Vibrotactile sensory feedback in hand prostheses

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Abstract— **Reports showed that the lack of sensory feedback in myoelectric hand prostheses increased the rejection factor for the user.**
Purpose: **The aim will be to investigate necessary functions needed in a sensory feedback system in a hand prosthesis and look into appropriate hardware that fulfills these requirements.**
Methods: **The core hardware is built on two Arduino Nano circuits. The force sensing sensors, electromyography sensors and the sensory feedback vibrators are the main components for the setup.**
Results: **This project is ready to test electromyographic controlled hand prosthesis with sensory feedback. In addition to this, several features have been added to the setup such as an calibration mode with Bluetooth interface, a real time clock and the opportunity to store information on an SD card.**
Conclusions: **Even though this project resulted in a successful, functioning sensory feedback system, it needs to be evaluated and preferably on amputees.**

I. INTRODUCTION

IMAGINE that you would grab a glass of water, but you would not know if you grabbed it, nor how hard you are holding the glass unless you have visual feedback, meaning, you need to focus your attention at the glass the whole time. This is an everyday challenge for prostheses users. A straight forward and uncomplicated hand prostheses that fulfill their purpose of improving the quality of life for a person in need of aid and also provide full sensory feedback simply are not commercially available. Such sensory feedback system could coexist with myoelectric control system so that amputees can experience a robot-like advanced hand prosthesis as part of their own body.

The experimental design is a sensory feedback where vibrators act as feedback. So grabbing a glass of water will give sensory feedback as vibration force on the upper arm or other suitable placement.

II. RESULT

The complete setup contains a fully functional sensory feedback system. In addition to all the hardware some software features are also added such as sleep mode, mapping values according to the hardware and storing these in text files. A graphical view of the setup is shown in figure 1.

The setup is built on two main parts. The first part consist of a Ottobock myobock hand prosthesis and five force sensing resistors attached to it. These are connected to a Arduino Nano card called the slave. The two Arduino cards (slave and master) are connected with a two wire interface. The second part is the master Arduino with different attachments and it is here most of the code is run. The master Arduino have the electromyography sensors attached to it along with the sensory feedback vibrators and a few breakout boards.

The breakout board consist of a Bluetooth card so the setup can be calibrated wirelessly. There is a SD card to store important data and a real time clock to keep track of time.

Since the setup will be powered with an external power source (battery) a sleep mode was implemented. The current drawn from the circuit was at approximately 180mA and dropped to about 35mA when sleep mode was enabled.

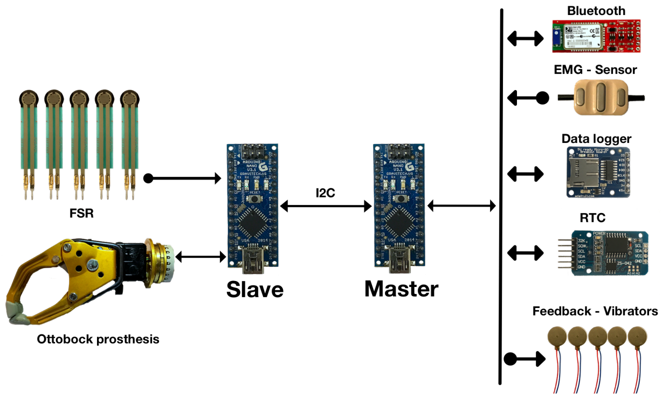

Fig. 1. An active electrical hand prosthesis from Ottobock.

III. DISCUSSION

By introducing two microcontrollers in the hand prosthesis setup, it opened up a world of new possibilities to connect and implement a diversity of new sensors. Only a fraction of them were implemented in this project.

IV. CONCLUSIONS

This project resulted in a successful, functioning sensory feedback system, it needs to be evaluated more thoroughly and preferably on amputees. Even though one can try to figure out what a patient or user would prefer in a sensory feedback system, to conduct a truly accurate investigation, would be with authentic test subjects. Many improvements would arise during the patient testings.

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