SMART EDUCATION

INTERACT

Interactive Multi-User Virtual Reality Training

SETTING THE SCENE

Industrial training with real equipment can be expensive, risky, and challenging to scale. Now, imagine a virtual reality (VR) training solution that offers a safer, more accessible, and cost-effective alternative. While VR holds great potential, current technology still falls short in delivering fully immersive and interactive experiences.

For one, today's VR devices only have limited on-board processing. On-board rendering, for example, necessarily sacrifices visual quality. A wired connection to a dedicated computing cluster, on the other hand, severely restricts the mobility of the training participants.

Then there's the issue of handheld controllers used to interact with the virtual world: they still feel clunky and unnatural, hindering true immersion.

Finally, desynchronization between the physical and virtual worlds can induce cybersickness in prolonged VR sessions, creating discomfort and diminishing focus.

INTERACT aims to break through these barriers, creating an immersive, multi-user VR experience that pushes the boundaries of interactive training.

FRAMING THE RESEARCH OBJECTIVE

The objective of the INTERACT project was threefold:

The primary goal was to eliminate the need for wired connections in VR headsets without compromising computational performance. This was to be achieved through low-latency and high-throughput wireless connectivity with edge and cloud computing infrastructure.

The second goal was to develop an intuitive and interactive VR platform for collaborative, multi-user industrial training simulations. By enabling tactile and immersive interactions within the virtual environment at minimal motion-to-photon latency, the platform aims to reduce the risk of cybersickness and enhance the overall training experience.

Lastly, these innovations were tested in real-world, human-centric experiments, specifically applied to two industrial VR training use cases.

THREE MAIN OUTCOMES

INTERACT developed **a wireless receiver** that connects the DisplayPort and USB port of the VR headset on one end, and the content rendering server on the other end. It transparently replaces the DisplayPort and USB cables with a high-speed wireless connection. The receiver integrates Pharrowtech's mmWave Wi-Fi RFIC (Radio Frequency Integrated Circuit) with Dekimo's low-latency FPGA-based DisplayPort-to-wireless converter board, enabling a wireless data rate of over 3.4 Gbps. By applying frame-by-frame compression and optimizing the protocols developed by imec – IDLab – UAntwerp, a per-frame worst-case latency below 10ms was achieved. This latency is within the tolerable limit to avoid cybersickness.

Rhinox' modular **VOLT framework for semi-automated creation of AR/VR training** applications was extended with support for multi-user experiences. Imec – IDLab – UGent integrated haptic feedback capabilities and developed techniques to keep the synchronization deviation between haptic and visual inputs below 20ms. This extended VOLT framework was subsequently put to the test to develop two VR training experiences with input from TEO-TRAINING: (i) a network teambuilding experience, where users have to work together to assemble electric light switches, and (ii) a single-player electrician training experience, where the user is asked to detect malfunctions in electrical machines using a multimeter.

A **subjective 'quality of experience' methodology** was developed to assess the effectiveness of the VR training applications. This methodology enables the evaluation of participants' learning potential, immersion, and comfort. Using this approach, Rhinox, TEO-TRAINING, and imec – IDLab – UGent evaluated the two training applications with the assistance of over 30 volunteer participants, recruited through INTERACT's industrial user group. Participants identified significant potential in VR training, as reflected in a general Mean Opinion Score above 4/5. However, adoption barriers remain, particularly for users with limited technological proficiency. To address this, accessibility should be maximized by designing VR experiences that are intuitive and self-explanatory.

NEXT STEPS

Using the results and insights of the INTERACT project, the partners will enrich their offering and related research:

- Pharrowtech will further explore adapting their mmWave RFIC, which is currently optimized for outdoor fixed-wireless-access, to indoor AR/VR applications and requirements. After a market and cost analysis, they will start the product development.
- Dekimo has obtained IP on reusable FPGA blocks for video processing applications, and will leverage this to expand its business in AR/VR, drone, and machine vision market segments.
- Rhinox will integrate multi-user VR support into its commercial VOLT AR/VR training framework.
- TEO has identified the potential benefits of VR for specific training and safety use cases, and is now looking for partnerships to build a collaborative VR content offering.
- The academic partners are participating in a variety of EU and national follow-up projects, where they are further building on the mmWave and VR knowledge gained in INTERACT, studying mmWave sensing, haptic integration, and cybersickness mitigation.

INTERACT project partners:

The INTERACT project was co-funded by imec, with project support from Agentschap Innoveren & Ondernemen

FACTS

NAME	**INTERACT**
OBJECTIVE	Enabling interactive and immersive multi-user VR training
TECHNOLOGIES USED	mmWave Wi-Fi RFIC, FPGA-based low-latency wireless display port solution, low-latency mmWave Wi-Fi protocol optimization, VR training software, human-centric subjective user analysis.
TYPE	imec.icon project
DURATION	01/03/2022 – 29/02/2024
PROJECT LEAD	Bert Waltniel, Rhinox (Cronos group)
RESEARCH LEAD	Jeroen Famaey, imec – IDLab – UAntwerpen
BUDGET	1.968.971,16 euro
PROJECT PARTNERS	Pharrowtech, Dekimo Leuven, TEO-TRAINING, Rhinox
RESEARCH GROUPS	imec – IDLab – UAntwerpen, imec - IDLab IBCN – UGent

WHAT IS AN

IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and/or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.

CONTACT US

WWW.CONTACTIMEC.COM