Development of a Sensor Glove or Wearable for Multi-Articulating Prosthetic Hands

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Several studies have shown that sensory feedback in active prostheses would partially unburden the patient and might improve prosthesis acceptance. The goal of this thesis was the development of a wearable device able to measure grasping forces and transmit them wirelessly. It will be part of the innovative FeetBack project, which investigates using the foot sole for feedback purposes. In a clinical study said project will evaluate feasibility and patient benefits of this.

Introduction

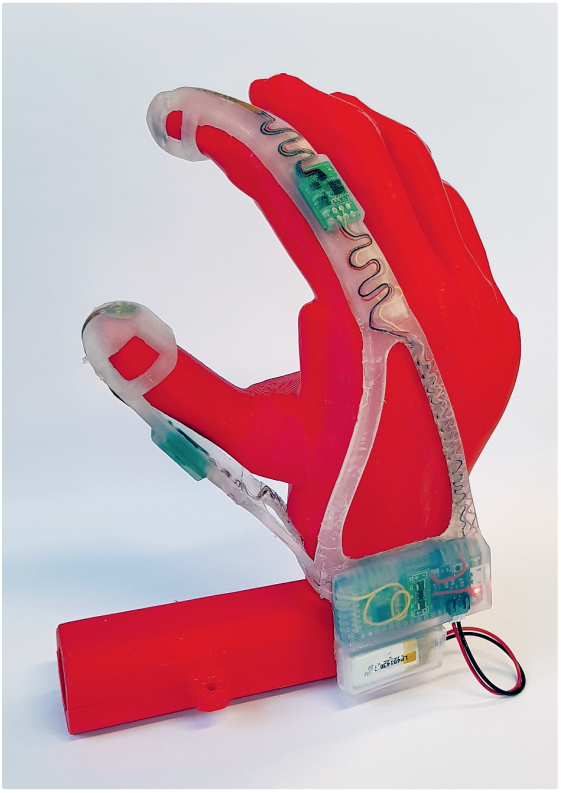
While there are several models of upper limb prostheses available on the market, they are very limited in providing sensory feedback.

The Biomedical Lab of BFH-TI has collaborated in several projects involving feedback in active upper limb prostheses. Subsequently, the FeetBack project was initiated to investigate the foot sole of patients for grasping feedback.

Objective

The goal of this thesis was the development of a wearable system, capable of sensing grasping forces to be used in a clinical study on the FeetBack project. For this purpose the wearable should be easy to mount and in no case hinder the movement of the prosthesis when used. In addition it should be usable by different test subjects. Consequently, it would have to endure several tests without breaking and should be easy to clean. The sensor must meet certain standards in terms of repeatability and sensitivity.

Appropriate electronics and materials had to be selected in order to satisfy the aforementioned requirements. Furthermore, a manufacturing procedure for a reliable repeatability had to be defined. Finally, the device had to be tested thoroughly.



Final prototype of grasping-force sensing wearable Device. The electronic components are completely embedded in silicone.

Methods

The feedback device, located on the foot sole, does not allow for differentiation between the fingers. Hence, it had been assessed that sensing the forces on the index and thumb would be sufficient to determine the applied load.

The wearable was made of silicone, as it is robust and easy to clean. The device was created by casting the silicone into 3D printed molds designed to house the electronics and cabling. The final shape was obtained by adding layers in subsequent steps. As a result, the only openings are the micro-USB and battery port.

Testing was performed with an indenter applying a known load. It was then compared to the measured value. Finally, the output was calibrated and slightly post-processed.

Outlook

The wearable device is designed specifically for the clinical study and is only able to measure grasping forces. The fingertip of the index closely resembles the other three fingers and the communication protocol used is I2C. Extending the device to support sensing for all the fingers or adding other sensors is therefore viable with minimal changes. As a result, differentiation of the fingers or temperature sensing could be added. Furthermore, it might be interesting to add slippage detection.

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