RFA for the Foot Posture Sensor Insole

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Problem:

Some patients with injuries develop a bad foot posture while walking, which can lead to knee issues and muscle mass loss. In growing children, if bad foot posture is not corrected, it can lead to significant muscle loss and even uneven growth in height of legs. Patients with mild cases of cerebral palsy also suffer from this and the only solution currently is physiotherapy and slings.

Solution:

We propose to design shoes with pressure sensors embedded into the sole which will be prescribed by physiotherapists for patients. The sensors will detect bad foot configurations as determined by a physiotherapist and we will provide haptic feedback (vibrations) to alert the patient and to help them change their habits.

The pressure sensors will be connected to a processor which will be on a PCB that we will design. The processor/battery will be put on either the tongue of the shoe or on an ankle band, depending on size. The band will be an extra piece to wear, but is a much better alternative to bulky slings.

The device will be programmed by the physiotherapist using software we will provide. The device itself will have a start/stop recording button. The software will display a picture of the foot with all the pressure sensor positions shown on it. The physiotherapist will press start and ask the patient to walk and then press stop. After transferring the data over a micro-USB the software will display the different readings from the sensors as they had occurred in real-time. This will let the physiotherapist know what he or she is dealing with. Next, he or she will have to choose when the vibrations go off based upon the relative difference in the readings from the sensors. He or she will then upload this data into the PCB through the micro-USB.

If someone has bad posture, they continuously keep their feet in the same wrong orientation while walking (confirmed by a physiotherapist). Therefore, once programmed, the insole will not need to be continuously updated, though occasional check-ups and reconfigurations may be necessary.

Either on the ankle band or somewhere on the shoe we will have a button that can be pressed which will shut off the vibration in cases where the user doesn't want vibration like sitting or other situations.

Possible Additional Features:

Counting how many times the vibration went off and recording the data. Use this data over a few months to see if the number of vibrations go down. The physiotherapist will be able to download this number of vibrations data through a micro-USB.

Solution Components:

Hardware

- Subsystem 1: Pressure Sensors - A number of pressure sensors will be embedded into the sole of the shoe. We are looking at two alternatives for this right now:
    - 5kg - 50kg Resistive Pressure Sensors
    - 50kg Half-bridge Load Cell Body Scale Weighting Sensors
- Subsystem 2: Power - Replaceable battery
- Subsystem 3: PCB - This will include a microprocessor to analyze the data incoming from the sensors and a micro-SD to store data.
- Subsystem 4: User Feedback - We need something to generate vibration for correctional notifications.
    - Mini Vibration Motors
- Subsystem 5: Buttons - We are looking at 4 buttons for the user to control behavior (turn off, turn on, start recording/stop recording). These can be accomplished with simple push buttons. These buttons will be used as input for the processor.

Software

- Subsystem 1: Basic program for the PCB that checks for any of the physiotherapist's conditions.
- Subsystem 2: Basic program/user interface to show the doctor what happened while he or she collected data and to allow him or her to tweak the condition in which the feedback goes off.

Proposed Timetable:

- Milestone 1: Hardware development -- Decide best placement of sensors on insole to get usable data and create PCB design. We may need to consider placement of PCB, sensors, and vibration motors; we want the insole to be comfortable, and lightweight.
- Milestone 2: Software/app development -- Decide how to collect and visualize data onto a simple, user-friendly application which can be used at orthopedic appointments to track progress. The data collected should also help correct posture in real-time through vibrational reminders.
- Milestone 3: Additional features if time permits.

Criterion for Success:

- The pressure sensor insole can accurately and reliably transmit weight distribution data to microprocessor to map/visualize foot orientation.
- If the user has an incorrect foot posture, the device should set off a vibrational reminder to correct foot posture.
- The device can be controlled and data can be visualized through a software application.