Towards the generation of real-time Digital Twins with the press of a button

James Wheeler[1], Franco Chen[1], Sean Walsh[1], Paulo Sacramento[1], Anatole Deligant[2], Bertrand Le Saux[2], Apolline Horn[2], Pierre Philippe Mathieu[2]

[1]Solenix Engineering Italia SRL, Frascati, Italy [2]European Space Agency, ESRIN, Frascati, Italy

Technical Themes:

Reduction of the AR/VR scenarios preparation time; Interfaces between AR/VR and other systems

Since 2018, the ESA Φ-lab has been active in VR/AR development [1], both in-house and with partners, having deployed a number of VR experiences and managed several external projects related to different aspects of the technology, including, more recently, Digital Twin demonstrators. One of these projects, DTUP (Digital Twin Urban Pilot), aimed at creating a textured digital surface model of the local town of Frascati, starting from a comprehensive UAV imagery campaign, Sentinel imagery, and ancillary information from IoT sensors and local infrastructure datasets from the municipal government. DTUP also delivered a UAV survey of ESRIN and this, together with an older UAV survey from 2018, allowed the generation of two 3D models of the ESRIN site using photogrammetry techniques. These two models were then exploited to build the first protoype of Digital Twin ESRIN (DT-ESRIN)[2], the first one suitable of being experienced with a general purpose VR headset. The ESA Φ-lab has further enhanced the DT ESRIN model with live IoT data relating to air quality and vegetation health parameters, as well as with an internal high resolution scan of the Φ-Lab building itself by AmbiensVR[3] (the Φ-Lab digital twin) including mapped audiovisual content.

The future vision is to build a pipeline for semi-automated digital twin generation, starting from high resolution UAV RGB images, typically available as sets of JPG images with EXIF metadata. The system would deliver a full drone to XR experience with minimal human interaction, as follows:

1. Press of a button to start pipeline
2. Triggering of automated drone deployment to survey a predefined AOI with appropriate sample density and accurate georeferencing
3. Generation of textured surface model from the collected images using photogrammetry and such techniques, calibrating automatically to a baseline DSM
4. Import of 3D model to an appropriate 3D engine and building or updating an XR experience that is integrated with in-situ data sources

This pipeline could be automated to repeat itself without human interaction, triggered for example by changes in IoT sensors (e.g. fire detection). Our intention is to work with open source software (opendronemap, blender, o3de) where possible. It is also envisaged to prototype the use of Earth Observation (EO) datasets from VHR sensors to both generate standalone textured DSMs as well as adding information to existing models.

References

[1] P. Sacramento, S. Loekken, P.P. Mathieu, The Virtual Reality activities of the ESA Φ-Lab, *AR/VR for European Space Programmes Workshop*, ESA/ESTEC December 2019

[2] P. Sacramento, A. Deligant, S. Loekken, P.P. Mathieu, EO space and multi-source data visualization using Virtual Reality in the ESA Φ-Lab, *2022 IEEE International Workshop On Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering (MetroXRAINE)*

[3] https://www.ambiensvr.com/