SAMUELI SCHOOL OF ENGINEERING
UNIVERSITY of CALIFORNIA · IRVINE

Department of Biomedical Engineering

DISSERTATION DEFENSE

Ronald Sahyouni

Friday, 03/09/2018, 3:30p.m.
Natural Sciences II, Room 3212

ABSTRACT OF THE DISSERTATION

NEUROPROSTHETIC APPROACHES TO SELECTIVE FACIAL NERVE STIMULATION

By

Ronald Sahyouni

Doctor of Philosophy in Biomedical Engineering
University of California, Irvine 2018

Professor Hamid Djalilian, Chair

Neuroprosthetic devices have become increasingly important in the treatment of clinical pathologies. In particular, the application of neuroprosthetic devices to restore function following damage to peripheral and cranial nerves has been demonstrated to be efficacious, safe, and is becoming readily adopted in the clinic. Neuroprosthetic devices have been successfully deployed in numerous cranial nerves, including the hypoglossal nerve to treat OSA and the vagus nerve to treat epilepsy, heart failure, and blood pressure. However, the application of neuroprosthetic devices to treat cranial nerve pathologies related to the facial nerve (FN) has not been explored.

FN injury can cause debilitating and permanent damage with oftentimes limited treatment options. In cases of FN injury, patients may develop permanent facial paralysis (FP), which can cause facial muscles to lose tone, and over time, atrophy and convert into scar tissue. FP arises from a variety of causes, including tumor, surgery, trauma or infection, and results in problems

with eye irritation, visual impairment, drooling, intraoral food retention, and demoralizing cosmetic deformities.

In recent decades, considerable efforts have been undertaken to care for patients with permanent FP. Several surgical interventions, including static and dynamic options, have been described for patients with unilateral FP. However, these interventions only address specific parts of the face, have a 10-15% failure rate, and require multiple procedures involving multiple surgical sites to accomplish functional goals. An alternative approach to facial reanimation is the utilization of neuroprosthetic technologies.

We demonstrate the ability of multichannel microelectrode array and multichannel cuff electrodes to selectively stimulate the feline FN in both acute and chronic settings, and couple this technology with closed loop circuitry to allow for restoration of volitional and graded hemifacial animation. We also present data from clinical investigations on human FN selectivity and demonstrate the application of these technologies to the recurrent laryngeal nerve.