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PERFORMING IN QUANTUM SPACE: A CREATIVE APPROACH TO N-DIMENSIONAL COMPUTING

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Abstract

This paper discusses a new approach to scientific and artistic computing that allows one to use the creative process of music performance to interact with n-dimensional data sets. Using a unique multi-user instrument, the AlloSphere, a three-story metal sphere in an echo-free chamber that immerses approximately twenty-five researchers in 4-Pi stereo radians of interactive visual and audio data, new scientific discoveries and emergent art transform science and art into a new field.

The transformative possibilities of the sciences through the media arts in the 21st century have their foundations in the high Renaissance as epitomized by Leonardo Da Vinci, master in arts, science and engineering [1]. Leonardo approached each of these disciplines from the perceptual side, as witnessed by his observational approach to science, his design approach in engineering, and his creative approach in art—painting continuously for hours on end in a perceptual state and then stopping for three or four days at a time.

Indeed, it seems as though these disciplines were much more united in a time when using the senses to understand complex information was a key to the learning process.

Throughout the centuries, as theories became formal rules in the sciences and phenomena became too abstract and complex to understand through perceptual awareness, researchers have come to rely more and more on empirical knowledge and analysis. Indeed, as we move into the sub-atomic, where the data is too small to perceive with our physical senses, how can we interact with this data intuitively and as second nature?

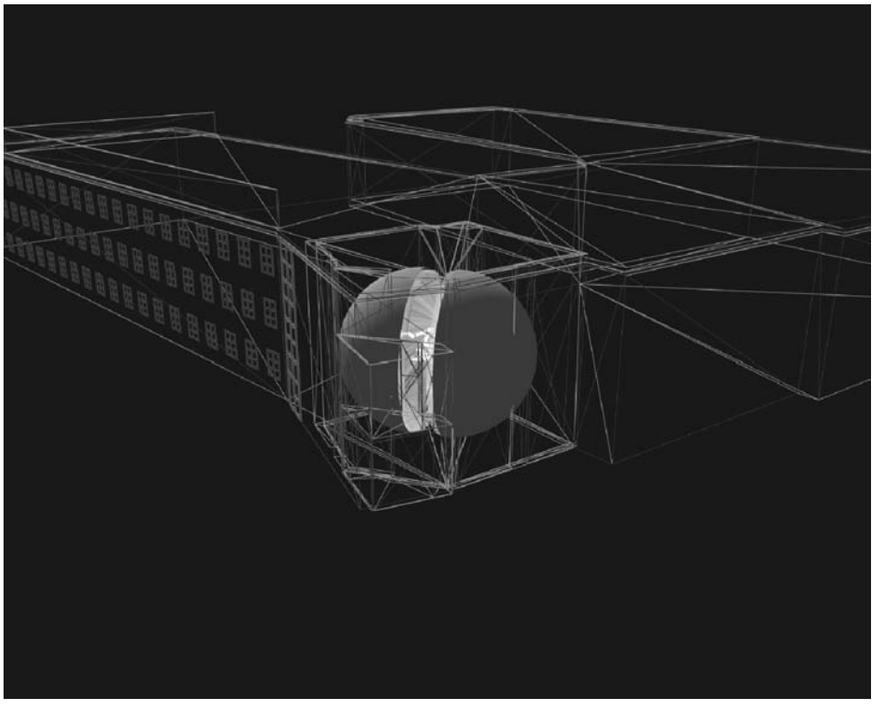
Certainly we will need a computational platform for simulating computational models of the real-world data being generated at the atomic and sub-automatic level, but is computation of complex equations enough to really understand and comprehend this data at an intuitive level, before moving back into the laboratory with lasers and magnetic force generators to enact another experiment with data yet too small to comprehend? Is there a way to use the computational platform as an interactive instrument to work with this data on the perceptual level? And if so, what type of instrument would be needed to immerse a team of researchers in atoms to see and hear electron spin? To be immersed in complex information as if in the real world, one needs an instrument with a display large enough to represent an n-dimensional real-world scenario, 4 pi stereo radians of immersion for precise representation, and a space properly prepared for no outside interference of visual or audio information.

The AlloSphere instrument, invented by this author, is a three-story metal sphere in an echo-free chamber that has been built as a large dynamically varying digital microscope, connected to a supercomputer. Approximately 25 researchers enter into the instrument and are suspended on the bridge in the middle of the metal sphere inside a near-to-anechoic chamber. Researchers pick up their various wireless and wired devices and literally perform their data as a musical ensemble would compose and perform a piece of music. The researchers are immersed in their data as if in the real world and have the ability to use their senses to experience complex information from the sub-atomic to the universal [2].

The following virtual rendering describes the Allosphere instrument to building scale, in Figure 1 below.

Implementing multi-sensory computing within a large immersive instrument/environment, the AlloSphere design stage, we are constructing a new paradigm for research using the creative process. Media artists are working with computer scientists to develop new modes of interaction, generation, and manipulation of n-dimensional data sets in a large-scale immersive computing system [3]. We have focused on building a highly general spectral solver that can be applied to simulation in areas such as quantum mechanics, fluid dynamics, and acoustics, as well as new visualization and sonification techniques that are scalable to higher-dimensional systems. These are part of a mathematical processing library and language that allow us to represent and work with scientific data that typically come in the form of a regular lattice of sampled values or a collection of position-value pairs, whether these data come from experimental measurements or are generated from abstract mathematical models. This library is the basis of our creative computational framework: a suite of techniques for data representation, analysis, transformation, generation and manipulation that is modeled on the techniques of the artistic process and allows control of the AlloSphere as a large multi-user instrument.

Fig. 1. Virtual rendering of the AlloSphere, built in 2007. (© AlloSphere Research Grp.)



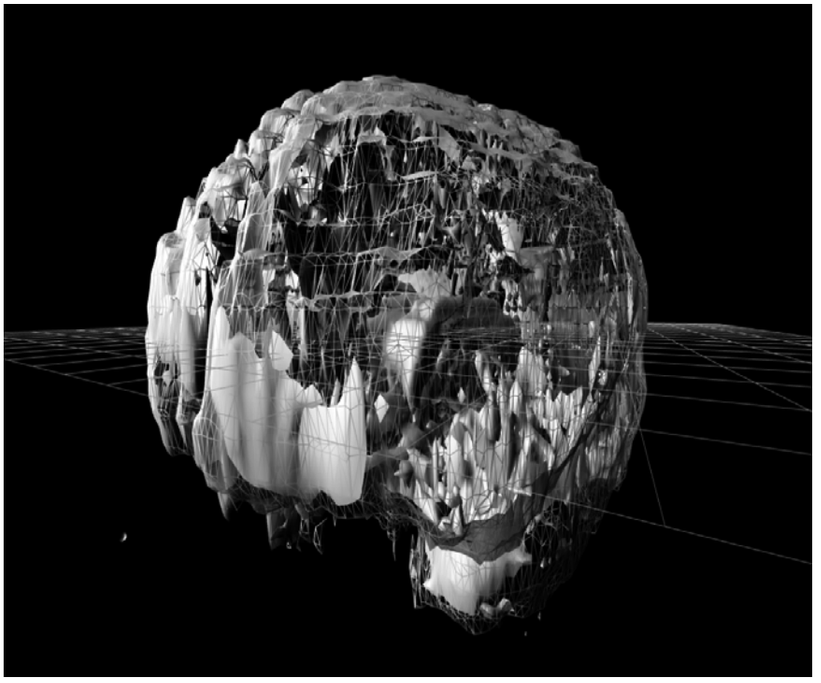


Fig. 2. The Allobrain – fMRI data of visual artist Marcos Novak in the AlloSphere. (© AlloSphere Research Grp.)

Generation and representation of very complex data visually and aurally will be accomplished through interactive gestural control, much in the same way that a musical ensemble would perform a musical composition or a team of surgeons would perform an operation [4].

The following research project demonstrates this unique multi-sensory, creative approach to immersive computing, a new way to intuitively control voluminous amounts of very complex data.

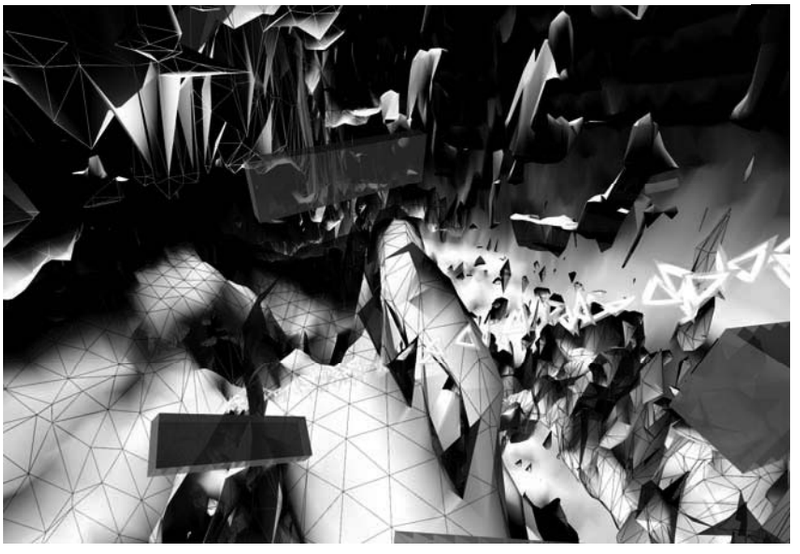
The Allobrain research project demonstrates unique ensemble style interaction, allowing a team of researchers to literally be immersed in and navigate through real fMRI brain data within the AlloSphere. The researchers perform the data just as an instrumental ensemble would perform a musical composition by using various wireless devices and tracking control for gestural interaction, to allow a specific individual or individuals to perform their specific task in the data set, just as an instrumentalist performs their musical part in a composition.

Different wireless controllers can be mapped for various functions, depending on how many people will be mining the data set at one time. Two hundred and fifty-six 2D slices of fMRI data are mapped to make a 3D structure of this real brain data. Figure 2 displays the brain as a world to explore.

Figure 3 displays computer agents represented by rectangular objects that mine the data set reporting blood density levels to the researchers who are controlling the agents through wireless controllers. The data set can be mined by a single researcher using a wireless joystick for navigation and agent control, or by a group of six researchers mining the same set, with one person navigating and five researchers using e-field sensors mounted on the bridge of the AlloSphere, functioning as the five lobes of the brain. Another paradigm could have one researcher navigating while another is controlling all 12 agents through a device that has 12 buttons [5]. These scenarios function as different instrumental combinations, performing various arrangements of a musical work.

By using the same concept of ensemble-style performance in immersive interactive visualization of n-dimensional data sets, researchers can apply the creative process of musical performance in understanding very complex scientific and mathematical data, naturalizing the approach to such information and facilitating the intuitive understanding of the infinitesimal and the infinite.

Fig. 3. Agent-based data mining. (© AlloSphere Research Grp.)



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