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Virtual Reality in Data Visualization: Interaction methods and devices

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Introduction

Data Visualization is an expanding Computing discipline applicable to any scientific area, which can be used as an "intelligence amplifier", providing users with a greater insight on their data. Though current data visualization tools offer a broad range of functionality, interaction with the data typically takes place using a 2D window through which the user can examine the visual data representation while controlling navigation with conventional devices (as keyboard and mouse). This mode of interaction reduces benefits users can obtain from those tools. Virtual Reality (VR), on the other hand, can place the user within the same space as their data and provide more natural and intuitive methods for navigating through the data visualization. This more user-centered style of interaction encourages exploration and can potentially create a more stimulating and productive visualization experience; as a consequence, using VR technology in Data Visualization is becoming an important research area.

Thanks to the computer entertainment industry, almost any PC has now a powerful graphics card allowing it to act as a desktop VR instance, thus, VR is becoming a more widespread technology. Yet, it still faces important human-factors challenges, specifically, more usable interaction devices and methods are needed for VR in general, as well as for its application to Data Visualization. Recent approaches to providing users with more natural interaction methods have shown that more than one mode of input can be both beneficial and intuitive as a communication medium between humans and computer applications. Although there are many different modes that could be used in these applications, hand gestures and speech appear to be two of the most logical.

This proposal is supported on a low cost Virtual Reality system (based on a Head Mounted Display, a camera and several sensors, and soon to be enriched with spatially located sound) used at IEETA, and is aimed at the identification, development and evaluation of applications, interaction methods and devices adequate to Data Visualization scenarios, where the use of VR might bring clear benefits for the users in the data exploration process. Different types of data may be considered,

such as data from Medical Imaging modalities, Mechanical Engineering simulations, geophysics and geochemistry simulations, enriched archaeological 3D models, etc.

Objectives and methodology

This thesis involves the development of software applications especially designed to visualize and interact with different data sets, as well as the integration, in the existing VR set-up, of off-the-shelf or specially designed hardware devices to improve interaction with the data. The work will focus mainly in the following topics:

- Study of the state of the art in Virtual Reality environments, as well as interaction in these environments.
- Identification of a set of interesting visualization problems that can benefit from the use of VR technology. Some examples include visualizing Medical Imaging, Mechanical Engineering, Geophysics and Geochemistry or enriched Archaeological 3D models, for which data are already available.
- Development of software to visualize the selected data in one or more VR configurations. Integration of additional interaction options, possibly through the integration of hardware devices (such as devices used in Computer Vision, Computer Games, etc.)
- Definition of interaction methods (e.g. gesture languages) adequate to navigate and interact with the developed applications, as well as their evaluation and validation with real users (i.e., the data owners).
- Study the possibility to integrate collaborative capabilities.

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