral and cognitive therapy

The use of XR technologies can provide patients with a sense of presence that replaces in vivo therapies and allows for remote access to therapies. It can also help minimize costs and resources by simulating environments and physical objects. XR technologies also enable easy collection of patient behavior parameters and biomarkers, which can be used to identify mental states and cognitive processes, track patient progress, and develop tools for emotional and cognitive regulation [4, 6].

The use case will address maintaining or improving cognitive skills, including attention, memory, language, orientation, abstract thinking, and perception, as well as helping patients cope with anxiety in situations they fear, such as needles, and teaching relaxation techniques through systematic desensitization in a virtual environment, accompanied by a therapist. Weekly therapy sessions with be conducted with about 10 patients at the Fundación Juan XXIII for approximately six months.

3.2 Immersive telepresence in supervised apartments

The Juan XXIII Foundation has a training apartment where people with intellectual disabilities are trained in daily living skills to have an autonomous life with necessary supports. They also have four supervised apartments in the same district where up to 4 people live after training in the training apartment. Each apartment has an educator present for a certain number of hours depending on the needs of the residents.

The main objective is to provide a tool that allows educators to perform tasks remotely as needed. An immersive telepresence system (Nokia Owl prototype [5]) will be installed in the supervised apartment, allowing the educator to connect remotely and feel as if they were there. This tool will also allow family members to virtually visit the apartment.

Additionally, the possibility of some of the residents using the telepresence system to visit distant relatives or places they cannot access regularly will be studied. This will allow for the study of the daily use of immersive telepresence and the improvement of

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the system's design to adapt to it. A telepresence system will be installed in each supervised apartment with a minimum of 15 hours of remote support per week, with at least 3 hours of weekly use for 6 months to ensure validation of the technology from both ends.

3.3 Teletraining for employment placement

The purpose of this case study is to validate the different technological elements developed in the project in the context of a training program. The study aims to analyze which elements can help the learning process, which may be necessary or counterproductive, and in what context. The specific elements to be analyzed will be determined as the project progresses, but at least the following will be considered: live video (telepresence) versus pre-recorded video, different camera positions (such as the teacher's point of view, a student's perspective, or a third-party view) [9], availability of natural interaction mechanisms (based on [3]), and availability of digital biomarker monitoring and emotional regulation.

To achieve these objectives, training activities will be developed that will be integrated into the curriculum of one of the professional certification courses offered by the Fundación Juan XXIII's Center for Employment Training. Specifically, this case study will involve the Basic Pastry Operations or Basic Cooking Operations course. During a four-month period of the academic year, up to 15 course participants will have access to these types of training sessions.

ACKNOWLEDGMENTS

INCLUVERSO 5G has been accepted for funding from the call for 5G-Avanced R&D projects under the "UNICO I+D 6G 2022 Program" of the Spanish Government, within the framework of the Recovery, Transformation and Resilience Plan.

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Received 23 February 2023; accepted 10 March 2023