K-Cave demonstration: Seismic information visualization system using the OpenCABIN library

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Abstract

We demonstrate a VR application running on a immersive projection display: K-Cave. We constructed seismic information visualization system using the OpenCABIN library. In this paper we describe the K-Cave hardware configuration, OpenCABIN library and seismic information system.

1. K-Cave: a CAVE at the Keio University

The K-Cave is a CAVE-clone VR display system at the Keio University. It consists of 3 screens, 6 projectors, 3 rendering PCs and a control PC. Binocular parallax is achieved by circular polarization filters in front of each projector and in a pair of glasses. Passive stereo feature does not require special high-end graphic display functions like genlock nor framelock. Dimensions of front and floor screens are 2.6 meters width and 2.1 meters height, and right screen is a square whose sides have length 2.1 meters. Each screen's pixel resolution is XGA (1024 x 768 pixels). The viewer's position is tracked by a magnetic position sensor: Ascension technology corporation's Flock of Birds with an Extended Range Transmitter. PCs are connected via 1000 base TX ethernet and using normal TCP/IP protocols. Each PC runs on the Linux operating system.

Figure 1: The K-Cave system.

2. OpenCABIN library

OpenCABIN library is a fundamental software library for developing virtual reality applications. After CABIN library was developed at the university of Tokyo[1], its successor, called OpenCABIN library, was developed from scratch as opensource software. It absorbs differences kinds of display systems, so we can easily develop applications for a multi-screen stereoscopic display. In addition to the basic nature as a VR library, it has two special features that enable application programmers to develop VR applications easily: plug-in mechanism and master/renderer programming paradigm.

From a software engineering viewpoint such as implementation, testing, debugging, reusability, flexibility, and quality control, it is desirable to construct a system as several independent parts rather than as a big monolithic part. Because of limits of almost all OpenGL implementations, two or more processes cannot access to an OpenGL window. So an OpenCABIN library application is formed as plug-in software and it is loaded and executed by an OpenCABIN library execution environment at runtime. An execution environment can execute one or more plug-in applications simultaneously. As a result, even though each application shows a simple 3D object, virtual space becomes sufficient with a lot of 3D objects. An application user can freely select which object is appeared in the virtual space at runtime.

An OpenCABIN library application consists of two parts: a master part and a renderer part. A master part is executed in a master process on a master computer, and controls the application's behavior by producing the application context. A renderer part is executed by renderer processes on renderer computers, and those processes render an application world according to reading the application context. A master part is guaranteed that it is always executed by a master process, so it is easy to develop applications which access outside servers via networks, and applications that share virtual space among CAVEs in remote places.

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3. Seismic visualization system

We developed seismic data visualization system[2, 3]. In this system, terrain data and plate structure data are visualized simultaneously according to the hypocenters. Since these data have three-dimensional locations, we organize database tables to have locational data. Therefore the user can see and understand those information intuitively, and will find characteristics of the earthquakes and relationships among earthquakes, terrain shapes and plate structures.

Our seismic data visualization system consists of plural applications. Each application displays single dataset such as hypocentral data, terrain data, basement depth data or plate data. They were developed using OpenCABIN library. Because each dataset includes locational information such as latitude and longitude, these data can be merged at the same location. A user can choose any combination of data types. Figure 2 shows that a user was operating to visualize the hypocenter data and terrain data around Tsukuba city. In this system, images acquired from a satellite are texture mapped onto the terrain shapes. Each sphere indicated a hypocenter: the sphere's position, color and radius indicated hypocentral location, depth and magnitude. She/he could understand each earthquake intuitively.

Figure 3 and 4 show that a user was seeing a combination among hypocenter, basement depth data and plate data. Views of combination among basement depth data, sea depth data, Pacific Ocean plate data and Philippine Sea plate data enabled a user to understand relationships of these data.

Through the operation of this system, an expert found that the depths of hypocenters in west Japan is relatively shallow and hypocenters from Tokai to Kanto are distributed on a plane. Also we can apparently see that hypocenters are distributed along the plate.

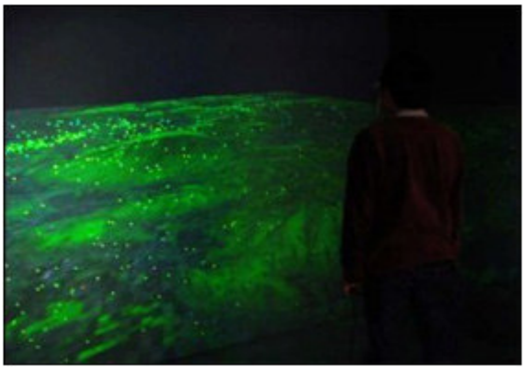

Figure 2: A view of hypocenter data and terrain data combination.

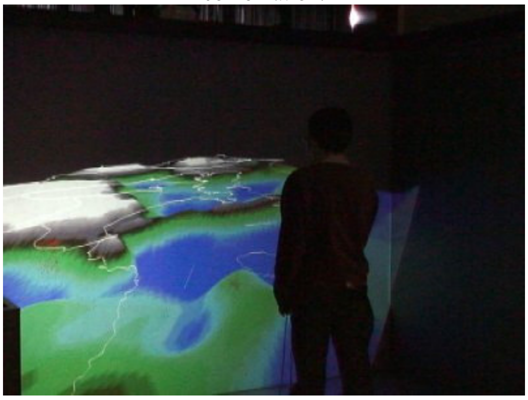

Figure 3: A view of hypocenter data and plate data combination.

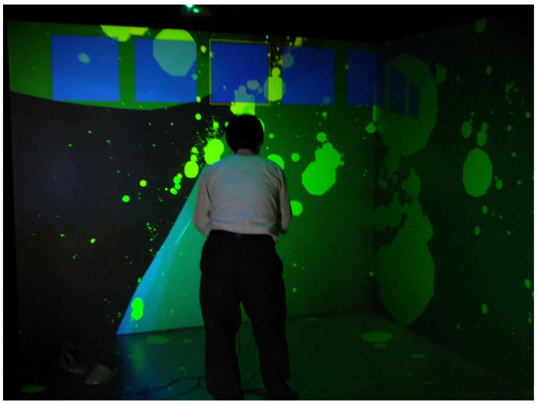

Figure 4: A view of hypocenter and plate data combination.

Acknowledgements

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