CONTROLLING HAND PROSTHESES USING PERIPHERAL INTRANEURAL INTERFACES

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INTRODUCTION

The development of more effective approaches to control dexterous hand prostheses is an important area of research that is currently addressed by several research groups. Among the possible solutions to achieve this goal, interfaces with the peripheral nervous system (PNS) and in particular intraneural electrodes can represent an interesting choice. In fact, they can provide an intimate and selective connection with the PNS without increasing in a significant way the invasiveness [1]. In this paper some recent research activities pursued by my team on this topic are briefly summarized.

DECODING OF GRASPING INFORMATION FROM INTRANEURAL SIGNALS

To verify the potentials of intraneural electrodes to decode grasping information, a thin-film longitudinal intrafascicular electrode (tf-LIFE, Fraunhofer Institute for Biomedical Engineering) was implanted in a right-handed male (P.P.) who suffered left arm trans-radial amputation due to a car accident 2 years ago. An algorithm able to sort spikes from the PNS ENG signals was used to verify the possibility to decode grasping information [2].

Results indicate that the combined used of tf-LIFEs and advanced signal processing/stimulation techniques allow identify different grip types usable to control a prosthetic device [2]. The possibility of delivering sensory feedback was also confirmed [3]. Moreover, training and learning capabilities of human-interface interaction, together with a progressive reorganization of the input/output characteristic of the sensorimotor areas previously governing the lost limb were shown.

Finally, the possibility of combining EEG and ENG signals to increase the decoding ability has been also recently shown [4].

DEVELOPMENT OF NOVEL INTERFACES

Current intraneural interfaces can already provide interesting results in terms of decoding and encoding ability but it still necessary to increase their selectivity, stability, and chronic usability. For this reason, we are investigating alternative solutions such as the "self-opening" [5] and "movable" intraneural electrodes [6], which could address some of these issues (see Figure 1).

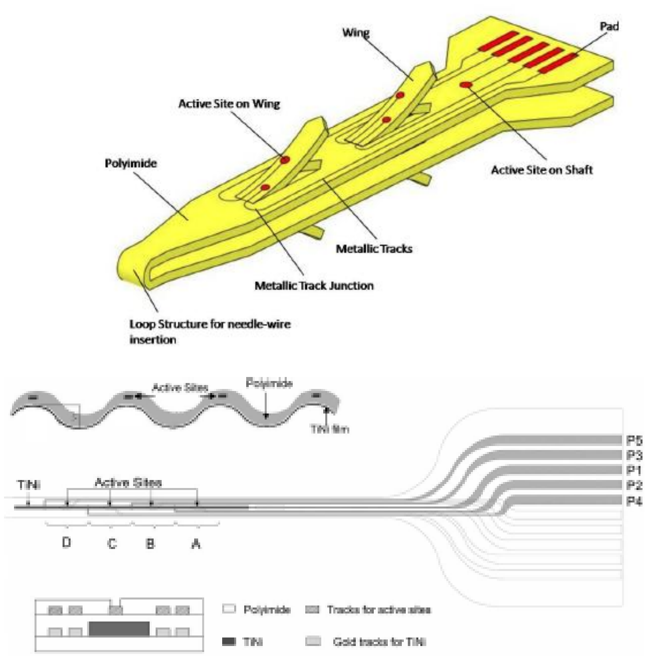

Figure 1: The self-opening (top, [5]) and the movable intraneural electrodes (bottom, [6]).

The possibility of developing more effective intraneural interfaces by using hybrid FEM/biophysical models has been also investigated [7].

DISCUSSION AND CONCLUSIONS

Intraneural interfaces with the PNS can represent a suitable way to create a natural and bi-directional link between the nervous system and artificial limbs.

However, additional efforts are necessary to completely characterize the potentials and limits of this approach and its clinical chronic usability. We are currently pursuing several approaches in order to address these issues.

ACKNOWLEDGEMENTS

This work was supported in part by the European Union (EU) within the TIME Project (FP7-ICT – 2007-224012,

Transverse, Intrafascicular Multichannel Electrode system for induction of sensation and treatment of phantom limb pain in amputees).

This work was carried out by several students and post-doc who are currently working or worked with me (L. Citi, J. Rigosa, J. Carpaneto, S. Raspopovic, M. Capogrosso, S. Bossi, A. Cutrone, P.N. Sergi). The implantation was carried out by the group of Prof. Paolo Maria Rossini (Campus Biomedico University, Rome, Italy).

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