BME 484 Biomedical Engineering Capstone Design

Project Proposal

Project Title: Intelligent Rock Climbing Shoes Using Pressure Sensing Technology for Contact Detection in Lower Extremity Prosthetics

Team:
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Abstract: Rock climbing with any prosthetic is a feat, however it is especially challenging for a lower extremity prosthetic user. While a person with an upper extremity prosthetic is able to see when they make sufficient contact with the hold, lower extremity prosthetic users do not have this ability. In addition to this, they cannot feel how much contact is made with the rock climbing hold. This project aims to solve this problem by developing intelligent rock climbing shoes that identify when sufficient contact is made, and allow disabled climbers an additional level of confidence. The shoe will be embedded with pressure sensors that, when activated, are able to measure the amount of force applied. Using this information, an algorithm will be created and executed in an app created in Android Studio, that will determine the climber's stability based on the reading from the pressure sensors. When completed, a user will be able to hear an audio signal in their headphones, via a bluetooth connection, when their prosthetic makes stable contact with the holds. Additionally, in the app the user will be able to calibrate the shoes to their specifications and also manipulate information such as weight for a customizable experience.

Innovation: There is a need for a basic climbing shoe that fits on a general prosthetic foot and gives direct real-time feedback for entry level climbers who do not wish to buy expensive climbing specific prosthetics.

Materials:
- Flexiforce pressure sensor A201-100lb- $120.50 for 8-pack
- Breadboard
- PCB
- Resistors
- buzzer
- ADC/DAC
- 3D printed protective case
- Rock climbing shoes- inexpensive when purchased used, $10-20
- Bluetooth modem
- Rock Climbing holds- can get various free holds or a set of 20 for about $30
- Plywood

Subtasks:

- Collect the necessary materials
- Create a circuit on the breadboard to test the pressure sensors
- Put the pressure sensors in the shoe and test the average output of human weight
  - Record values of multiple sensors when stepping on objects
  - Determine the value and number of sensors that translate to sufficient contact
- Test and optimize the system
  - Connect the pressure sensors to the PIC
  - Create software that describes a sufficient contact
  - When sufficient pressure is created, activate buzzer
- Create an app and connect app to software
  - Allow through app, to connect PIC to phone using bluetooth
    - Allow for weight calibration
  - Create audio output from phone based on prompt by user
    - Connect audio to the pressure reading
    - Connect vibrational feedback

Timeline:

iClimb Capstone Design Timeline	Timeframe
1. Team & topic	09/11/17
2. Design	09/18/17 – 09/25/17
3. IRB application (if applicable)	09/25/17 – 10/30/17
4. Mid-year progress report	10/30/17; 11/27/17 – 12/11/17
5. Project prototype	09/25/17 – 12/04/17
6. Testing & improvement	12/04/17 – 03/12/18
7. NEBEC Conference paper	11/27/17 – 02/05/18
8. Grant proposal (TBA)	03/05/18 – 03/26/18
9. NEBEC Conference (TBA)	04/09/18 – 04/23/18
10. Final Report	04/09/18 – 05/07/18

References:

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[2]M. Hessert, M. Vyas, J. Leach, K. Hu, L. Lipsitz and V. Novak, "Foot pressure distribution during walking in young and old adults", *BMC Geriatrics*, 2005. [Online]. Available: https://bmcgeriatr.biomedcentral.com/articles/10.1186/1471-2318-5-8. [Accessed: 18- Sep- 2017].

[3]Ridley, Harriet. (2017, May 9). "The New Adaptive Foot: A Step Forward For Adaptive Climbing". [Online]

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[4]"VA Adaptive Sports Home", *Va.gov*, 2017. [Online]. Available: https://www.va.gov/adaptivesports/. [Accessed: 17- Sep- 2017].

[5]"3 Top Harmful Effects Of Wearing High Heels - Joint Essential", *Jointessential.com*, 2017. [Online]. Available: http://www.jointessential.com/3-top-harmful-effects-of-wearing-high-heels/. [Accessed: 13- Nov- 2013].

[6]"Getting Started | Android Developers", *Developer.android.com*, 2017. [Online]. Available: https://developer.android.com/training/index.html. [Accessed: 19- Sep- 2017].