Development of a Hand Exoskeleton for Somatosensory and Motor Training

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Robotics
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Robotic rehabilitation therapy can yield better results than conventional rehabilitation therapies for motor impairment by providing high assistance intensity and live objective data. Devices solely focused on motor rehabilitation do not benefit patients with sensory deficits. An active hand exoskeleton is developed that targets both motor and sensory rehabilitation.

Introduction

Most available rehabilitation hand exoskeletons cover the user's skin, thus reducing natural somatosensory feedback.urthermore they are not compatible with novel rehabilitation techniques such as transcutaneous electrical stimulation.

Goal and challenges

In this work a device is built that provides enough range of motion and force to move the fingers and execute common hand gestures such as grasping an object, tapping on a flat surface and pinching with the thumb and another finger. It provides finger position tracking to analyse the finger movements and possibly recreate the hand in a 3D environment, where the patient could grasp virtual objects and feel them pushing back. The device may be used in combination with electrical stimulation and shall hence be electrical noise-proof. The weight and volume of the device shall be minimized, as to provide a seamless experience to the patient and it shall be easy to put on and off. Finally, the device shall cover as little surface of the hand's palmar side as possible as to maximize natural somatosensory feedback.

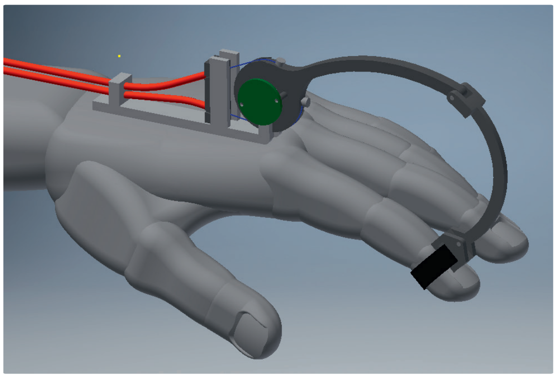

Figure 1: Mechanism for one finger

Materials and Methods

Bowden cables (Steel cable through polymer tubing) are used in order to minimize weight and increase potential force output by allowing placement of the actuators, motors and control unit away from the hand. The cables wind up around a motor's axis and the capstan of the mechanism, so they extend or flex the connected finger as the motor turns.
This mechanism is comprised of serially linked segments, strapped on one end near the fingertip and on the other to the dorsal side of the hand.
The finger position tracking is done using encoders on the active joint of the mechanism for precise angle readings.
The unique parts are 3D printed to minimize weight and volume of the device whilst still providing enough stability to move the fingers without tearing.
a Microcontroller takes care of driving the motors, reading the encoder values and outputting data for the 3D visualization.

Outlook

The device will be tested by a small group of healthy participants for feedback on potential improvements. It can then be used to track fingers and give haptic feedback in a 3D environment for therapy, as well as industrial and consumer applications using virtual reality.

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