Medical Xpress

Pushing through brain barriers

October 21 2009

Understanding the inner workings of the brain remains one of the last frontiers in all of neurobiology. A Case Western Reserve University engineering professor is developing a miniaturized low-power device to detect how electrical signals and neurotransmitters in the brain work.

Pedram Mohseni, assistant professor of electrical engineering and computer science at Case School of Engineering, was awarded a $675,000 Faculty Early Career Development grant from the National Science Foundation to pursue the project. The award is stimulus money from the American Recovery and Reinvestment Act.

The brain, which contains trillions of intricately interconnected neurons, is decidedly complex. It fundamentally works by a combination of fast information-carrying electrical signals called action potentials, and chemical neurotransmitters acting on fast time scales in microscopic conjunctions between neurons called synapses. These action potentials are conducted along axons at rates up to 100 meters/second, whereas neurotransmitters, of which there are over one hundred identified to date, will traverse the synaptic cleft and act on target neurons in 1 millisecond or less.

Great strides have been made over the last few years in developing multisite microsensors for monitoring both the chemical and electrical signals in the brain. In sharp contrast, development of instruments for high-site-density brain monitoring supporting these powerful new microsensors has lagged behind considerably. The two main technical limitations of existing devices are large size and high power needs.

Specifically in this CAREER project, Mohseni will develop a miniaturized low-power device for brain use to support neurobiological experiments in small laboratory animals. This new instrument will simultaneously record 16 channels of chemical and electrical neural activity in the brain from multiple microsensors, measuring neurotransmitters and action potentials in real time, as these signals happen, during behavior.

A state-of-the-art engineering method called very-large-scale-integration (VLSI) will be used to fabricate the device, roughly the size of a common cold capsule. VLSI is the same fabrication process used to create integrated circuits that are at the heart of today's consumer electronics and portable devices such as personal cell phones and computers.

Miniature hearing aid or wristwatch batteries can serve as the power supply. To permit natural behavior by the animal during experiments, this device will be safely implanted under the skin and will transmit recorded brain signals wirelessly using an impulse ultra wideband (I-UWB) telemetry link. I-UWB is an elegant communications technique for short-distance high-data-rate telemetry that has traditionally been used for radar imaging and precision positioning, Mohseni explained. Its newer applications include personal computer peripherals such as wireless monitors or printers.

In collaboration with Prof. Paul A. Garris, a neurobiologist/analytical chemist in the Department of Biological Sciences, Illinois State University, the new device will support a novel set of experiments investigating the role of dopamine in sociosexual behavior using the Syrian hamster. This study addresses a fundamental yet unresolved issue in goal-directed behavior and uses an animal model that uniquely lends itself to identifying brain-behavior relationships. Dopamine, an important neurotransmitter, is critically involved in the brain functions of motivation and learning, yet its precise role has eluded definition despite decades of extensive study.

Source: Case Western Reserve University (news : web)