Miniaturized and Minimally Invasive Interfaces to the Brain

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Abstract

Smart and connected medical implants are the next frontier in the Internet of Things (IoT) and are set to revolutionize healthcare. Advancing our ability to interface technology with biological environments will enable patients to be monitored and receive treatment at home, and in the long term, have chronically implanted electronic devices seamlessly integrate with their everyday lives. As an example, clinically viable and minimally invasive neural interfaces stand to transform disease care for patients of neurological conditions. Recently there has been an explosion of research in Brain-Machine Interfaces (BMI) that has shown incredible results in using electronic signals from the motor cortex of the brain to control artificial limbs, providing hope for patients with spinal cord injuries. A major impediment to clinical translation is that state-of-the-art clinical neural interfaces are large, wired and require open-skull operation which leaves the patient at risk of infection and unable to move. Future, less invasive interfaces with increased numbers of electrodes, signal processing, and wireless connectivity will enable advanced prosthetics, disease control and completely new user-computer interfaces.

Substantial improvements in neural implant longevity are needed to transition BMI systems from research labs to clinical practice. In particular, scale and power remain formidable challenges in the realization of chronic and stable neural recording. Currently, there are two opposing trends in the field: (1) increasing number of recording sites, and (2) reduction of implant size. This talk will discuss current and future trends in large-scale neural recording. In particular, we will focus on technology that enables large-scale neural recording in a small and non-obtrusive size and with low power dissipation. Importantly, these implants must perform within the established IEEE and FCC safety limits, while the small size and low power dissipation of the implants minimize the foreign body response and tissue heating respectively.