VIRTUAL REALITY ENABLED EXPLORATION OF PLANETARY GEOLOGIC ANALOGS – TOWARDS VR-ENABLED ROBOTIC EXPLORATION OF THE MOON. M. Alexandra Matiella Novak[1], K.D. Runyon[1], J. Strang[1], C. Hibbitts[1], J. Heldmann[2], [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD, 20723, [2]NASA Ames.

Introduction: Virtual Reality (VR) offers a powerful method for post-hoc visualization and interaction with data collected in the field. VR environments and tools enable multiple researchers to participate remotely, and VR databases can be revisited at later times to increase the return of field data. In this work, we explore how well VR simulation of a field site compares to field-collected data, present a proposed methodology for the development of the VR environment, and suggest ways the environment can be explored physically and virtually for both terrestrial and other planetary applications.

This approach pairs the natural function of a field geologist with real-time data-driven analysis and an ability to view outputs in both graphical and 3D formats. The application of existing techniques and technologies in data collection and reconstruction – e.g., LiDAR data with Poisson surface reconstruction [1] – enables the integration and addition of these methods into existing analysis with minimal impact on field operation and instrumentation and could even be applied to existing geological data sets.

Analog Field Geology Work in Virtual Reality: VR tools and methods can be used in planetary analog field studies for testing their capabilities and limitations for supporting future planetary surface exploration. Analog field studies mature operational concepts and activities for future planetary exploration, such as extensive data collection and real-time geologic analysis [2, 3]. Also, real-time decision making protocols for pursuing field discoveries can be tested through a progression of analog missions, where operational activities are repeatedly tested and developed, including tool usage, team activities, and real-time decision making [4, 5, 6]. Additionally, analog missions allow the demonstration of rapidly prototyped technologies in remote, extreme, and challenging test environments before they are considered for spaceflight. These technologies are then matured through iterative testing in integrated mission scenarios that enable operationally-influenced design.

VR Field Geology: Here, we share our results from a study to demonstrate our ability to integrate LiDAR and other field data from Kings Bowl (KB) Lava Field (part of the Craters of the Moon National Monument and Preserve in Idaho) to enable VR field geology. Our primary source of input for the KB volcanic terrain is a LiDAR point cloud file obtained from a backpack LiDAR instrument used in the field.

Our virtual tools and KB field data allow us to test 1.) the accuracy of VR measurements vs. field measurements (and therefore a simulation of a field study); and 2), the consistency between multiple investigators taking measurements of the same features; and 3) advanced capabilities in the field, such as measuring large distances. A primary value of this effort comes from the ability for researchers to make measurements in a virtual environment as if they were physically present on a remote planetary surface [7].

VR-Enabled Robotic Exploration: Building on these VR-enabled analog field studies, we are now investigating how these VR environments and technologies can enable human and robotic exploration of planetary surfaces. For example, astronauts who will conduct geologic exploration and other science on the lunar surface during the early Artemis missions will be highly time-constrained and possibly mobility-limited. To help maximize astronaut scientific productivity on the Moon, the Space Exploration Sector at Johns Hopkins APL is developing the “Lunar Avatar” Telerobotic concept for conducting lunar field geology. The superior mobility offered by the all-terrain robot will enable access to rugged and dangerous terrain while an anthropomorphic manipulator will enable use of astronaut-compatible EVA tools, allowing for exploration and scientific discovery in regions not accessible to humans. Merging of persistently-updated mixed reality from Avatar’s sensors with remote manipulation would help mitigate the most disruptive effects of the ~5-second delay for the Earth-based operator, potentially enabling an Earth-based operator to operate LunarAvatar on the Moon with much less impact from communication delay. Techniques discussed above and derived from KB data could potentially be used to scientifically explore this virtual lunar environment.

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