Let me hear your body talk

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Five University of Houston researchers are teaching computers how to listen when your body talks.

Thanks to a $900,000 NSF grant that addresses the needs of the increasing complexity of collecting and analyzing biomedical data, this quintet of UH computer scientists can now more easily tackle this mining of health information from patients in real-time as a team.

With a primary focus of merging non-invasive imaging technologies with computational resources, the grant seeks to extend knowledge of how humans learn, study brain function and behavior, detect cognitive impairment, provide continuous non-invasive monitoring of human physiology, analyze facial expressions and the underlying cognitive state, and improve biometrics-based security.

"The project will involve a hybrid software system designed to acquire, analyze, integrate, securely store and visualize large volumes of data obtained from a human subject in real time," said George Zouridakis, principal investigator on the NSF grant.

An associate professor of computer science and director of the Biomedical Imaging Lab at UH, Zouridakis is joined on the project by Professor Marc Garbey, who is also the chair of the computer science department, Associate Professors Ioannis Kakadiaris and Ioannis Pavlidis, and Assistant Professor Ricardo Vilalta. The grant relies on this team of computer scientists to combine the best existing tools and practices of information technology and to develop software tools specific to the common needs of real-world applications in biomedicine.

Titled "Acquisition of a Hybrid System and Research Infrastructure for Large-Scale Integration of Biomedical Data," the grant is the largest instrumentation grant ever awarded to UH by the NSF. The preliminary results of this grant were obtained as a result of work done on a highly competitive grant funded by Microsoft on "Computational Data Grids for Scientific and Biomedical Applications."

With each scientist having a different area of expertise and a separate laboratory specializing in different structural and functional imaging modalities, the grant seeks to unify these labs, extending the range of technologies and adding computation and visualization resources. Zouridakis' research, for instance, involves dense-array scanners to capture and analyze the electrical, magnetic and infrared aspects of brain activity in an effort to understand brain function and behavior, detect cognitive impairment and disease states, model human learning and develop adaptive training protocols.

As author of several new families of algorithms for distributed computing published in main international journals of the field, Garbey's focus is in computational life sciences and high-performance computing. With expertise in tissue remodeling, applications of his research involve vein graft failure and neurovascular diseases.

Examining the human form and function at the micro and macro levels, Kakadiaris founded and directs the Computational Biomedicine Lab whose members are pioneering research in the areas of cardiovascular informatics and multispectral biometrics. For example, this group has developed technology with the potential to alert physicians to heart attack risk by enabling them to detect regions of blood vessels prone to future rupture and sudden blockage. Early detection is essential in the practice of cardiology to reduce the number of fatalities occurring annually due to unpredicted heart attacks and strokes. In biometrics, the group has developed a radical new approach by combining information from visible and infrared spectrum cameras to obtain a unique biometric signature of a person's face.

Pavlidis, director of the Computational Physiology Lab, has developed an Automatic THErmal Monitoring System, or ATHEMOS, a system that allows a computer to perform touchless physiological monitoring of its human user's health, including measurements of blood flow, pulse and breathing rate to draw inferences about a variety of symptoms on a continuous basis. This aims to add a new dimension in human-computer interaction, aspiring to use the abundant computing resources at home and the office in combination with novel sensing, algorithmic and interface methods to enhance the user's experience, as well as create a new widespread preventive medicine paradigm for computers to one day monitor the actual health of their users during computer use.

Vilalta, whose research involves analyzing massive amounts of data with the goal of extracting meaningful and informative patterns, is co-director of the Data Mining and Machine Learning Group at UH. The group has applications in planetary science and particle physics, such as the automated analysis and characterization of Martian topography. He will be applying this expertise in the analysis of biomedical datasets stemming from multiple sensors.

The grant helps with the training of graduate and undergraduate students working in the labs by encouraging their participation, both as experimental subjects and as researchers. Data from test subjects will be collected by state-of-the-art sensing systems that already exist in the laboratories of the investigators or will be acquired with support from this grant and will include thermal cameras, 3-D geometry video cameras and multimodality brain activity scanners. This hybrid system will be capable of integrating MRI and CT scans, as well as live neurophysiological data collected at remote collaborating institutions.

"This grant will facilitate the development of breakthrough technology in the area of computational biomedicine," said John Bear, dean of the College of Natural Sciences and Mathematics. "And once the system is in place, it will be available to the research community from both academia and industry."

Once a year, a special three-day short course on computational biomedicine applications will be organized by the scientists working on the grant. The course mainly will be tailored to the doctoral level and will be widely open to academics. The next course will be held in the fall of 2006.

Source: University of Houston