Digitalising and Enhancing Procedures: The Mixed Reality System for Operation, AIT/AIV Support and Reporting

Kaj Helin[1], Jaakko Karjalainen[1], Paul Kiernan[2], Gianluca Casarosa[3],
[1]VTT Technical Research Centre of Finland Ltd, Tampere, Finland
[2]SKYTEK Ltd, Dublin, Ireland
[3]ESA – European Space Research and Technology Centre (ESTEC), Noordwijk, The Netherlands

Abstract

This abstract presents an approach towards digitalizing and enhancing operational procedures within the Test Centre of the European Space Agency (ESA) by exploiting Mixed Reality (MR) systems. The first phase, known as "VirWAIT - Virtual Workplace for AIT & PA Training and Operations Support" [1], focuses on developing the VirWAIT MR system, which was built on the MS HoloLens 2 mixed reality platform. This system serves as a novel user interface integrated with the ESA Mobile Procedure Viewer system called mobiPV, which database has been expanded with MR capabilities. The MR system was tested in two main uses cases 1) installation of thermocouples on an Heat Plate used as GSE for the Solar wind Magnetosphere Ionosphere Link Explorer – *SMILE*, and 2) phase 2 sensor installation on *TEDY (TEst DummY)* for a vibration test campaign on the Hydra facility (see Figure 1). The MR system was preliminary tested for the configuration of the JUpiter ICy moons Explorer's (*Juice*) Network Data Interface Unit (NDIU) in preparation to the Thermal Vacuum test campaign [1].

Figure 1. The VirWAIT use cases. Left: Thermocouples installation to SMILE. Right: Sensors installation to TEDY.

Building upon the success of VirWAIT MR, the second phase, the project called "DPIAR-V1 - Digitalisation of Procedure and Introduction of Augmented Reality (Step 1)" [2], represents a continuation of the ESA's MR use cases and development. The project outcome was a complete end to end solution for the authoring (off- and on-site), deployment and usage of MR to support execution of manual procedures and operations within the Test Centre of the European Space Agency. The MR procedure execution application, currently deployable on HoloLens2 devices support access to deployed procedures, execution and viewing of details instructions with MR support such as annotation display, Point-of-Interest highlighting, multimedia support and STAMP sensor information. DPIAR-v1 also supports the gathering of details logging (see Figure 2 - left) and multimedia steaming information during the procedure execution. Remote observation supports both live remote viewing and following on session, and saved streams review. The archived streams can be searched for and accessed via e.g. Procedure number, Procedure identifier, Date/Time of test campaign/procedure, Sensor identifier, …

The DPIAR-V1 MR system has been tested in two main uses cases 1) *Large Space Simulator* – Basement procedure (see Figure 2), and 2) *Vacuum Test Chamber* - Operating Procedure and Pre-operation, showcasing its adaptability and efficacy across diverse operational scenarios [2].
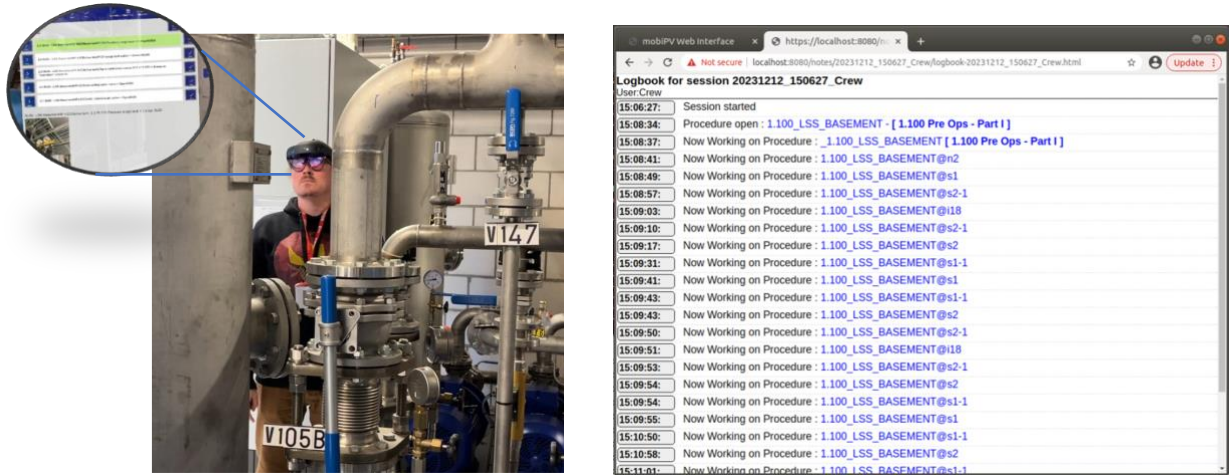

Figure 2. The MR systems in use during procedure execution (LSS- Basement procedure) and its automatic reporting.

The DPIAR-v1 system offers a notable advantage due to its optimized operational workflow, which enables the reduction of the MR procedure authoring time. This is achieved through a combination of semi-automated off-site procedure template and intuitive on-site authoring methods via HoloLens 2. These features streamline the preparation and modification of procedures, thereby playing a crucial role in facilitating the deployment of MR technology in daily operational activities.

Through the continuation by VirWAIT and DPIAR-V1 projects, the Test Centre Division of the European Space Agency highlights its strong interest in applying MR technology to maintenance and operation procedures of Test facilities, but also to training of operators and where possible to AIT tasks. Videos documenting the development and outcome can be found in the Appendix.

APPEDIX

Video during VirWAIT development (2021): https://youtu.be/gefrH8EJXWU?si=2B7dchjDbz44T_3i

Video of DPIAR-v1 (2024): https://www.linkedin.com/posts/kaj-helin-8523a62_spacetech-xr-ar-activity-7157658812429086721-nABe?utm_source=share&utm_medium=member_desktop

REFERENCE

[1] Helin, K., Karjalainen, J., Kuula, T., Kiernan, P., Casarosa, G., & Oliveira, D. M. (2021). *The Mixed Reality System for AIT/AIV in Space Domain – The Remote User Test of the First Integrated Prototype*. Abstract from 4th International Conference of Aerospace and Aeronautics , Valencia, Spain.
[2] Helin, K., Karjalainen, J., Kiernan, P., & Casarosa, G. (2023). *Digitalisation of Procedure and Introduction of Augmented Reality*. Abstract from ESA- AR/VR for Space Programmes 2023, Noordwijk, Netherlands.