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A Collaborative Data Integration and Visualization Platform for Planetary Exploration:The Mars 2020 Campfire and Mars Mission Minder

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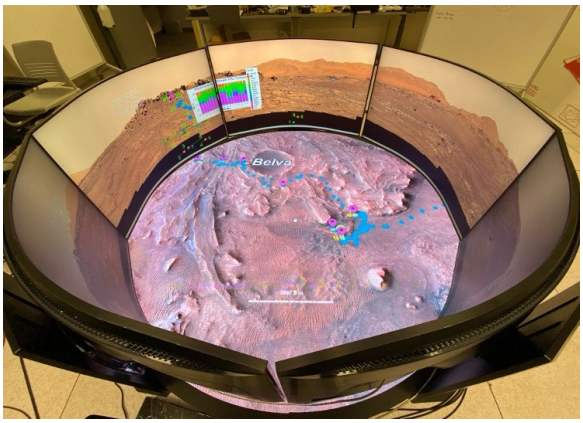

The Mars Perseverance Rover is critical to a decades-long investigation of Mars' habitability and NASA's Mars Sample Return campaign. The Perseverance instrument payload, including SHERLOC, LIBS, and PIXL, is capturing an unprecedented wealth of data about Mars' surface. We introduce two new tools for data exploration and analytics. Firstly, we apply the Rensselaer Campfire, a multi-user, collaborative, immersive computing interface, to facilitate interactive data analytics with real-time, publicly-available planetary observational data. "Mars 2020 on the Campfire" transcends traditional data presentation methods by integrating a geolocated, multi-faceted dataset atop an interactive map of the rover's journey. Secondly, through a course-based data analytics research program, we have engaged undergraduate teams to develop an interactive application, the "Mars Mission Minder", which enables data exploration on personal computing platforms. Both the Campfire and Mars Mission Minder can be shared interactively and virtually across institutions.

The Campfire [1,2] is a desk-height, six-foot panoramic screen and floor projection (Figure 1), connected to two large displays that host data analytics content. The system integrates high-resolution panoramic and aerial imagery, and 3D terrestrial models with instrument data. The Mars Mission Minder is an interactive app that allows users to choose data sets and analytical techniques based on a suite of scientific questions. By leveraging cutting-edge data analytics and sophisticated visualization tools, our project offers a comprehensive, intuitive data exploration. Participating scientists can select data by geospatial location, sampling metadata category, or even PIXL, LIBS, and SHERLOC data class. The data analytics platform allows users to explore the relationship between organic compounds, mineralogy, and inorganic compositions. Results highlight mineral/organic compound co-location, and enable prediction of most likely locations for abiotic organic synthesis. Integrating a comprehensive data analytics suite emphasizes analytical rigor with dynamic visualizations. This platform enables hypothesis testing and can accelerate discovery, foster cross-disciplinary collaborations, and serve as an example for ongoing and future astrobiology and planetary science missions.

[1] EL Ameres, Ph.D. diss., RPI, USA, 2018; [2] EL Ameres and GP Clement, U.S. Patent 10,996,552 B2. May 2021.