Evolvement of Augmented Reality System for AIT/AIV and Orbit Operations – Four Use Cases

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Abstract

In this work we introduce a development and evolvement of augmented reality (AR) system for AIT/AIV and orbit operations. Development has been done is two ESA contracts and a H2020 project, and system has been evaluated in four use-cases (see Figure 1). VTT has been the main AR system developer in all contracts.

The first use case was done in ESA contract called "EdcAR[1] - Augmented Reality for Assembly, Integration, Testing and Verification, and Operations" and use case was AR-based Centralized Cabin Filter Replacement in ISS and the test group included 14 subjects. The second and third use cases was developed and evaluated within the Horizon 2020 project "WEKIT[2] — Wearable Experience for Knowledge Intensive Training". In the second use case had 17 persons test group and task was AR-supported installation of Automated Transfer Vehicle in ISS. The third use case was Rover Maintenance in Mars/Moon Terrain Demonstrator and 199 subjects were testing the system for 6 months period. The last use case, Life support box B4 error repair, was developed and evaluated within ESA contract called "MobiPV4Hololens[3] - Prototype a Media Helmet for MobiPV Implemented Using MS HoloLens". It was evaluated with 5 test subjects.

2016 - Augmented Reality for AIT, AIV and Orbit Operations (ESA-EdcAR)

2017 – AR supported installation of the Temporary Stowage Rack in the ISS (WEKIT)

2018 – AR based Rover Maintenance in Mars Terrain Demonstrator (WEKIT)

2019 – MobiPV procedure viewer to Hololens (ESA-MobiPV4Hololens)
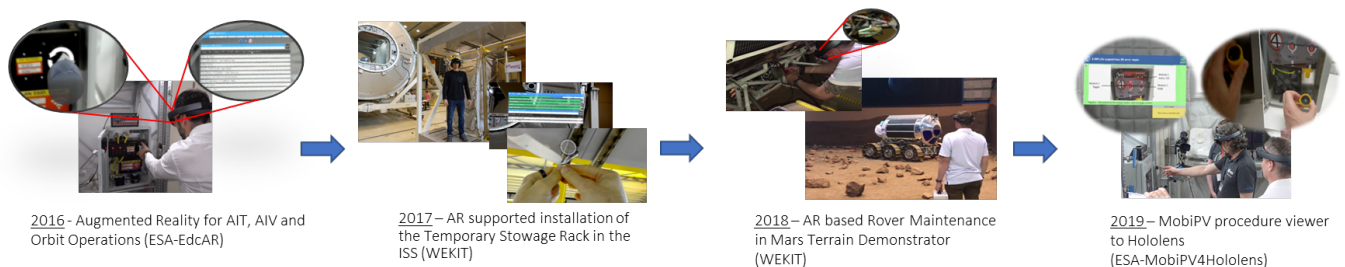
Figure 1. Development and evolvement of AR system for AIT/AIV and orbit operations

AR system has been updated after each use case based on the user feedback and expert evaluations. Following main updates and improvements has been implemented: (1) list and card type of user interface, (2) user guidance to augmented annotations, (3) interaction concept (voice command, gestures and button), and (4) and sensor interface and visualization.

After the third use case evaluation, the system usability of the AR system was reached the range of acceptable as System Usability Scale (SUS) was 69. This result encouraged to implement AR-system to astronauts procedure viewer (MobiPV) even all AR-features wasn't supported.

As the AR-system has been already partially implemented to the space system and its usability has reached a reasonable level, it can be suggested that the AR-system is potentially a useful tool for supporting and facilitating AIT/AIV and operations, even though the tool is still in prototyping phase.

Note, as the work has been done in several projects and partners. Contributors of each case will be highlighted during presentation.

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[1] The European Space Agency contract 4000113373/15/NL/MH "Augmented Reality for AIT, AIV and Operations"

[2] The European Union's Horizon 2020 research and innovation programmes project WEKIT under grant agreement No 687669

[3] The European Space Agency contract 4000125238/18/NL/AF/as "Prototype a Media Helmet for MobiPV Implemented Using MS HoloLens"