Project in Informatics

Project 5

Shop Floor Co-located Collaborative Training using Large Displays & Virtual Environments

Milestone 4:

Project Presentation

THEIA

sight goddess

universidade de aveiro

deti

ieeta

Group 9

Andreia Portela 97953

Diana Siso 98607

Miguel Marques 100850

Raquel Ferreira 98323

Tomé Carvalho 97939

Supervisors

Bernardo Marques

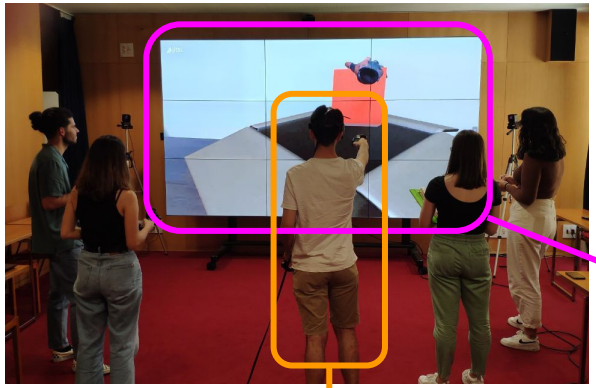
Paulo Dias

Overview/Context

- Project theme is inspired by a real-life scenario:
  - Address training procedures in a chain work scenario
- Goals:
  - Provide features for assisting trainers
  - Support trainees learning new procedures
- How?
  - Co-located Collaborative Training
  - Use of Virtual Reality (VR) & Large Displays

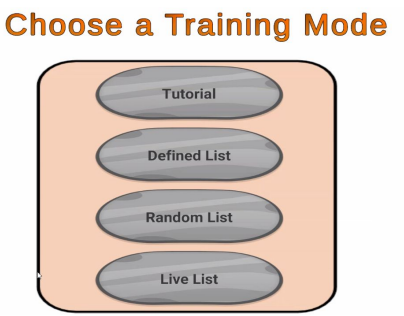
AUGMANITY
AUGMENTED HUMANITY

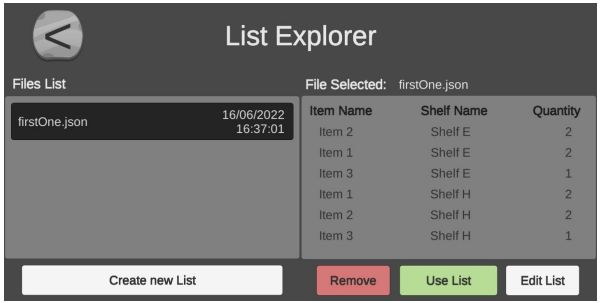
Architecture

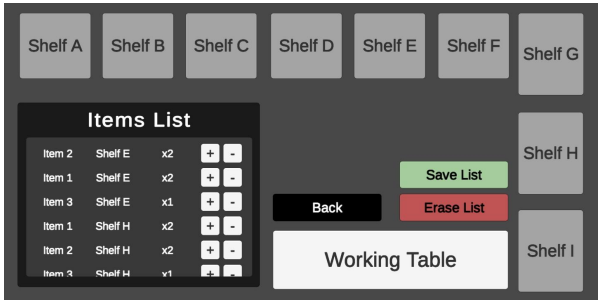


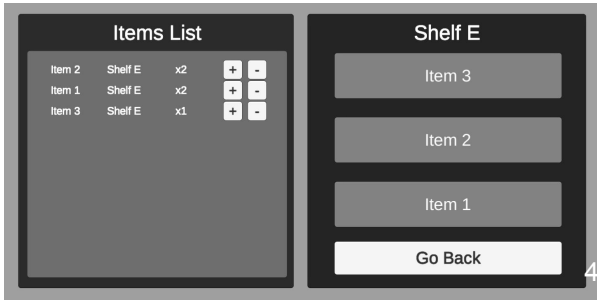
2D Interfaces

- Initial Menu
- Information and Help Pages
- Trainer Menu
- Connection Page
- Training Mode
- Score Page
- Input Trainee Name Page
- List Explorer
- List Creation Pages



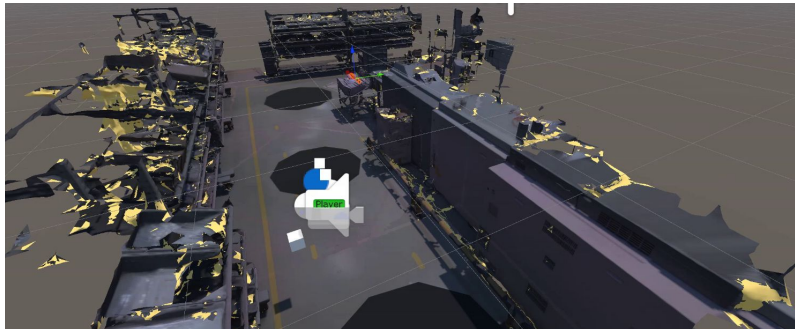


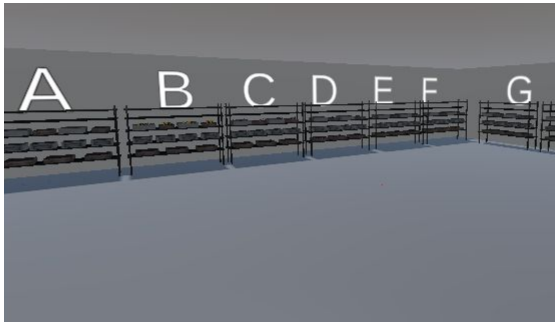


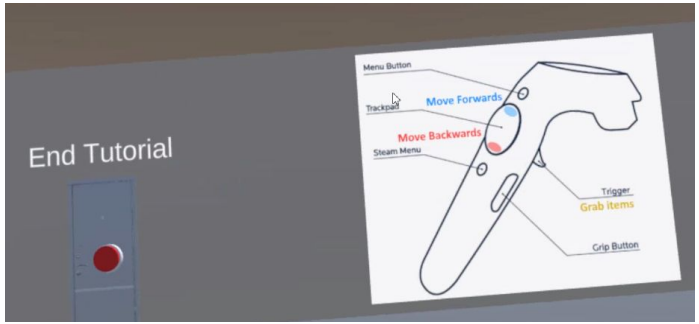


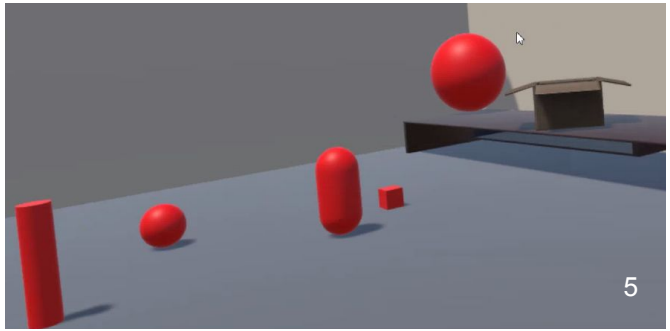
3D Interfaces (VR World)

- BOSCH Environment
- Tutorial Environment
- Virtual Environment









Virtual Environment

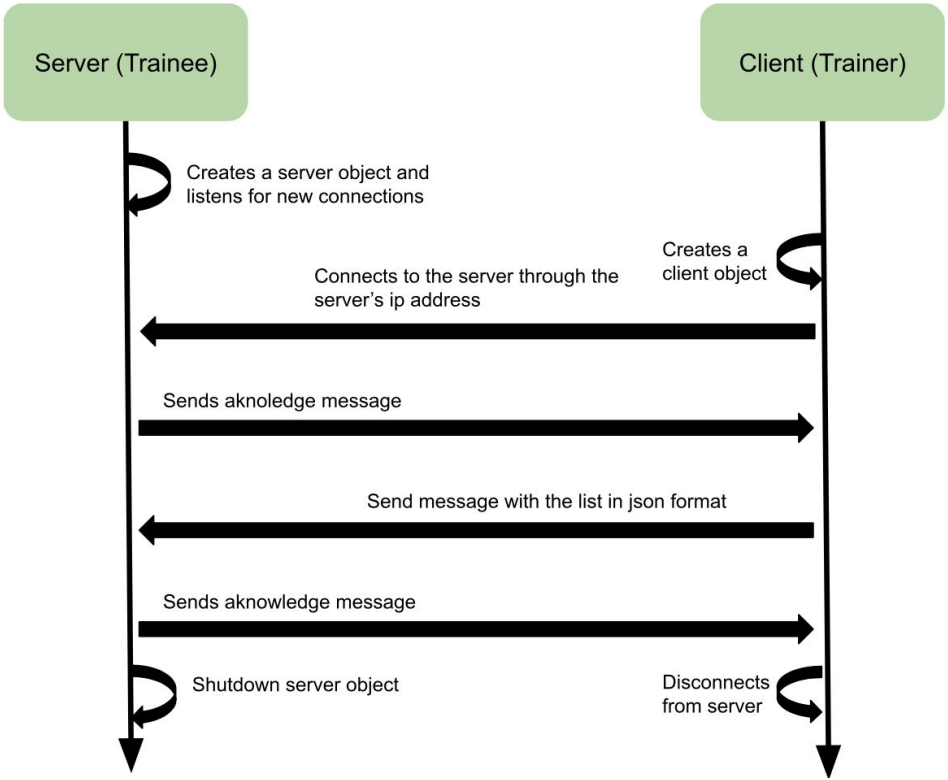
unity

Asset Store

Virtual Environment

3D Reconstruction - Bosch Environment

Trainee - Trainer Communication



- We used Network Manager from Unity to perform communication
- This system only works if the 2 devices running the applications are in the same network.
- The server only starts listening to new connections when the trainee chooses the option *Live List*

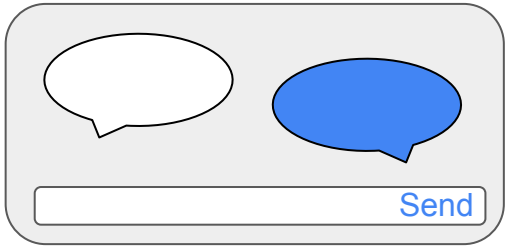
Tools

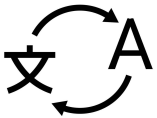
Concluding remarks

- Overall, the various milestones allowed us to iteratively address the challenges proposed;
- We created a platform allowing new operators to train in a collaborative safe environment with multiple individuals;
- Using VR allows us to provide an immersive experience, while the remaining audience can also learn from each other training sessions via de Large Display;
- Industrial companies may use such processes in the future, before moving their operators to the shop floors

Future Work

- Support chat capabilities for the audience;
- Conduct a user study - evaluate usability and preferences;
- Support various individuals using HMD simultaneously training;
- Support remote collaboration;
- Support different languages (idioms).





Poster Publication

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Supporting Multi-User Co-located Training for Industrial Procedures through Immersive Virtual Reality (VR) and a Large-scale Display

Author1 [*1], Author2 [†1], Author3 [‡1], Author4 [§1], Author5 [¶1], Author6 [‖1], Author7 [**2], Author8 [††]

[1] Institution, Country, [2] Institution, Country

Figure 1: Multi-user co-located collaboration for industrial training procedures. A trainee uses an Immersive Virtual Reality (VR) headset and controllers (A), while the remaining trainees (B) and the trainer (C) visualize and interact with the virtual content through a large-scale display, a wireless pointer (D) and a 2D tablet interface (E) for providing help and sharing suggestions.

Abstract

Virtual Reality (VR) has enormous potential to support training scenarios in the most diverse areas of application. In industry scenarios, it can allow operators to acquire new skills and higher levels of confidence before moving to real-world activities. Trainees must immerse themselves within the task space, which means using a Head-Mounted Display (HMD) to experience a virtual representation of the environment. Nevertheless, such activities are mostly isolated, removing the ability to perform training sessions in a collaborative manner with a trainer and other trainees that are learning how to perform identical tasks. This work presents a multi-user co-located training prototype based on VR, wireless controllers/pointer and a large-scale display. By using a shared immersive display, while a trainee is immersed in the VR environment, the trainer can visualize the same content and explain what to do, as well as interact, highlight areas of interest or correct possible mistakes. This enables other trainees to assist and learn from each other training sessions, better preparing themselves. As use-case, we took inspiration from a real-life collaborative scenario thanks to a research project with partners from the industry sector.

Index Terms: Multi-user Co-located Collaboration—Virtual Reality—Large-scale Display—Training;

*e-mail: author1@xyz.com
†e-mail: author2@xyz.com
‡e-mail: author3@xyz.com
§e-mail: author4@xyz.com
¶e-mail: author5@xyz.com
‖e-mail: author6@xyz.com
**e-mail: author7@xyz.com
††e-mail: author8@xyz.com

1 Introduction

Human operators experience increased complexity during everyday practices in modern industrial scenarios, compelling them to understand a variety of procedures as well as being highly flexible in these dynamic working environments [5]. In turn, such complexity also enhances the potential for errors and accidents. Therefore, the transference of knowledge to new operators is a vital process, requiring training to ensure they are fully aware of their responsibilities and how to proceed during their daily tasks [7, 8].

In such contexts, training scenarios can be described as activities planned by individuals with high expertise with the goal of helping new operators learning new skills, and obtaining additional knowledge that relate to specific useful competencies. Training activities can improve operators capability, productivity, leading to better performance in the shop floor when such individuals are introduced to their intended responsibilities [7].

This everlasting need for skilled operators leads researchers to explore more effective training methodologies [7]. This is a trending topic of Virtual Reality (VR) applications for various decades. The main purpose of such applications is to create environments based on simulations of real-life scenarios that users can immerse themselves on and being stimulated by, while providing means to navigate through and at the same time, interact with the virtual elements [2, 4, 8, 9]. This way, operators can be completely immersed in a synthetic recreation of small or larger areas of industrial, while learning new skills before advancing into the real-world activities. Using VR allows operators to practice how to perform specific activities while reducing costs and safety risks. Also, without pressure of making mistakes and being afraid of affecting production [1, 3, 6, 10].

Despite these benefits, such applications are commonly characterized for providing isolated immersive experiences. This means the ability to perform co-located collaborative training sessions with larger teams (i.e., a trainer and other trainees that are also learning how to perform identical tasks) is ignored, affecting physical relations, operators acceptance and VR environments credibility.

The main novelty is the possibility to provide training sessions that can be experienced in a collaborative manner. This way, while being immersed in the VR environment, a trainee can be supervised by its trainer, who can can visualize the same content and explain what to do, as well as interact with virtual content, highlight areas of interest or indicate possible mistakes and how to react to them. Likewise, this approach enable that other trainees can also assist and learn from each other training sessions.

Figure 2: Overview of the real-life industrial scenario that inspired the creation of the VR environment for multi-user co-located training.

This study is being conducting user studies with target-users to evaluate how they react to this type of learning approach. Plus, we intent to integrate 3D reconstructions of real-life industrial environments and situated audio for improving the level of realism of the VR experience. Furthermore, we aim to support remote collaboration as an additional feature for more complex use-cases, possibly through the inclusion of avatars.

Acknowledgments

To everyone involved in discussion groups, thanks for your time and expertise. This research was conducted under the .....

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References

[1] R. Barkokebas, C. Ritter, V. Sirbu, X. Li, and M. Al-Hussein. Application of virtual reality in task training in the construction manufacturing industry. In *Proceedings of the International Symposium on Automation and Robotics in Construction, ISARC*, vol. 36, pp. 796–803, 2019.

[2] E. Bottani and G. Vignali. Augmented reality technology in the manufacturing industry: A review of the last decade. *IISE Transactions*, 51(3):284–310, 2019.

[3] M. Juraschek, L. Büth, G. Posselt, and C. Herrmann. Mixed reality in learning factories. *Procedia Manufacturing*, 23:153–158, 2018.

[4] H. Kim, J. Young, D. Medeiros, S. Thompson, and T. Rhee. Telegate: Immersive multi-user collaboration for mixed reality 360 video. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pp. 532–533, 2021.

[5] B. Marques, S. Silva, J. Alves, A. Rocha, P. Dias, and B. S. Santos. Remote Collaboration in Maintenance Contexts using Augmented Reality: Insights from a Participatory Process. *International Journal on Interactive Design and Manufacturing, IJIDeM*, pp. 1–19, 2022.

[6] R. Palmarini, J. A. Erkoyuncu, R. Roy, and H. Torabmostaedi. A systematic review of augmented reality applications in maintenance. *Robotics and Computer-Integrated Manufacturing*, 49:215–228, 2018.

[7] D. S. Patle, D. Manca, S. Nazir, and S. Sharma. Operator training simulators in virtual reality environment for process operators: a review. *Virtual Reality*, 23(3):293–311, 2019.

[8] J. J. Roldán, E. Crespo, A. Martín-Barrio, E. Peña-Tapia, and A. Barrientos. A training system for industry 4.0 operators in complex assemblies based on virtual reality and process mining. *Robotics and computer-integrated manufacturing*, 59:305–316, 2019.

[9] C. Siedler, M. Glatt, P. Weber, A. Ebert, and J. C. Aurich. Engineering changes in manufacturing systems supported by ar/vr collaboration. *Procedia CIRP*, 96:307–312, 2021.

[10] X. Wang, S. K. Ong, and A. Y. Nee. A comprehensive survey of augmented reality assembly research. *Advances in Manufacturing*, 4(1):1–22, 2016.