Work in Progress: A Head-to-head Comparison of Navigation Techniques for Exploring 3D Geoscience Data Sets

Abstract

This work in progress is investigating which 3D navigation techniques are most useful for the exploration of geoscience terrain data sets at a 61-inch Powerwall. Our task is to explore the terrain looking for interesting geological features. Four techniques are implemented at this time and we are particularly interested in the relative social, ergonomic, and performance characteristics of the techniques. Early observations about the techniques are reported.

1 Introduction

Our task is to explore terrain on planetary surfaces in order to discover, map, document and understand geological features related to key problems in the evolution of Earth-like planets. In this case study, we are exploring the planet Mars in order to find evidence for the presence of water in the past history of Mars. Geological features and their sequential relationships permit us to determine the climate history of Mars. For example, the presence of tropical mountain glacier deposits signals a past climate when spin-axis obliquity was about 45 degrees and water from the polar ice caps was transported to the equatorial regions. The presence of liquid water-carved channels signals a past warmer and wetter climate different from the global cold hyperarid climate of today. We explore vast areas in search of these types of features and their relationships [Dickson et al. 2008], and thus navigation tools need to be flexible, intuitive, and easy to use. We use multiple high-resolution data sets obtained by several spacecraft currently in orbit around Mars and engage a group of undergraduates, graduate students and staff in the analysis and testing of the range of 3D navigation techniques described below. The synergism helps produce increased scientific returns.

We have previously investigated both a Cave and Fish Tank Virtual Reality system [Forsberg et al. 2006] and observed different pros and cons to both. A 61-inch stereo-capable Samsung HDTV provides an interesting middle ground. But what user interface should be used with this form factor?

2 3D Navigation Techniques

Many 3D navigation interaction techniques have been developed (for desktops, video games, and immersive displays) and many evaluations have been done [Bowman et al. 2004]. Our investigation targets the needs of geoscience researchers and may discover new requirements, metrics, and comparative results than prior work.

The techniques we have implemented so far are: 1) keyboard controls (as in first person shooters), 2) Spaceball 3D Mouse driven navigation, 3) Logitech Gamepad navigation (as many game consoles use), and 4) an airplane control wheel using a Wiimote. We have not implemented all navigation techniques, but are trying for a breadth of techniques that are known to be popular (e.g., keyboard navigation) or appear to be promising for collaborative exploration at a 61-inch Powerwall (e.g., a wireless device like the Wiimote). Our current metrics to determine the "most useful" navigation techniques are: 1) completeness (i.e., degree to which a technique provides the required control), 2) ease of use, 3) comfort (i.e., degree to which a technique is ergonomic), and 4) "onlooker rating" (i.e., how onlookers rate the navigation experience).

3 Preliminary Observations

We have observed so far that for collaborative viewing, the Spaceball has been the preferred input device for navigating. It is easier for the driver, and much nicer for onlookers. Movements are very smooth and less jarring than either a 3D wand or regular mouse. *In fact, while we generally think of navigation from the perspective of the driver, the strongest opinions are frequently voiced by those not driving.* The wireless Wiimote as a flight control wheel is effective and intuitive but has limitations– e.g., it does not reliably sense rotation about the vertical axis which some users think is a more intuitive way to steer. The keyboard is easy to use but it is somewhat awkward to use at a comfortable viewing distance. The gamepad works well for 3rd person style viewing and especially for orbiting features of interest.

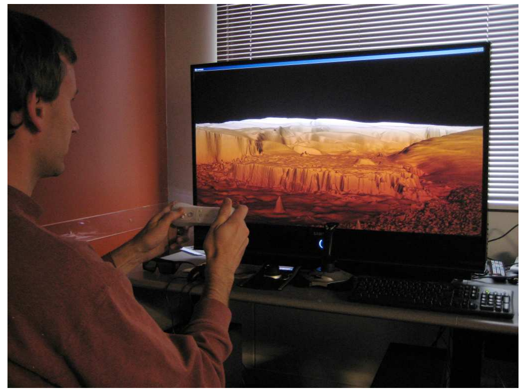

Figure 1: *How do navigation techniques compare for flying through 3D geoscience data sets? Does display size change effectiveness or preference? We are investigating questions like these in a collaboration with geoscientists researching remote locations such as Mars. Shown here, a user navigates a Martian landscape using an airplane control wheel navigation metaphor.*

4 Conclusion

There is much to learn from comparing navigation techniques applied to real-world geoscience research. At this stage we are adapting our user interface to a new kind of display and investigating which navigation methods work best in collaboration with geoscientists. We hope to contribute new knowledge about 3D navigation for geoscience through our investigation. We thank the NASA AISR program for its support of this work.

References

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