TBD

Lunar Rover Motion-Based Simulation System

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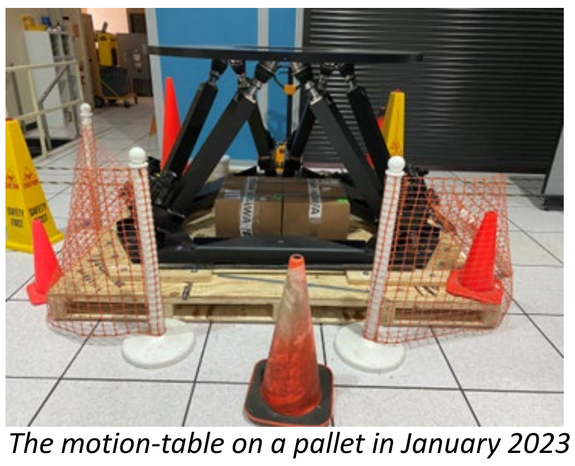
EXECUTIVE SUMMARY

Our team developed a motion-based simulation system for lunar terrain vehicles which resides at Johnson Space Center's Systems Engineering Simulator (SES) facility. This activity integrates existing fixed base simulation capabilities with a newly procured motion base platform for the design, development, evaluation, and training associated with lunar terrain vehicles. This incorporates a South Pole Lunar virtual reality simulation, combined with a pair of VR headsets, integrated within a rover cockpit on a motion platform for evaluating human performance and vehicle handling qualities for concept roving vehicle designs for surface mobility operations.

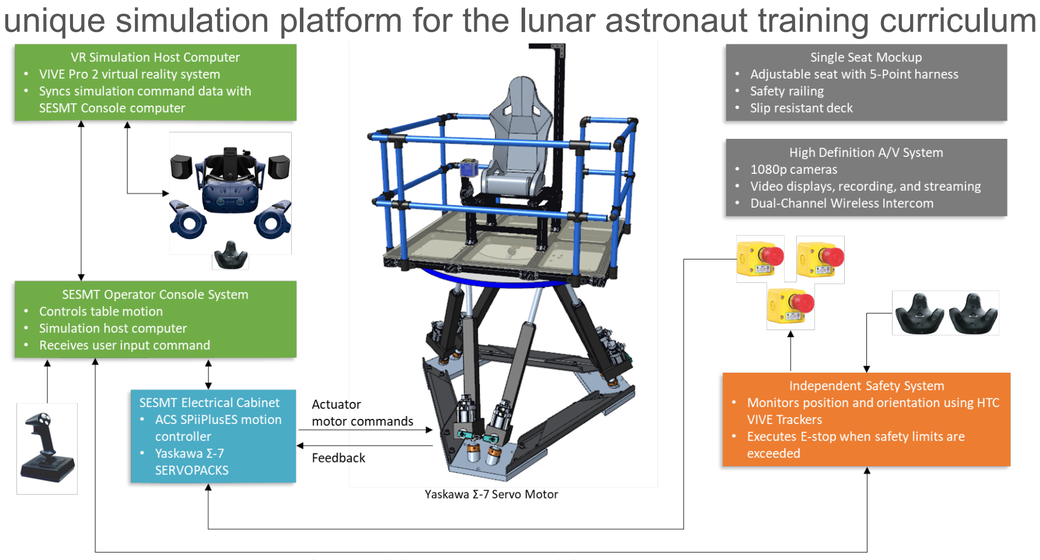


The motion-table on a pallet in January 2023

The finished NASA motion table system

INNOVATION

Motion and visual cue influences are critical in any simulator system, as they impact multiple aspects of the human's neurovestibular and visual systems. As of this writing, the only lunar rover motion simulator is housed at the General Motors (GM) Milford Proving Ground, which only simulates the motions of a traditional car. A NASA Test Team completed a motion-based simulation system for NASA's Lunar Terrain Vehicle (LTV). This activity integrated existing fixed base simulation capabilities with a newly procured six-degree of freedom motion platform with a South Pole Lunar virtual reality simulation using Lunar Reconnaissance Orbiter 1m/pixel high-resolution imagery. The motion-based system received its Human Rating Certification on March 2023. The capability this system provides directly benefits the NASA's Extravehicular Activity and Human Surface Mobility Program and NASA's Flight Operations Directorate in evaluating the driving qualities of vehicle concepts, human performance related to the operating of a lunar surface vehicle, and assessment of suit related driving impacts. It would also provide direct operational benefit by providing a first-in-class and unique simulation platform for the lunar astronaut training curriculum.



NASA's JSC SES motion table architecture

COLLABORATION

Below is a list of collaborators who without them this motion-based simulator could not have been developed.

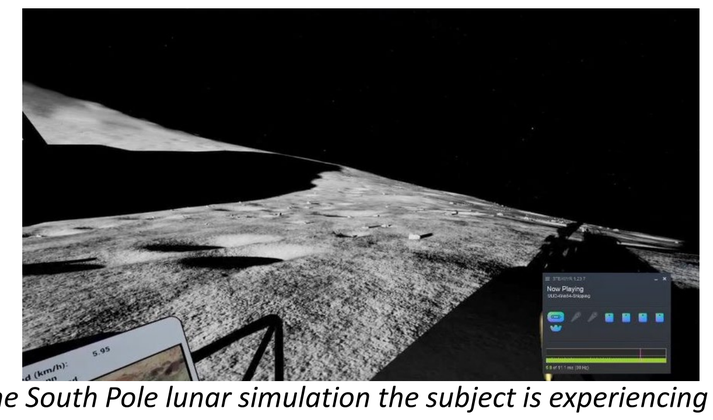
1. JSC's Automation and Robotics Systems, Simulation, and Graphics Branch
2. NASA's Extravehicular Activity and Human Surface Mobility (EHP) program
3. JSC.s Center for Design and Space Architecture (CDSA)

OUTCOMES & INFUSION

The outcome of the innovative project.

1. Successful development of a washout algorithm to synchronize the motion-base with new visual simulation graphics
2. Developed a motion-based architecture
3. Developed facility, training, maintenance, operations, and medical System Operating Procedures (SOPs)
4. Received a Human Rating Certification for a single seat cockpit
5. Developed first full lunar simulator to be used for lunar design since the Apollo Lunar Roving Vehicle (LRV) simulator
6. Developed first standard road test track for lunar vehicle handling qualities
7. System went from a TRL 4 to a TRL 5 in less than seven months
8. Possible future collaborations with the JSC Counter Measures team and the Human Landing System team

A test driver during the handling qualities study

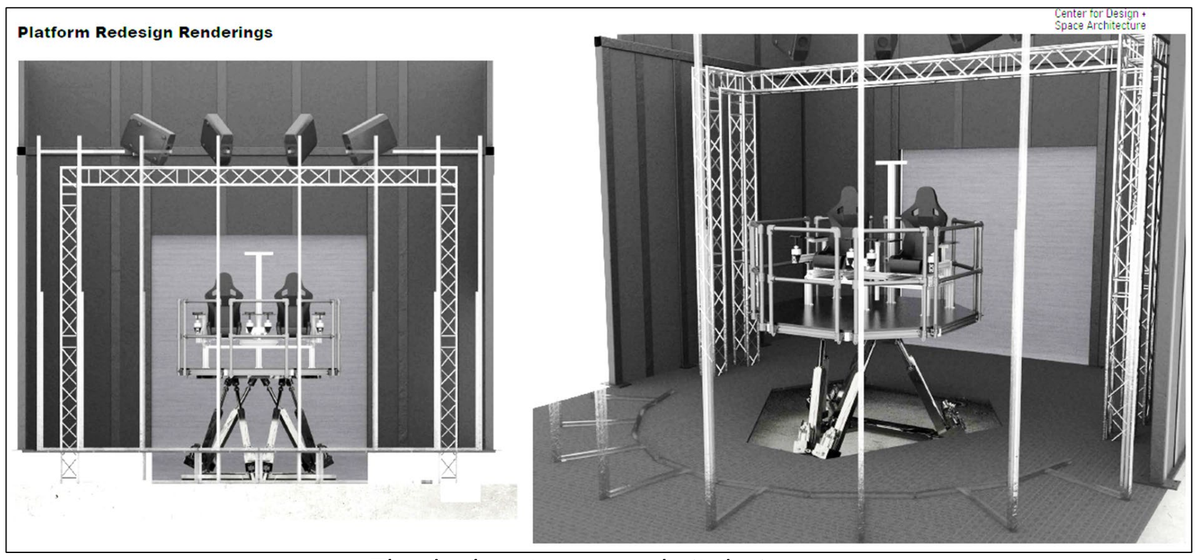


The South Pole lunar simulation the subject is experiencing

FUTURE WORK

Future work, pursuits and next steps

1. Design, assemble, and integrate a dual seat rover cockpit
2. Provide a projection or monitor system for the motion-based system
3. Integrate the dual T-Handle Controller
4. Integrate the innovative Tri-Rotor Controller
5. Refine the motion table's washout and calibration techniques
6. Test new cockpit on motion table with a rover handling qualities refined testing protocol



The dual seat rover cockpit design

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