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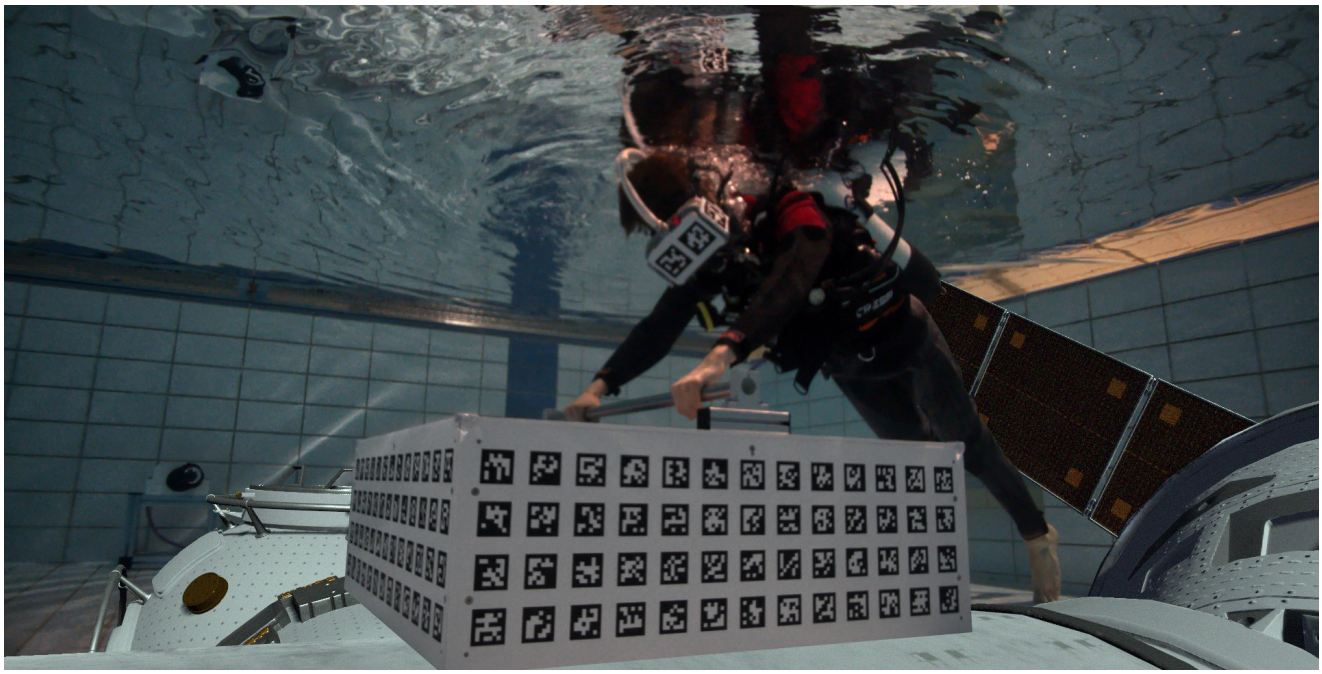

Underwater VR for Astronaut Training

Executive summary

Activity type: study

New ideas to make XR a reality

Informatics XVII – Robotics, Julius Maximilian University of Würzburg, Germany

Activity summary:
This research integrates a complete diving mask with a custom-made VR headset to replicate a space-like setting. Alongside designing and building a waterproof VR headset, a pivotal aspect involves implementing a tracking system to ascertain spatial positioning and orientation. Employing an external tracking system, comprising four cameras housed underwater and affixed to aluminum rails this is achieved using fiducial markers.

→ THE EUROPEAN SPACE AGENCY

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Executive summary

Pools are excellent places for testing many nautical technologies, as well as training divers or astronauts in simulated weightlessness. However, for extensive astronaut training underwater, a large pool is necessary. NASA's Neutral Buoyancy Laboratory (NBL) is an astronaut training facility located at the Sonny Carter Training Facility near the Johnson Space Center in Houston, Texas, and contains 23 million liters of water. The NBL contains a full-scale mock-up of the International Space Station to train astronauts for spacewalks, including tool handling or rescue tasks. In Europe, Blue Abyss Ltd. is currently building the world's largest and deepest indoor pool in Cornwall, also having space applications in mind. A virtual reality (VR) solution supports astronaut training and overcomes the need for large pools, as the space environment can be well-simulated in VR.

This study combines a full-face diving mask with a custom-built VR headset for simulating a space environment. Besides constructing a watertight VR headset, a tracking system to determine the position and orientation in space plays an important role. We use an outside-in tracking system consisting of four cameras in underwater housings, mounted on aluminum rails, covering a 2$\times$3.5 m experimental area, which enables tracking of reference markers placed on the underwater VR diving mask.

For calibration, a rectangular cuboidal structure with reference markers is placed in the experimental area, which additionally serves as a handrail to perform basic Extra Vehicular Activity (EVA) tasks. The position tracking of the underwater headset and mirroring of physical objects in VR enables the user to move physically in the virtual environment and interact with the physical objects, such as the handrail. Due to the underwater environment, refraction at the different media interfaces needs to be considered for both calibration and tracking.

A VR experience of a spacewalk at the planned Lunar Gateway was successfully demonstrated in a pool using the proposed underwater VR system.

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