

Augmented Reality Tool for Operationally Relevant 3D Sensorimotor Assessments

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EXECUTIVE SUMMARY

Augmented reality (AR) operational tools have been considered for lunar and Martian missions; however, limited to no AR medical assessments have been developed. Due to limited or delayed communication with ground support for Artemis, Gateway, and beyond, a new level of crew autonomy is required. Sensorimotor disturbances are at their highest following gravitational transitions where a self-assessment tool could help inform crew capabilities prior to completion of operational tasks. Therefore, the purpose of this project was to extend the existing capabilities of an AR sensorimotor assessment tool to develop a 3-dimensional (3D) task mimicking the full body mobility and coordination required to perform surface/planetary Extravehicular Activity (EVA).

INNOVATION

This project leveraged the *Augmented Reality Operations Readiness Assessment* (AURORA), a toolkit that provides operationally- and clinically-informed sensorimotor assessments. This project has expanded the toolkit with the following novel features:

- A new 3D target acquisition task that simulates operational aspects of a Lunar surface EVA (e.g., geology sampling)
- Requires greater body posture range of motion during target acquisitions
- Extends interaction sequences (i.e., 9 target selections)
- Novel scene-to-room calibration leveraging embedded sensors
- Newly integrated metrics of performance (e.g., path ratio index)

COLLABORATION

The project was completed within the Neuroscience Laboratory. The project outcome can enhance capabilities for research studies currently funded by the NASA JSC Human Research Program (HRP). After further validation studies under multiple space analogs (e.g., parabolic flight), this assessment could be used by flight surgeons (SD) and crew (CB) in future flight missions as a space-conscious AR assessment tool.

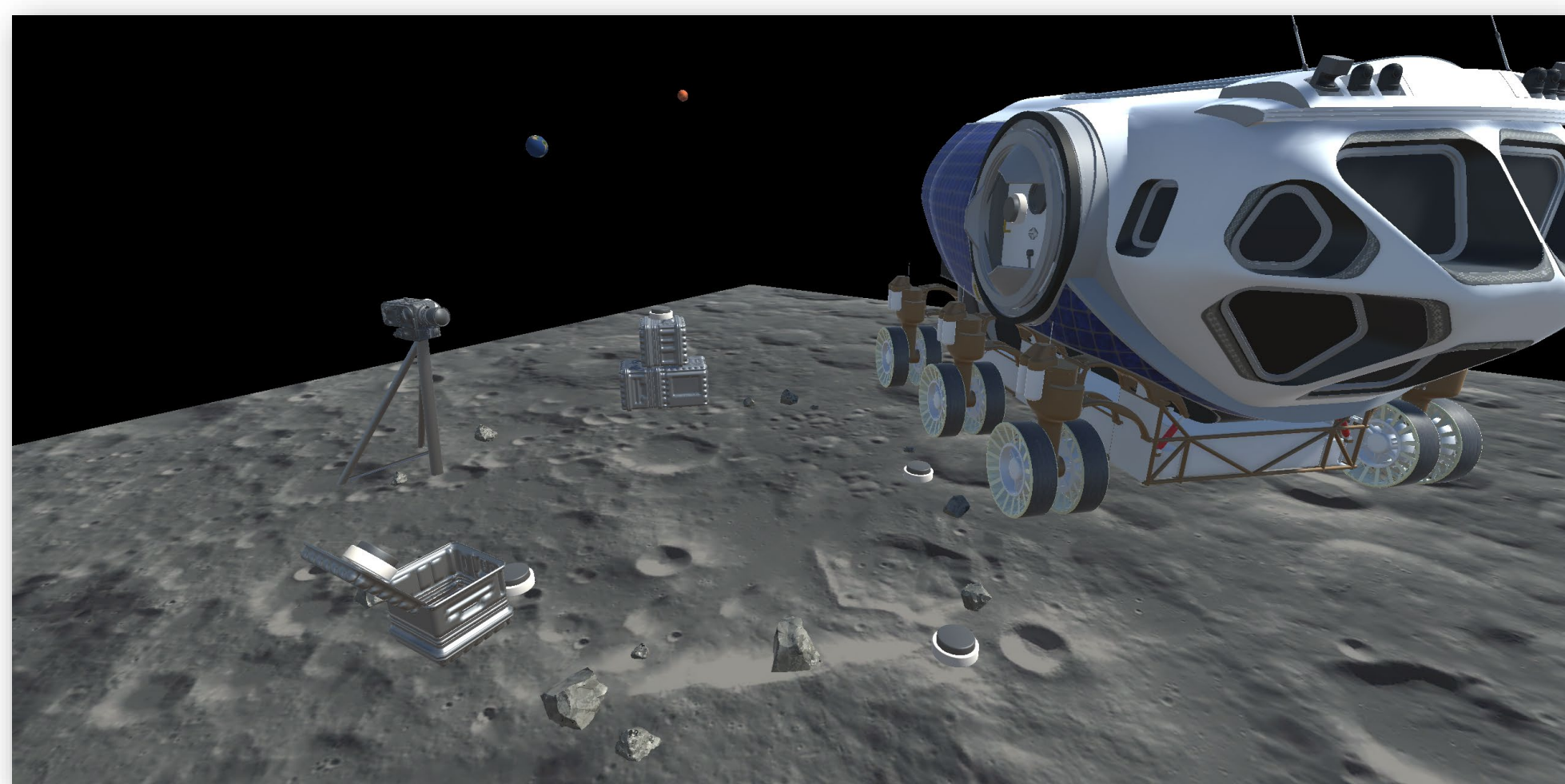


Figure 1: 3D operational assessment Lunar scene and target buttons

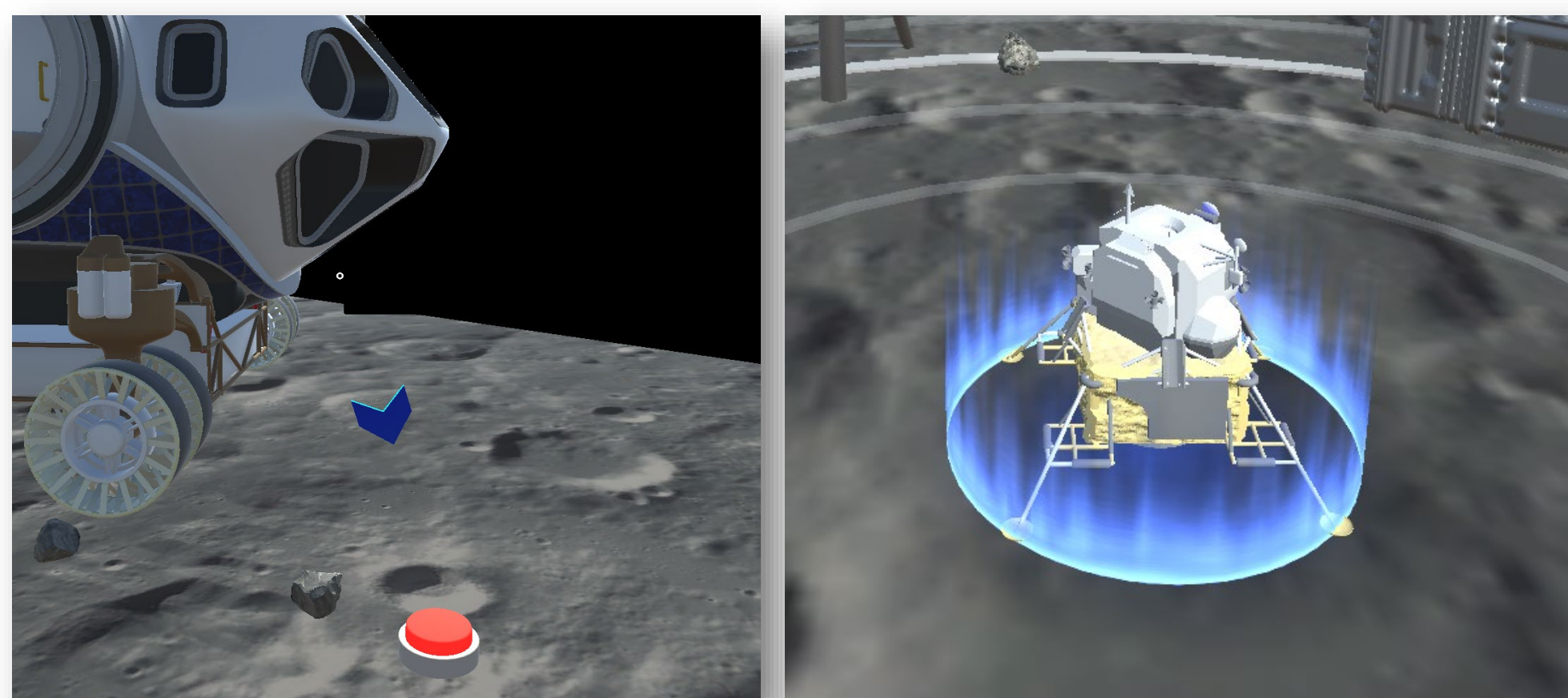


Figure 2: Assistive visual cues to help orient to targets outside of user's field of view (left). Novel scene-to-room calibration method (right).

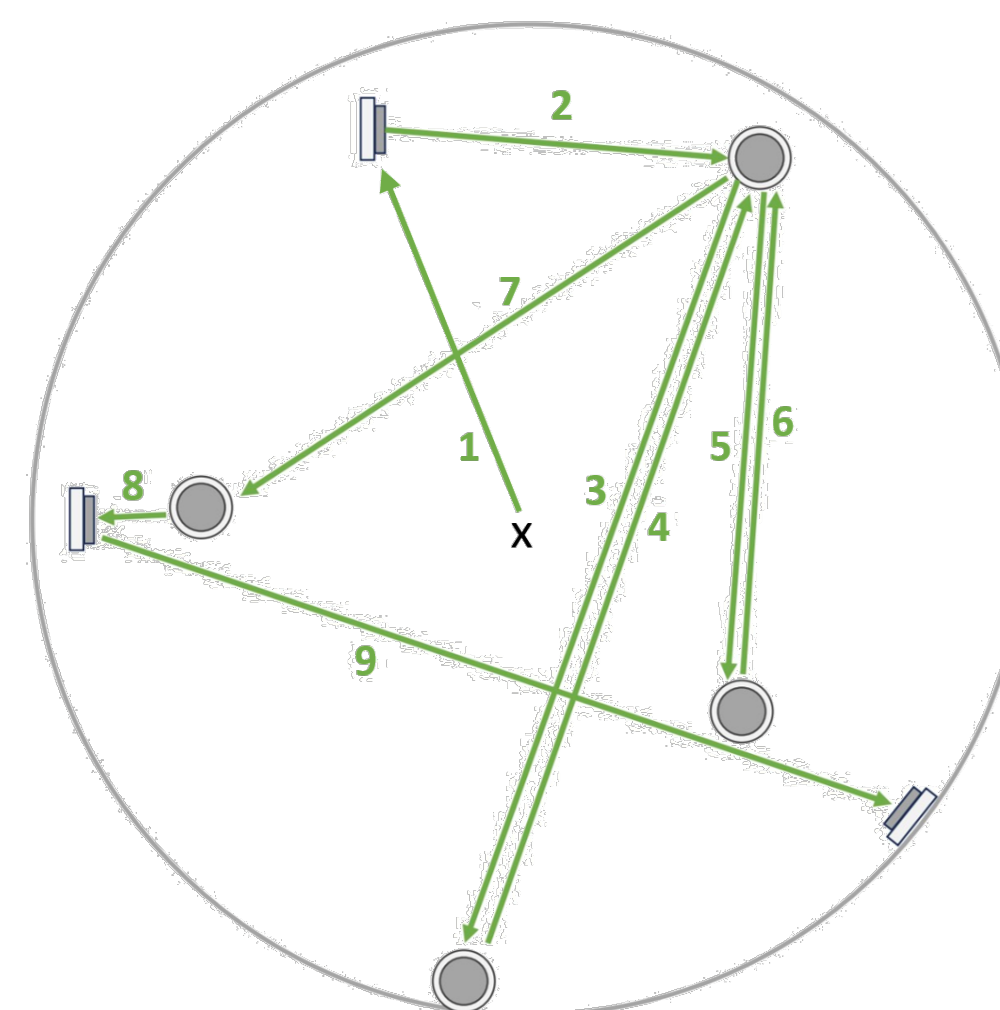


Figure 3: Top-down view activation pattern (left). User summary metrics (right)

OUTCOMES & INFUSION

The final product was a standalone application to evaluate dynamic balance and eye-hand-body coordination in a 3D framework. The following milestones were completed:

1. Developed a Lunar environment with holographic targets (**Figure 1**)
2. Developed visual and auditory assistive cues (**Figure 2**)
3. Developed an algorithm to generate target activation patterns (**Figure 3**)
4. Developed an algorithm for embedded sensor logging and on-board calculation for post-trial summary metrics (**Figure 3**)
5. Developed a time-independent metrics of performance (**Figure 3**)
6. *New milestone: Integrated effortless and consistent scene-to-room calibration and head calibration for post-trial summary metrics (**Figure 2**)

Internal pilot testing on individuals (n = 10) with no or minimal experience with AR or the HoloLens environment was completed. The results were as follows:

- All users were able to successfully interact with the HoloLens environment following initial instructions from project team.
- Users were able to complete the task with only onscreen direction.
- Instructions and task objectives were deemed intuitive.
- Scene-to-room calibration was reported as straightforward.
- Visual cueing during the task was constructive and essential for task completion.
- Additional auditory cueing was requested for head calibration instructions.
- Updates to the user-interface screens and calibration sequences were informed by pilot testing results.

FUTURE WORK

There are various future pathways of work for 3D assessment:

1. Integrate the assessment into a NASA HRP-funded study
2. Integrate a visual disruption to mimic postflight performance to enhance ground based sensorimotor disruption analogs
3. Validate AR sensorimotor tasks in lunar G through parabolic flight or other spaceflight analogs (e.g., Active Response Gravity Offload System)
4. Develop additional metrics of performance