Stanford University

Applied Physics 483 Optics & Electronics Seminar
(Spring 2017 speakers organized by Prof. B. T. Khuri-Yakub)

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ULTRASONIC NEUROSTIMULATION IN THE RETINA

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Noninvasive neurostimulation with near-cellular spatial resolution has applications both in the clinic for diagnosis or therapy of disease, and for basic understanding of neural circuits. Ultrasound is best known for imaging biological tissue, but it has recently been shown that ultrasound can stimulate and modulate neural activity. Although this approach has the potential to reach anywhere in the brain noninvasively, the capabilities of ultrasound have not been fully realized, in part because its mechanisms of action in the nervous system are not well understood.

The retina is a thin sheet of neural tissue with an intricate network of cells that heavily processes visual images before transmission through the optic nerve. We have used the in vitro retina as a test bed to characterize the capabilities of ultrasonic neurostimulation and to understand its mechanisms and effects on neural circuits. I will discuss our studies showing that ultrasound can stimulate retinal neurons with high spatial and temporal precision approaching that achievable with visual stimuli. We have further combined ultrasonic stimulation with optical imaging to observe microscopic mechanical displacements that indicate that radiation pressure is the likely physical mechanism through which ultrasound activates the retina. I will further discuss the prospects for ultrasonic neurostimulation elsewhere in the brain and its potential use as a neural prosthesis.

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