National Aeronautics and Space Administration

A Virtual Reality Stereo Viewer Application for Improved Operational Efficiency on Mars Rover Missions

Principal Investigator: Jacqueline Ryan (398); Co-Investigators: Lauren Gold (Arizona State University)

Program: FY22 R&TD Innovative Spontaneous Concepts

Objectives:

- Develop a Virtual Reality (VR) product for stereo panoramic viewing.
- Facilitate better situational awareness of planetary surface environments.
- Design comfort features for various user Inter-Pupillary Distances (IPD).
- Render 3D object overlays (rover, traverse path) on stereo panoramas for safety and suitability assessment of robotic activities.

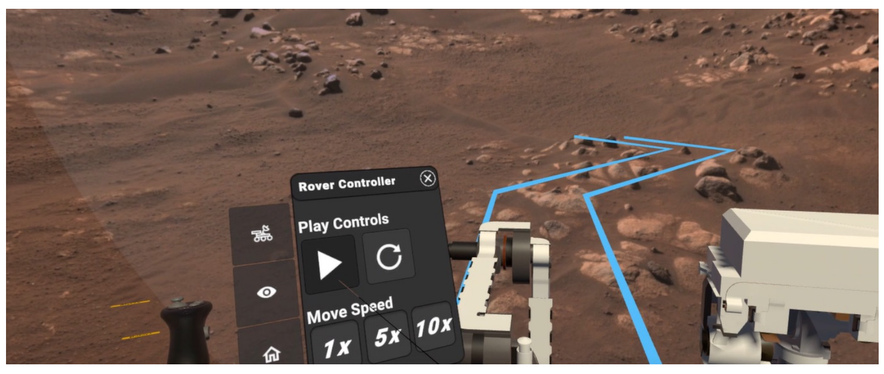

Figure 1. Screenshot of the user interface panel.

Background: VR technology provides bright, high-fidelity image views and allows users to move their heads for an intuitive understanding of image panoramas. This is an innovation on previous stereoscopic viewing technology, such as NVIDIA shutter glasses used in RSVP Qard [3], but requires new rendering techniques to account for the flexibility of 6 degree of freedom (6 DoF) head motion when using an HMD.

Approach and Results:

The source image data was stitched a priori using the Cylindrical Perspective Hybrid Projection (CPHP) also know as Equi-angular Projection (EAP) [1][2]. CPHP provides an excellent stereo effect at the expense of greater disparity at the poles, while also providing detail around the equator. A VR application was built in the Unity 3D game engine and the stitched imagery was rendered onto a skybox, a special type of geometry that functions as a “background” in a scene.

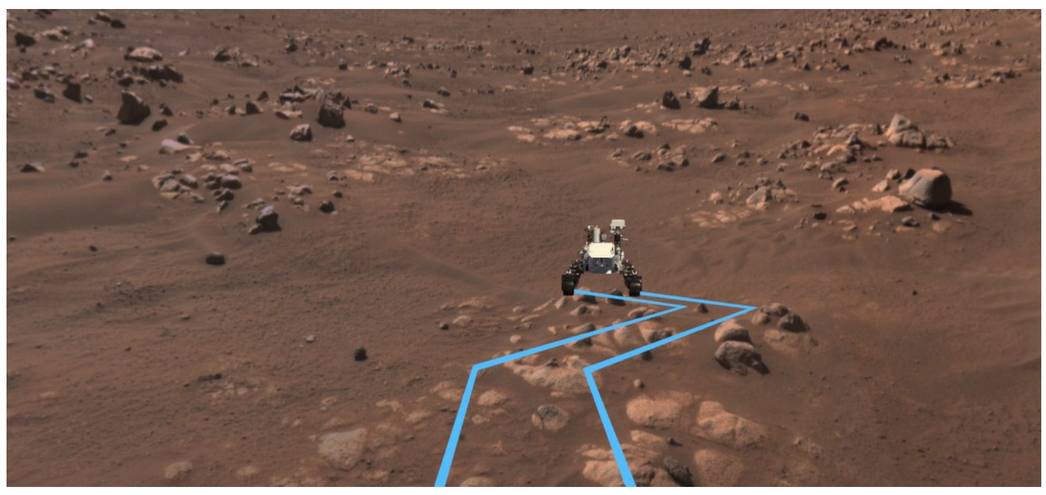

Figure 2. Screenshot of the application with the rover 3D overlay.

Significance/Benefits to JPL and NASA: This work created a stereoscopic visualization that facilitates a better understanding of planetary environments for the purpose of assessing the safety of complex rover motion activities. Applies to rover operations on MSL and Mars 2020, as well as sample depot assessment on MSR where traditional mesh techniques do not apply.

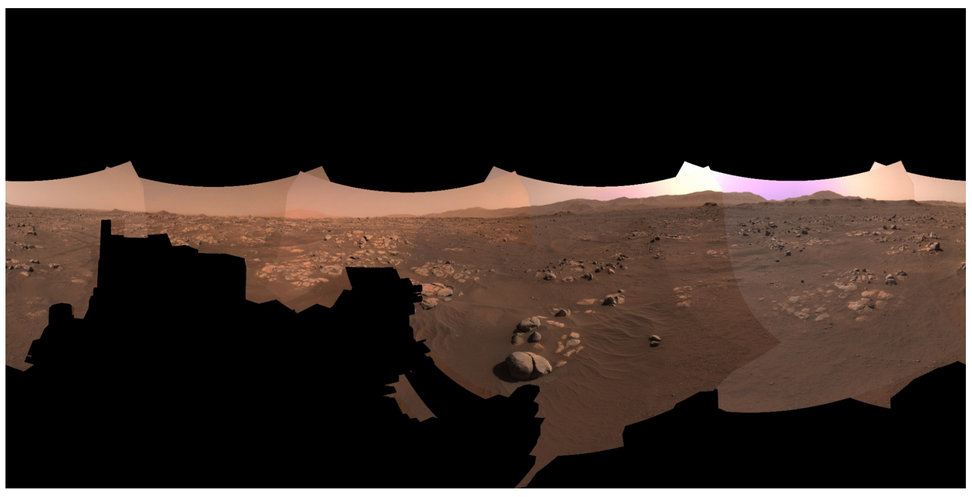

Figure 3. CPHP Mosaic with sample data from Sol 99 of the Mars 2020 Rover mission. Rover hardware is masked to eliminate distracting parallax effects between camera eyes.

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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

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[2] Z. Chen, Y. Li, Y. Zhang, “Recent advances in omnidirectional video coding for virtual reality: Projection and evaluation,” 2018 Signal Processing,Volume 146, Pages 66-78, doi: 10.1016/j.sigpro.2018.01.004.
[3] F. R. Hartman, J. Wright and B. Cooper, "The evolution of three dimensional visualization for commanding the Mars rovers," *2014 IEEE VIS International Workshop on 3DVis (3DVis)*, 2014, pp. 51-54, doi: 10.1109/3DVis.2014.7160100.
[4] T. Marrinan and M. E. Papka, "Real-Time Omnidirectional Stereo Rendering: Generating 360° Surround-View Panoramic Images for Comfortable Immersive Viewing," in *IEEE Transactions on Visualization and Computer Graphics*, vol. 27, no. 5, pp. 2587- 2596, May 2021, doi: 10.1109/TVCG.2021.3067780.

PI/Task Mgr. Contact Information:
Email: jacqueline.ryan@jpl.nasa.gov