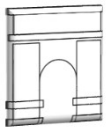
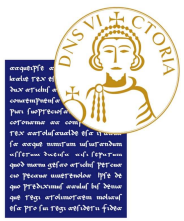
Trained staff on
outcomes and digital oriented
teaching and learning



DECEMBER, 3-6 2024
BENEVENTO, ITALY

EXTENDABLE – network of EXTENDed reAlity-enaBLEd laboratories for remote practical training

Ing. Enrico Picariello



UNIVERSITÀ DEGLI STUDI
DEL SANNIO Benevento

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The importance of accessing laboratories (1)

Accessing laboratories and performing activities is a fundamental aspect of STEM discipline training.

The knowledge acquired during theoretical lectures cannot be reinforced and enriched without those activities.

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The importance of accessing laboratories (2)

What happens if the classroom is overcrowded or, as has happened more recently, in case of movement restrictions due to a pandemic?

To address these issues, the goal of EXTENDABLE is to create a network of laboratories which will enable the execution of laboratory activities through the use of extended reality.

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The importance of accessing laboratories (3)

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Extended Reality

Augmented Reality (AR), Virtual Reality (VR) and Extended Reality (XR) technologies are adopted to enhance the learning experience and gap the bridge between physical and digital learning environments.

Augmented reality: Superimposes digital content, like images or 3D models onto the real world, so that user can interact with them.

Virtual Reality: Immerse the users directly into a virtual environment, usually with head-mounted displays and controllers to track movement and provide haptic feedback,

Extended Reality: encompasses AR, VR and mixed reality, where the real and virtual world are blended seamlessly

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Benefits and Challenges (1)

- Ability to create immersive environments that captivate learners' attention and sustain their engagement;

- Unlike passive consumption of information, AR, VR, and XR enable learners to interact with content, manipulate virtual objects, and make decisions in dynamic scenarios.

- AR, VR, and XR can provide personalized and adaptive learning experiences, instead of a "one-size-fits-all" approach.

- Collaboration and social interaction, which are often limited in distance learning environments, are greatly enhanced by XR technologies.

- Fields that require hands-on practice, such as medicine, engineering, and aviation, benefit immensely from the safe and controlled environments provided by XR technologies.

- Promote Inclusivity. These technologies can accommodate diverse learning needs and abilities, making education more accessible to all.

- Long-term benefits of integrating AR, VR, and XR into distance learning extend beyond the classroom, preparing learners for the demands of the modern workforce.

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Benefits and Challenges (2)

- A primary challenge in implementing AR, VR, and XR lies in the cost and accessibility of the required technology. High-quality VR headsets, AR-enabled devices, and other related hardware are often prohibitively expensive.

- XR technologies often demand robust computational power, high-speed internet, and reliable networks to deliver seamless experiences.

- Effective XR applications require a multidisciplinary approach that combines instructional design, software development, and an understanding of educational psychology.

- Both educators and students may face difficulties in adopting these tools, particularly if they have limited prior experience with immersive technologies.

- Data Privacy. These technologies often collect extensive data on users, including behavioral patterns, biometric information, and location data, raising significant privacy issues

- The risk of over-reliance on technology. While AR, VR, and XR offer unique capabilities, they are not a panacea for all educational challenges.

- Prolonged use of VR headsets can lead to discomfort, motion sickness, or eye strain, particularly for users who are not accustomed to such devices.

- The sustainability of implementing AR, VR, and XR technologies

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Develop a virtual laboratory

In 2021 the Unit's researchers proposed a remote laboratory application, based on augmented reality, to allow the students to conduct laboratory experiences operating on 3D digital reconstruction of the instruments.

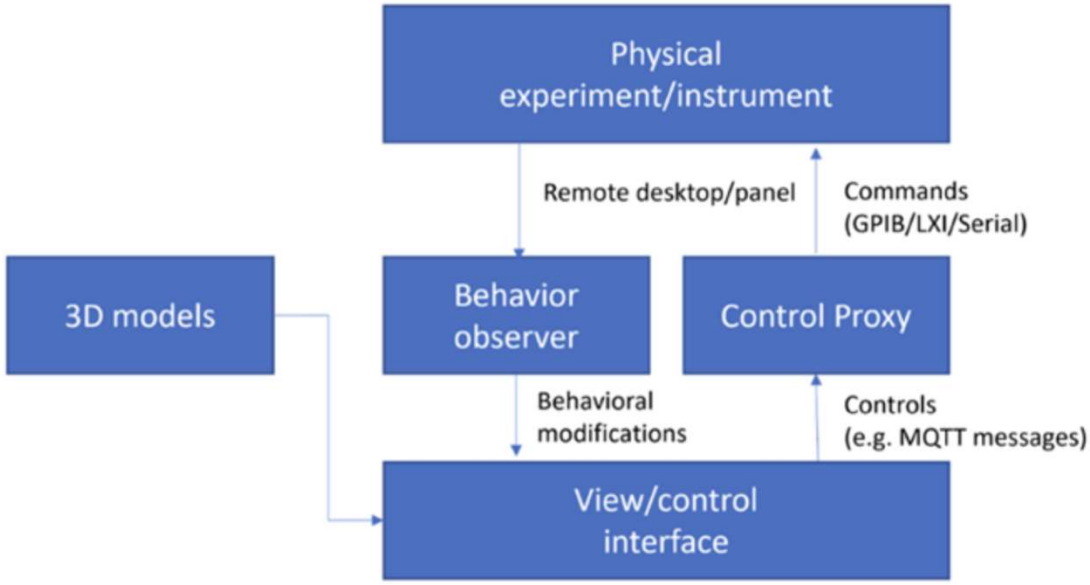

Fig.2. Block diagram of the framework to be developed.

However, even this solution, although interactive because it is based on gamification techniques, with advantages for engagement, does not completely solve the problems related to the risk of isolation.

It also not includes all the preparatory actions needed to make a measure, for example building a circuit or preparing the instrumentation.

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Introducing Metaverse

Thanks to the technological advances of VR virtual reality, distance learning is converging towards the use of computer-reconstructed immersive 3D environments, which represent the digital twin of a classroom or physical university campus.

This alternative virtual world, which allows teachers and students to interact with each other, through a three-dimensional version of themselves in avatar format, performing any action they would also do in the real world such as moving, talking, and thus bringing their identity into the digital world, is called the Metaverse and could soon become the new frontier of e-learning.

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Introducing Metaverse

Therefore, the Metaverse lends itself not only to the creation of simple virtual classrooms, but is a candidate to transform remote learning from passive to active: (i) through the creation of virtual simulations, to allow users to practice with real scenarios, but in a controlled and risk-free environment; (ii) fostering collaboration, thanks to the sharing of digital space, where users can meet to exchange opinions, share doubts or make decisions collaboratively; (iii) promoting practicality, with the implementation of theoretical notions, not always possible in the physical context.

And it is precisely in the Metaverse, therefore, that the Unit researchers saw the opportunity to take remote laboratories to a level never reached before. In practice, starting from the remote AR laboratory, developed in 2021, they integrated the digital AR tools into an immersive 3D environment, suitably reconstructed and equipped with several additional functions compared to the physical laboratory, thus creating the first and most advanced laboratory of measurements and electronic instrumentation in the Metaverse.

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Learning in the Metaverse

Many universities are experimenting with immersive learning environments that go beyond traditional classrooms.

Stanford University: Virtual Physics Lab
In the lab, students can interact with three-dimensional models of phenomena such as quantum mechanics, electromagnetism, and thermodynamics.

Massachusetts Institute of Technology (MIT): iLab in the Metaverse
MIT has expanded its famous iLab Project into the Metaverse, creating advanced remote labs that span different scientific and engineering disciplines.

University of Tokyo: Metaverse Environmental Science Lab
The University of Tokyo has developed a Metaverse Environmental Science Lab, which allows students to explore and analyze virtual ecosystems in a simulated environment.

Harvard University: Virtual Chemistry Lab
Harvard has launched a Virtual Chemistry Lab in the Metaverse, where students can perform complex chemical experiments in a safe and controlled environment.

University of California, Berkeley: Remote Earthquake Simulation Lab
UC Berkeley has created a Remote Earthquake Simulation Lab within the Metaverse, designed to study the impact of earthquakes on infrastructure.

And many other institutions, like the Universities of Glasgow, Zurich, Milan, and Singapore.

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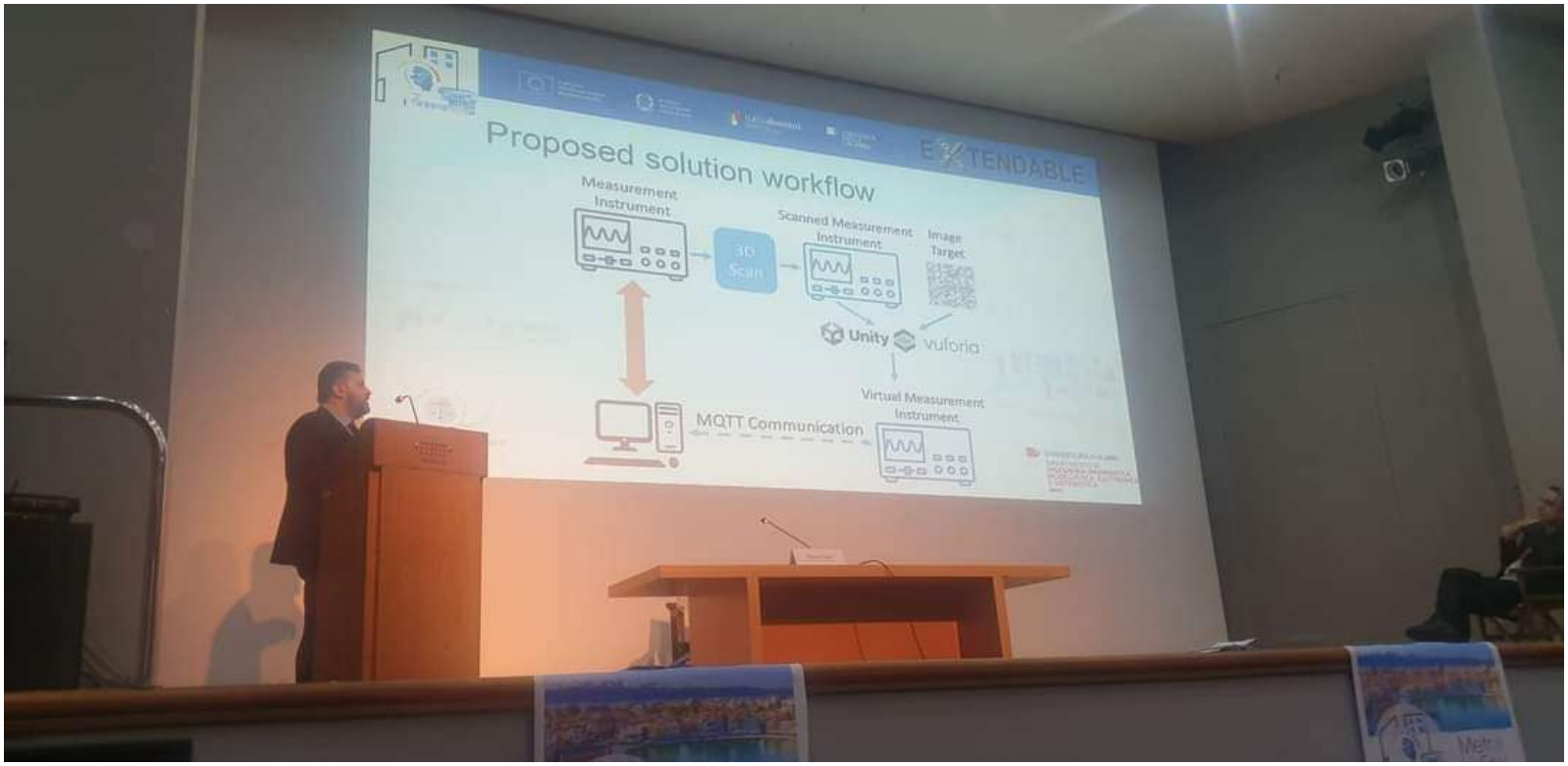
EXTENDABLE (1)



Prof. Lamonaca presents the activity of the project EXTENDABLE at the 2024 IEEE International workshop on Metrology for Living Environment (Metro LivEnv)

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EXTENDABLE (2)

An example of an AR measurement setup with a virtual Multimeter and Power Supply

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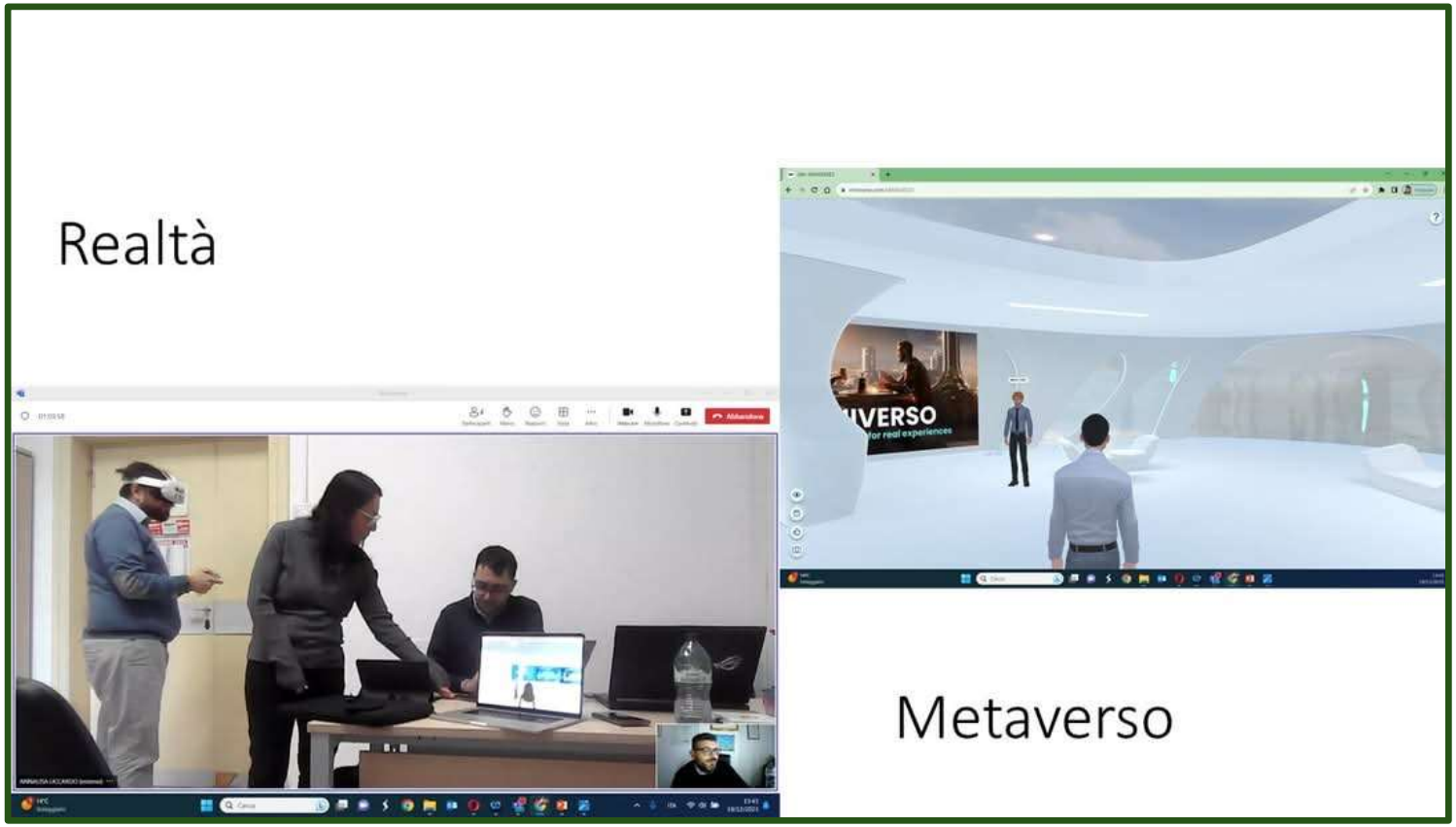
EXTENDABLE (3)



The Unit researchers and their avatar in the Metaverse (1)

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EXTENDABLE (4)

Nella Realtà

Nel Metaverso

The Unit researchers and their avatar in the Metaverse (2)

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CONCLUSIONS

The Metaverse represents an emerging technological frontier, destined to revolutionize university education, offering new possibilities for learning, collaboration and research.
Many universities are experimenting with immersive learning environments that go beyond traditional classrooms. Through the use of customizable avatars, students can participate in lectures, seminars, workshops in virtual spaces, which simulate highly interactive and dynamic learning environments. Global accessibility, enabled by the Metaverse, makes university education more inclusive.

Future work will be focused on the implementation of some laboratory experiences in the metaverse at each of the 3 universities, integration of the remote instrumentation control into the metaverse, and also verify if there are some integration issues.

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Thank you for the Attention!

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https://www.facebook.com/profile.php?id=61556543673333

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