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UH researchers helping Pentagon build mind-controlled prosthetics

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University of Houston researchers are helping the Pentagon build reliable mind-controlled prosthetic devices that military and civilian amputees can use the rest of their lives.

Prosthetic limbs that can be maneuvered by neural implants have shown promise in the laboratory, but there are challenges to making them work in the real world. Chief among these obstacles is the neural implants' nearly inevitable failure over time, often in a matter of weeks.

Badrinath "Badri" Roysam, chair of UH's department of electrical and computer engineering and Hugh and Lillie Cranz Cullen University Professor, is leading a multi-institution team effort to identify the combination of factors that cause neural implants to fail.

Roysam and his group have received a three-year, $5.4 million grant from the Defense Advanced Research Projects Agency (DARPA), the military's high-tech research agency. Researchers from Seattle Children's Research Institute, the University of Michigan, Rensselaer Polytechnic Institute and two companies also are involved in the project.

The grant is part of DARPA's Histology for Interface Stability Over Time program, which is the next phase of its Revolutionizing Prosthetics project that began in 2000. The grant money is allocated in two phases, with $3.2 million being awarded immediately and the remaining $2.2 million being awarded based on performance.

Roysam said neural implants can fail within six to eight weeks. Once implanted, the brain treats these tiny devices like foreign objects and immediately begins to try to isolate them for its own protection.

"The tissue surrounding the device undergoes complex changes that in the end isolate it electrically. At this point, it (the implant) stops functioning," Roysam said.
Researchers understand the fundamentals of the brain's reaction to the implants, but they still have many questions that Roysam's team will seek to answer.

The work begins in Michigan, where a team led by professor Daryl Kipke will build specialized neural implants for use in laboratory testing. Researchers at the Seattle institute, under the direction of William Shain, will take three-dimensional images of how different brain cells are reacting to an implant. Shain's lab is a world leader in multispectral laser scanning confocal microscopy, an imaging technique that produces high-resolution three-dimensional images of brain tissue, with each different type of tissue and cell assigned a unique color.

Those images will be transmitted to UH, where Roysam's team will run them through a sophisticated and powerful software platform called FARSIGHT, which will analyze the histology, or cellular makeup, of the images. Developed by a collaborative team led by Roysam with the support of the National Institutes of Health, FARSIGHT will translate these images into data that quantifies the response of each individual brain cell and cell type to the implant.

RPI researchers Kristin Bennett and Mark Embrechts will then use advanced pattern recognition software and techniques to identify the factors that cause implants to fail prematurely.

Using this information, they will recommend design changes to

researchers in Michigan, restarting the whole process.

Roysam, who joined UH last year after working as professor of electrical, computer and systems engineering and professor of biomedical engineering at RPI, noted that each contributing group is a world leader in its respective field.

"I am blessed with a dream team," he said. "We have pre-eminent leaders in implant design, 3-D multispectral imaging, quantitative histology, and pattern recognition on our team. Ideally, the team will be able to make great strides in the understanding of neural implant failure."

"DARPA has a vision of a future where a soldier who has lost a limb will regain full use of that limb again through advanced technology. We're proud to be part of this effort, which will also benefit civilians," he said.

Provided by University of Houston