Australian neuroscientists map how Alzheimer's engulfs the brain using SGI high performance computing technology

University of Queensland and UCLA (US) neuroscientists using using a powerful new imaging analysis technique have created the first three-dimensional video maps showing how Alzheimer's disease systematically engulfs the brains of living patients. Dramatic time-lapse videos were built on an SGI Onyx family visualization system, starting with enormous data sets that were assembled on a 64-processor SGI Origin 3000 server at UCLA. That process began with raw data acquired on a Bruker AVANCETM Electronics Medspec S200 MRI scanner interfaced to a Silicon Graphics O2 system and preprocessed on a Silicon Graphics Octane system at the University of Queensland's Centre for Magnetic Resonance. The work was part of an ongoing University of Queensland project investigating early Alzheimer's disease. These moving images, available online at www.loni.ucla.edu/~thompson/AD_4D/dynamic.html, show the sequential destruction of brain areas that control memory function, then emotion and inhibition, and finally sensation. They also illustrate the fact that the disease spares small brain regions that control vision and other basic functions that typically remain intact in Alzheimer's patients. The latest findings appeared in the February edition of the peer-reviewed Journal of Neuroscience. Earlier findings from this data processed by Andrew Janke at the University of Queensland were described in a paper published in Magnetic Resonance in Medicine in 2001 that subsequently won the International Society for Magnetic Resonance in Medicine's W.S. Moore Award. The UCLA analysis technique, which detects very fine changes in magnetic resonance imaging (MRI) brain scans, offers doctors and researchers a powerful new tool that could speed diagnosis, intervention, and development of new therapies. Use of the SGI Origin compute server enables the research team to examine results from scan computations after an overnight computer run, compared with a run of up to 10 weeks on previous technology. "For the first time, you can see Alzheimer's disease progressing in living patients," said Paul Thompson, an assistant professor of neurology at the David Geffen School of Medicine at UCLA and the study's chief investigator. "We were stunned to see a spreading wave of tissue loss. Initially confined to memory areas, this loss moved across the brain like a wildfire, destroying more and more tissue as the disease progressed. "These experiments are simply not possible without high-performance computing," explained Thompson. "We are helped tremendously by our SGI hardware." "It's been fascinating to delve into the fourth dimension with this latest work with UCLA, incorporating movement over time into stereo images depicting disease progression in Alzheimer's dementia," added co-investigator Greig de Zubicaray of the University of Queensland's Centre for Magnetic Resonance. "The Center's Andrew Janke, who processes many of the images acquired during our project, found SGI technologies to be integral to this intriguing and, in many ways, groundbreaking research." Alzheimer's afflicts 10 percent of people older than 65. Physicians know that brain lesions, called amyloid plaques and tangles, accumulate in Alzheimer's patients' brains and are associated with memory loss, disorientation and declining ability to cope with everyday life as brain cells die. In order to track this cell death, the research team scanned 12 Alzheimer's patients and 14 healthy elderly volunteers with MRI brain scans every three months for two years. Computational techniques used imaging data from 60,000 scanned points to compare the affected brains with healthy brains. Using the new image analysis technique, the researchers found that the Alzheimer's patients lost an average of 5.3 percent of their gray matter per year. Brain cells were purged even faster in some brain regions, with patients losing up to 10 percent in memory regions each year. In contrast, healthy elderly volunteers lost only 0.9 percent of their brain tissue annually. The time-lapse video based on these scans revealed that the leading edge of cell loss moved forward like a burning frontier. As patients' symptoms worsened, the wave of cell loss hit frontal and central brain regions. These brain areas control patients' inhibitions and emotional states. After two years, the disease had engulfed virtually the entire brain. One goal of this research is to create a methodology for determining the effectiveness of drugs in slowing the progress of Alzheimer's disease or delaying its onset. This requires the detection of minute changes in brain tissue. The use of SGI Onyx visualization system technology with RealityMonster graphics enables the research team to highlight these changes by showing sequential images as a real-time movie. The next step for the program is a clinical trial that establishes the value of the visualization approach. "This type of imaging will allow doctors and researchers to pinpoint where and how fast the disease is spreading," said Thompson, who also serves as a researcher at the UCLA Laboratory of Neuro Imaging. "We will urgently apply this method to reveal how drugs and vaccines combat the wave of brain damage caused by Alzheimer's disease." For further information about SGI's involvement in medical and health care research, including diagnostic imaging and computer-aided surgery and simulations, visit www.sgi.com/go/medical. About SGI SGI, also known as Silicon Graphics, Inc., is the world's leader in high-performance computing, visualization and the management of complex data. SGI's vision is to provide technology that enables the most significant scientific and creative breakthroughs of the 21st century. Whether it's sharing images to aid in brain surgery, finding oil more efficiently, studying global climate or enabling the transition from analog to digital broadcasting, SGI is dedicated to addressing the next class of challenges for scientific, engineering and creative users. SGI was named on FORTUNE magazine's 2003 list of "Top 100 Companies to Work For." With offices worldwide, the company is headquartered in Mountain View, Calif., and can be found on the Web at www.sgi.com.