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Center for Advanced Computing Research
Caltech
Pasadena, California

Center for Computational Sciences
Lexington, Kentucky

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Oak Ridge, Tennessee

Center for Innovative Computer
Applications at Indiana University
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Houston, Texas

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High Performance Computing
Education and Research
Albuquerque, New Mexico

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Atmospheric Research
Boulder, Colorado

National Center for Supercomputing
Applications at UIUC
Champaign, Illinois

National Energy Research
Scientific Computing Center
Berkeley, California

National Supercomputer Center
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Las Vegas, Nevada

North Carolina Supercomputing
Center at MCNC
Research Triangle Park, North Carolina

Ohio Supercomputer Center
Columbus, Ohio

Pittsburgh Supercomputing Center
Pittsburgh, Pennsylvania

Purdue University
West Lafayette, Indiana

San Diego Supercomputer Center
San Diego, California

Supercomputer Computations
Research Institute
Tallahassee, Florida

Texas A&M University
Supercomputer Center
College Station, Texas

Texas Advanced Computing Center
Austin, Texas

The Pennsylvania State University
University Park, Pennsylvania

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Gainesville, Florida

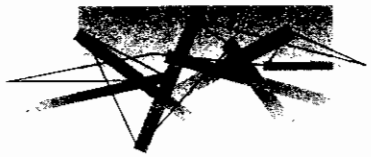
University of Maryland
College Park, Maryland

University of Southern California
Information Sciences Institute
Marina del Rey, California

University of Utah, Center
for High Performance Computing
Salt Lake City, Utah

University of Wisconsin
Madison, Wisconsin

C A S C



HIGH PERFORMANCE COMPUTING IMPROVES MEDICINE AND HEALTH CARE

America faces the dual challenge of reducing national health care costs while also providing affordable, quality service and treatment for all its citizens. High performance computing is providing an incredibly powerful tool for achieving both these goals.

Federal support for research that applies the most advanced computer technology to problems in medicine and health is proving a sound investment. Enhanced training, better treatment planning and increased service to remote geographic areas all contribute to improved quality of care and significant cost savings. Such research also enables medical science to make dramatic breakthroughs in understanding the complexities of the human body and in developing effective treatments for such devastating illnesses as heart disease and cancer.

Here are some examples of this work:

Safer Sinus Surgery - - Functional endoscopic sinus surgery is performed directly through a patient's nostrils, using delicate instruments and a tiny camera that transmits images to a monitor. Though minimally invasive, and usually done on an outpatient basis, this operation carries risk because of close proximity to the brain, optic nerves and eyes. Researchers at the Ohio Supercomputer Center (OSC) and the Ohio State University Medical Center, in collaboration with Madigan Army Medical Center, The University of Washington HITLab, Lockheed Martin and Immersion Corporation, are creating a virtual environment so that surgery residents can hone their endoscopic skills on digital models before ever operating on patients.

Simulations of the nasal cavity and the paranasal sinuses are created with data from the National Library of Medicine's Visible Human Project. Force reflecting stimuli such as probing and cutting are integrated with the visual elements. The system is currently being evaluated for its efficacy as a standard component of medical training and evaluation.

Improving the Epidural - - While the epidural is a common anesthetic used in childbirth, back and hip surgeries, in inexperienced hands it poses major neurological risks. Using a force reflecting "cyber-glove" created at OSC, residents at the Ohio University College of Medicine and other Ohio medical centers are conducting "virtual" trials before ever working on patients.

Power Wheelchair Proficiency - - With funding from the US Department of Education and the National Institute for Disability and Rehabilitation Research, OSC researchers are using virtual technology to teach wheelchair users how to navigate as they make the transition from manual to power equipment. The technology is also assisting healthcare providers in assessing client performance. It is also being used to evaluate architectural designs for compliance with the Americans with Disabilities Act, with the goal of universal wheelchair access for public and private buildings.

Cancer Diagnosis - - Computerized methods hold great promise for more accurate diagnosis of cancer. Using Software for pattern-recognition and image classification, researchers at the Pittsburgh Supercomputing Center and the University of Pittsburgh Medical Center are developing methods to automate the analysis of microscope images of tissue. Such techniques will make it possible to compare a patient's biopsy with large archives of slides, providing objective statistical analysis of the degree of malignancy.

The Brain In Real Time - - The ability to view the dynamics of the brain during mental activity is leading to advances in neurosurgery and better treatment for cognitive disorders such as schizophrenia, amnesia and epilepsy. By linking the most advanced supercomputing system with a Magnetic Resonance Imaging (MRI) scanner, scientists at Carnegie Mellon University, the University of Pittsburgh Medical Center and the Pittsburgh Supercomputing Center are able to watch 3-D action images of a patient's brain in real-time as it responds to various physical and chemical stimuli. Similarly, at the University of Florida Brain Institute scientists are combining 3-D imaging and high performance computing to study brain reactions, and are using the technology to organize and analyze the vast amounts of data generated by such research.

DNA Modeling - - More accurate modeling of DNA opens doors to better understanding of disease processes and for the design of new therapeutic drugs. Researchers at the National Institute of Environmental Health Science, the University of California, San Francisco and the Pittsburgh Supercomputing Center have collaborated to develop an efficient, accurate method of modeling the electrical charges between DNA and other large biomolecules. This work is providing new understanding of the interactions between DNA and proteins, which could be critical in abating and perhaps even curing maladies and diseases ranging from indigestion to arthritis.

The Human Body In Motion - - A professor of Kinesiology and Health Education at the University of Texas at Austin, in conjunction with the Texas Advanced Supercomputing Center (TACC), is developing complex simulations of the lower human musculo-skeletal system in motion. The simulations take into account contractions and bone loading patterns involving 54 muscles and 23 ranges of joint movement. Creating these models has thus far consumed one CPU year -- the equivalent of 8,760 hours of computing time, if performed on a single processor as in the past. Because such simulations are now done by linking several computers together and working "in parallel," it has consumed only 10 computer days or 240 hours of actual clock time. The research has numerous applications including designing better artificial joints, predicting the effects of long-term space flight on the musculo-skeletal system and for anthropologists in studying the anatomy of pre-human hominoids.

Remote Telemicroscopy - - A cooperative effort between the San Diego Supercomputer Center (SDSC), the National Center for Microscopy and Imaging Research at the University of California, San Diego (UCSD), and the Cornell Program of Computer Graphics is enabling medical researchers throughout the country to take advantage of UCSD's coveted intermediate-voltage electronic microscope for disease diagnosis via the Internet. Tissue samples are sent to San Diego for placement in the microscope. Researchers can study the samples from their home base and use high performance computing for 3-D visualization and analysis of biological structures.

Biomedical Imaging - - A supercomputing software application called MPIRE, currently being developed at the San Diego Supercomputer Center, will enable physicians to examine medical images such as MRI's and CAT scans interactively from different locales via a Web interface. Medical scanning techniques produce very large data sets that require high performance computers to visualize and manipulate. This approach provides the power of supercomputers and the benefit of expert opinions that, because of geography, might not otherwise be available. This is called a "transparent" supercomputing application because the doctors need not know about supercomputing, just how to use a web page.

Computational Steering -- At the University of Utah, a $34.5 million supercomputer built around one of the world's most powerful graphics systems is allowing scientists to investigate time-critical problems of the human body that only a few years ago were unapproachable. At the University's new Visual Supercomputing Center, in a technique called "computational steering," three-dimensional imaging is combined with new data management tools, to intervene in complex biomedical, chemical or engineering situations in real-time.

Current "computational steering" research is focused on improving the treatment of severe epilepsy. Using the supercomputer, with information grafted from electroencephalograms (EEG) and nuclear magnetic resonance (MRI) tests, researchers can precisely pinpoint the malfunctioning brain tissue causing an epileptic seizure and identify the best way to remove it, obtaining results in seconds or minutes rather than days or weeks. Other research is helping reduce treatment-related risks for those cardiac patients with a high likelihood of repeat heart attacks.

Human Genome Project -- Computer scientists at Berkeley Lab and the National Energy Research Supercomputer Center in Berkeley, California, are using high performance computing to advance the Human Genome Project - - the massive international effort to better understand human genetic makeup, particularly how diseases are inherited and how they can be stopped. To give some idea of its complexity, the Project's first goal is to map the location of some 100,000 genes arranged along the 23 pairs of chromosomes that make up the full complement of human DNA, and to map the location of three billion "base pairs" found in each chromosome.

Genome Project researchers at NERSC and Berkeley Lab are developing high speed data management tools to organize, catalogue and make easily available the vast amounts of information generated. They are also working on new high performance computing analytical tools for the next phase of the Human Genome Project. These efforts are benefiting molecular biologists at Johns Hopkins School of Medicine, the Protein Data Bank at Brookhaven National Lab, the German Genome Resource Center in Berlin and other Genome Project institutions.