HUMAN MACHINE INTERFACE FOR HAND PROSTHESIS BASED ON COMPUTER VISION AND ELECTROMYOGRAPHY.

Akari Ishikawa*, Dandara Andrade, Amparo Muñoz, Eric Rohmer.

Abstract

Controlling the upper limb prosthesis using muscular contractions requires the amputees intense and long period training, where frustration can lead to abandonment of the device. In this project we are proposing a Human Machine Interface (HMI) not only focused on muscular activity reading but in an innovative solution, based on computer vision. With a camera attached to the prosthesis, we desined a system that identifies objects, and suggests interactions based on the user's preferences.

Key words: Hand Prosthesis, Computer Vision, Human-Machine Interface.

Introduction

Replacing a human limb with an artificial device is a challenge not only for health sciences but also for technological areas. Amputees experience everyday issues like difficulties in executing daily tasks. Although commercial high end prostheses like [1] offer a great set of predefined grasps (14 or more), to deal with daily activities, their selection is based on complex muscle contraction readings (i.e. Electromyography EMG) assigning one contraction to one grasp. This is another challenge for the amputees due to the damage to their muscles near the amputation, which often leads to the abandonment of the prosthesis. We propose an innovative solution based on hybrid EMG and computer vision, to facilitate the selection of the type of interaction with everyday life objects for high end but also low cost open hardware prosthetics like in [2].

Results and Discussion

As seen in Fig. 1 the amputee is simply *taking a picture* of the object to interact with, using the embedded camera inside the prosthesis. The object in the picture is recognized using a machine learning algorithm and by looking in a database it finds associated grasping types and suggests the most probable ones. The user simply *validates* the selection to interact with the object, ask for the *next* suggestion, or *cancel* the interaction. These four actions (in *italic*) are *achievable* with the EMG device, reducing drastically the complexity of the selecting process compare to the traditional one.

Figure 1: Overview of the platform in use

Using this technique, we are not limiting the number of possible predefined interactions to grasping and can even

extend them to some specific actions to interact with a particular object (e.g. a computer mouse). Figure 2a presents some possible object interactions achieved by a generic simulated hand using V-REP robotic framework [3]. The performances of the prosthetic to suggest the most appropriate grasp is correlated to the performance of the image classification algorithm and the database.

Figure 2: a) Seven possible interactions. b) Classification of a picture and selection of the associated grasping.

In Fig. 2b are shown three pictures taken in real conditions of use. Even though the objects are sometimes transparent (bottle), located in cluttered environments (bottle), partially cropped (bottle and keyboard), or without texture (bottle and mouse), the algorithm successfully nametags the object in the image. The database that associates interactions to nametags is constantly growing and "adjusting" to the amputee's preferences as he uses the system.

Conclusions

Our motivation for this project was based in two objectives: build an **easy to use** prosthesis with **lower costs**. Compared to other prostheses interfaces, ours has a reduced complexity and allow the selection complex of interactions with everyday objects, providing an experience closer to reality and a less frustrating learning process. Thus, we are expecting the proposed HMI to have a better acceptance among the amputees.

[1] Bebionic hand: <http://bebionic.com/>

[2] J. E. F. Hernandez, V. Ferman, A. Lemus, E. Rohmer. "An Affordable Open-Source Multifunctional Upper-Limb Prosthesis with Intrinsic Actuation." In proc of the IEEE Workshop on Adv. Robotics and its Social Impacts, 2017.

[3] E. Rohmer, S. P. N. Singh, M. Freese. V-REP: A versatile and scalable robot simulation framework. In 2013 IEEE/RSJ Int. Conf. on Intel. Robots and Sys. 1321 – 1326, 2013.