EE Department Seminars

January 25, 2010, Monday, 2 p.m.
Yorgo Istefanopulos Meeting Lounge (KB 217)

Smart Floating Light Activated MicroElectrical Stimulators Neurostimulation Devices that are Optically Powered, Addressable, and Fabricated with Standard CMOS Processes

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Neurostimulation devices have typically been controlled using microelectrode arrays with penetrating shanks. However, the mismatch between the mechanical properties of these electrodes and that of the neural tissue stands as the main cause of tissue response in chronic implants. That is, the implanted electrode is very rigid and when it moves as a rigid body inside the soft neural tissue causes mechanical stress and consequently a strong tissue response. Also, because of the need to connect the electrode contacts to the external electronics, no mater how small and flexible the electrodes are, the tethering of the interconnects contributes to tissue response in chronic implants.

An obvious way of eliminating the electrode shanks and the substrate is to get rid of all the interconnects and transfer the stimulation current to each stimulating electrode wirelessly. In that case, the electrode becomes a floating device both mechanically and electrically. Eliminating the interconnects would improve device longevity by solving the wire brakeage problem which is usually the most common source of failure in implantable neural stimulators. More importantly, the tethering forces due to interconnects, which is the main source of chronic tissue reaction, would be eliminated. Without the wires attached, the electrode would float and move along with the neural tissue as the surrounding tissue experiences translational and rotational movements. Finally, the amount of tissue that is replaced by a floating stimulator without a shank can be much less due to its small size.

We have demonstrated the feasibility of optically activated wireless micro-stimulation with our next step being the development of individually addressable devices in order to increase the number of stimulation channels as required in many neural prosthetic applications. Optical methods allow the design of a device that can generate supra-threshold currents for neural stimulation with device sizes that are in the sub-millimeter range. To that end, we are currently researching the usage of standard CMOS processes to optically power digital and analog circuits for use in micro-electrical stimulation of neurological tissue.

David S. Freedman is a post-doctoral fellow in Professor M. Selim Unlu's group at Boston University focusing on neurostimulation and neurorecording microelectronic devices. He received his PhD in Electrical Engineering in 2010 from Boston University working with mixed-mode circuits for use in auditory biomimetic systems. He graduated from the University of California San Diego with a Bachelor of Science in Electrical Engineering and a Bachelor of Arts in Economics in 2005.