EEE 401 Group Design 2019/20

Brain Computer Control of a Hand Orthosis

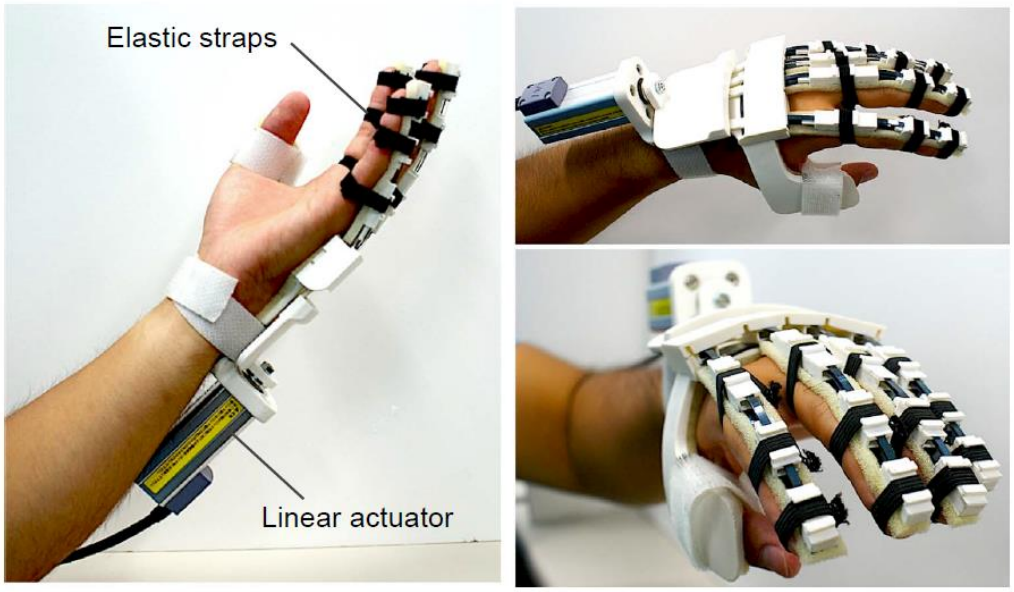

Figure 1: The Arata orthosis design

Your Group Design project is to fabricate the hand orthosis in Figure 1, as presented in the following paper:

Arata, J., Ohmoto, K., Gassert, R., Lambercy, O., Fujimoto, H. and Wada, I., 2013, May. A new hand exoskeleton device for rehabilitation using a three-layered sliding spring mechanism. In 2013 IEEE International Conference on Robotics and Automation (pp. 3902-3907). IEEE.

You are to then acquire EEG signals from human subjects and use their intent to move their arms up or down to open or close the orthosis (by energizing the actuator).

I have split the task as follows:

1. [TASK 1] Acquisition of signals using OpenBCI
   You will master how to acquire EEG signals using OpenBCI. This will entail becoming familiar with EEG, types of EEG, the specifications of EEG systems, the 10-20 international system of electrode placement, actual use of the OpenBCI (safely and accurately applying the electrodes), acquiring signals from the EEG, storing them. They will also master aspects of EEG data acquisition protocols: how to select patients, how to officially obtain consent, typical session lengths, how to provide cues etc.

2. EEG Signal processing to extract movement intent

   Once the EEG signals are acquired, they must be processed to extract movement intent. This can be split into two sub-categories of tasks.

   a. [TASK 2] Determining a suitable physiological process or event related potential that can be used for extracting movement intent. In order to do this, the students in this task must do some reading, particularly from the textbook by Rao, to know the general

categories of ERP that can be used. I will then link them up with a graduate student in Germany, Marius, who will advise them on which to use, and how to go about it. They must write code to preprocess the acquired EEG signals, and then extract the ERP, which will serve as feature vectors for the classifier aspect.

b. [TASK 3] They must build a classifier (some sort of deep network preferred, but you're free to propose alternatives) that will be trained using the feature vectors above to detect whether the hand is being moved up or down. They must also use this information to actuate the orthosis to open or close.

3. [TASK 4] Construct an orthosis which can be actuated by the classifier
   Students under this task must fabricate a working version of the Arata orthosis in the reference above. They must read this paper as well as two other related Arata papers. They must they fabricate a version of the orthosis which can be actuated by the software parts above. I have given this same project to Macaulay Michael, a Part V student. While I expect you to independently fabricate your orthosis, you can collaborate with him. 3D printer and 3D filament will be made available to you free.

Assignment

TASK 1: Emmanuel and Michael (*any other person can volunteer to join)*
TASK 2: Michael and Emmanuel *(any other person can volunteer to join)*
TASK 3: Fawaz *(any other person can volunteer to join)*
TASK 4: Lawson and Fawaz (*any other person can volunteer to join)*