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Toward the Use of Immersive Technologies for Interactive Visualization

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Abstract

Virtual and augmented reality technologies have significantly advanced and come down in price during the last few years. These technologies can provide a great tool for highly interactive visualization approaches of a variety of data types. In addition, setting up and managing a virtual and augmented reality laboratory can be quite involved, particularly with large-screen display systems. Thus, this keynote presentation will outline some of the key elements to make this more manageable by discussing the frameworks and components needed to integrate the hardware and software into a more manageable package. Examples for visualizations and their applications using this environment will be discussed from a variety of disciplines to illustrate the versatility of the virtual and augmented reality environment available in the laboratories that are available to faculty and students to perform their research.

Introduction

Human kind has been processing data for thousands of years. The first known data processing occured around 19,000 BC. Our Paleolithic ancestors performed simple calculations using a baboon tool called the Ishango bone. During the 1640s, John Gruant collected information about deaths in London. Statistics he gathered included number of deaths, mortality rate per age group, and cause of death.

In the 1880s, Herman Hollerith was inspired by a train conductor punching train tickets. This started the idea of using punch cards for writing and processing data. Fritz Pfleumer received a patent in 1928 for a magnetic tape to replace wire recordings. This technology was then used for magnetic tapes and floppy disks later on.

Nowadays, data collection exploded. While we collected just 2 zetabytes in 2010, current projections suggest that we will collected 181 zetabytes in 2025 suggesting an exponential growth in the data humans collect.

Processing these vasts amount of data through conventional methods is near impossible. There is a great need for automating this process. In some cases, AI tools can be useful for data processing. However, interactive visualization tools can be of great benefit when processing the entirety of the data with some preprocessing.

Especially, interactive visualizations can benefit from devices and display systems that were originally developed for virtual or augmented reality applications. These devices provide direct interaction through body movement in which the visualization reacts to typically the head movement such that the data appear static in space as the user moves around. Head-mounted displays (HMDs) and stereo glasses to display different images for the left and right eye allow the user to perceive the visualization in 3D. Input devices are tracked in 3D space as well providing very intuitive interaction mechanisms. HMDs usually come with their own tracking system: either lighthouse sensors or camera-based inside-out tracking. Larger screen-based systems, such as CAVEs or large display walls, often use optical tracking systems that use a set of several cameras to determine 3D location.

There are different options in terms of which software to use. VRUI [4] is a great option as it provides an OpenGL context one can render virtually anything into. VRUI supports almost any configuration of display systems, including CAVE-type displays, large display walls, tiled displays, and HMDs [11]. The OpenGL context also allows for the use of other OpenGL-based toolkits and library to also support a large array of display systems, such as VTK [7] and OpenSceneGraph [1].

Paraview [2] now also supports CAVE-type display systems, HMDs, and other virtual reality systems through the use of the XR-interface [8]. Even game engines, such as Unitỹciteunityurl, can be used in CAVE-type systems using the Uni-CAVE plugin [9].

We have used these types of display systems [12] with these software environment successfully for comparative visualizations for molecular models [5], vascular structures [10], training for nursing students [6] and Medicaid personnel [3], volumetric visualization, and flow visualizations. This keynote presentation will outline some of the technology, software environments, and applications.

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Author Biography

Thomas Wischgoll received his Master's degree in computer science in 1998 from the University of Kaiserslautern, Germany, and his PhD from the same institution in 2002. He was working as a post-doctoral researcher at the University of California, Irvine until 2005 and is currently an associate professor and the Director of Visualization Research at Wright State University. His research interests include large-scale visualization, flow and scientific visualization, as well as biomedical imaging and visualization. In the area of vector field visualization, Dr. Wischgoll completed the topological analysis of vector fields by developing an algorithm that detects closed streamlines, a missing link between branches of a topological skeleton. In the realm of biomedical engineering, he developed a visualization system that facilitates the analyses of large-scale vascular models of a heart represented geometrically by several hundred million polygons. The models are derived from CT scans and feature a simulated flow inside the blood vessels. Dr. Wischgoll developed methodologies for analyzing such volumetric data and extracting quantitative measurements at very high accuracy for further analysis. His research work in the field of large-scale, scientific visualization and analysis resulted in more than thirty peer-reviewed publications, including IEEE and ACM. Dr. Wischgoll is a member of ACM SIGGRAPH, IEEE Visualization & Graphics Technical Committee, and the IEEE Compute Society.