Passive Wireless Neurosensing System for Multi-unit Neuronal Activity Monitoring

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Intracranial techniques for electrophysiological recording are crucial in assessing normal and pathological neuronal activity. Signal activity can be collected to represent groups of neurons (electrocorticography, ECoG, and local field potentials, LFP) or individual (neuronal spiking) levels, each offering invaluable information about the brain's functioning. To better assess the normal operation of the brain's functioning wireless recorders have been proposed. However, current wireless systems are generally bulky as they require the use of integrated power sources that may lead to heat-generating tissue-damage.

To remove the need for batteries in existing neural sensors, we proposed a passive, wireless, and fully implantable next-generation wireless neurosensing system (WiNS). We have already performed initial *in vivo* validation for recording evoked activation, equivalent of ECoG (C. Moncion, et.al. IEEE JERM, pp. 199-205, 2019). This device consists of an implant and interrogator antenna, and electrodes integrated with a demodulation circuit. Recently, WiNS has been incorporated with an impedance matching network to address mismatches between the neural probes and recording circuits (C. Moncion, et.al., IEEE IMBioC, pp. 76 – 78, 2018). The impedance matching network includes a Schottky diode connected to the electrodes through a bipolar junction transistor to function as an impedance buffer (W.C. Chen, et.al. IEEE JERM, pp. 233-239, 2019). This adaptation along with a novel impedance reducing electrochemical coating on the microelectrodes allowing for strong recording of individual neuronal spikes. This complements our earlier population (neural groups) recordings and is an important achievement.

Building on our WiNS system validation to date, we set out to conduct a study to record the individual activity of multiple individual neurons. Achieving this goal, combined with our previous accomplishments demonstrates that WiNS can be applied for multiscale neuronal activity monitoring. In this paper, we will present *in vivo* recordings of spontaneous neuron activity from the somatosensory cortex and hippocampus. Our recordings have also sensed evoked activity in these regions following electrical hind limb stimulation in 5 rats. These experiments were carried on in compliance with the Institutional Animal Care and Use Committee (IACUC) at Florida International University (Approval No. 17-042). We are currently pursuing measured data and post-processing to extract neural spiking activity at varied rat states. In addition, we are evaluating our system's ability to sense and transmit this high-frequency activity with minimal distortion to key components. The collected data and interpretation of results will be presented at the conference. All in all, a preliminary analysis indicates that WiNS will greatly impact future neuroscience research and lead to practical clinical options.