Immersive Virtual Environments for Human Exploration

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Abstract

The Immersive Virtual Human Exploration (IVHE) activity is exploring the potential of using fully immersive, 3D virtual environments to further exploration of the solar system. By producing interactive virtual environments based on collected sensor data, IVHE could expand human exploration to areas that are currently inaccessible to humans, promote involvement in exploration by a greater portion of the scientific community, reduce risk for future human missions, and encourage public participation in space exploration. As a collaborative effort, the National Institute of Aerospace and the NASA Langley Research Center are integrating expertise in data visualization, instrumentation/sensors, and robotics to develop a proof-of-concept demonstration for assessing IVHE challenges and technology gaps. Affording natural interactions and collaborative, multi-user investigations, immersive applications will further support the achievement of informational insights. Supporting In-Situ Resource Utilization of lunar regolith for the construction of lunar habitats and supporting structures, IVHE aims to identify challenges in processing construction units and building structures. The project is exploring the possibility of supporting telerobotics for remote control through direct, intuitive interaction techniques within virtual environments. By providing a visualization environment capable of integrating spatial and physical data with more abstract types of data, information can be explored within a more meaningful context, allowing insights that might otherwise be missed.

1 Benefits of Immersive Technologies

Immersive virtual environments provide users to interact within a 3D, computer-generated world though a first-person perspective. Such systems often employ high-fidelity visual displays, taking advantage of features such as stereoscopy, head tracking with head-based rendering, high field of view, and the ability to interact though physical movements. Many studies have shown that such immersive features improve understanding of spatial structures and information (e.g., [Ware and Mitchell 2005; Schuchardt and Bowman 2007]). Evidence has also shown that intuitive, body-based interaction techniques can improve performance on mental processing tasks by allowing users to take advantage of actions used in everyday life (e.g., [Zanbaka et al. 2004]). Further, by allowing integrated visualizations of both physical and abstract information within a single environment, IVHE will support the exploration of data within the context of their relationships to other data items.

The project is also investigating methods for supporting collaborative scientific and engineering work. Large displays and immersive systems provide improved support for multiple participants to work within a collocated space. Additionally, networked, distributed systems will allow remote users to participate in the same virtual environment as those in different locations — even using different display platforms.

Additonally, with the aid of virtual worlds, the exploration of virtual representations of foreign environments will be possible via robotics and sensors, and can be done from the safety of a computer or immersive system lab. Virtual environments can be explored by anyone — from experienced research scientists to curious children — without additional, advanced training and preparation for every explorer.

2 Structure Construction

A specific goal of IVHE is supporting the In-Situ Resource Utilization (ISRU) of lunar regolith for the construction of lunar habitats and supporting structures (as discussed by [Faierson et al. 2008] and [Faierson and Logan 2010]). IVHE aims to identify challenges in processing construction units and building structures. The project will aid in testing and refining construction procedures, inspecting individual building components, and validating structural integrity during construction. The additional spatial cues offered by immersive virtual environments will support explorations of potential sites and construction simulations under varying constraints and conditions. Interactive simulations of building activities using the Lunar Surface Manipulation System (LSMS) will provide insights into the challenges of constructing various types of structures. Through experimentation with virtual interaction techniques, the IVHE project is investigating the best methods for remote control of the LSMS. This interaction may also be used to assist in the training autonomous robotics operations for inspection, construction, and exploration related tasks.

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