Development of a Smart Walking Cane with Biofeedback

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Introduction

- 27 million adults suffer from Osteoarthritis in the United States
- Reducing knee adduction moment, KAM, has been shown to decrease pain and improve function

- Wanted to create a walking aid that encourages increased cane loading and KAM reduction using a vibrotactile biofeedback loop
Device Requirements

- Provide cane load biofeedback
- Mobile battery operated
- Able to store data
- Person up to 113 kg (250 lbs)
- Able to measure force from 0N to 222N
- Able to record date and time
- Similar weight to conventional cane.
- Able to mechanically withstand up to 222N
Initial Design

- Force Link outputs charged based on piezoelectric effect. Displacement results in a charge being created.

- When compressed an Inline Amplifier creates a charge from 0-5V; can detect up to 265N.

Handle holding electronics bent during testing
Current Design

- 6mm motor
- On and off switch
- PBC protects components and allows for sturdy exterior
- Smart Cane provides biofeedback in the form of a vibration when 20% of user’s body weight is loaded
Electronics

- Promicro controls computerized system
- Open logger allows data to be stored on SD card
- Real Time Clock records actual time and date for record keeping
- Motor controller controls vibrating motor
Electronic Communication

- **Motor Controller**
- **ProMicro**
- **RTC**
- **SD Logger**
- **Inline Amp**

**Pulse Width Modulation (PWM)**

**Inter-Integrated Circuit (I²C)**

**Serial Link**

**10bit Resolution Analog Pin**
Force Measurement Validation

Force Measured by Cane and Force Plate

RMS Error ±2.5 N
Arduino Software

- Records force
- Records peaks
- Turns motor on and off
- Loop repeats every 20 milliseconds, 50 hertz
### Conclusion

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Smart Cane</th>
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<tbody>
<tr>
<td>Provide cane load biofeedback</td>
<td>Vibrotactile feedback loop</td>
</tr>
<tr>
<td>Mobile battery operated</td>
<td>Untethered and uses Li-ion batteries</td>
</tr>
<tr>
<td>Able to store data</td>
<td>Data logger uses SD card</td>
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<tr>
<td>Person up to 113 kg (250 lbs)</td>
<td>Yes</td>
</tr>
<tr>
<td>Able to measure force from 0N to 222N</td>
<td>Up to 265N</td>
</tr>
<tr>
<td>Able to record date and time</td>
<td>Uses RTC for real time and date</td>
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<tr>
<td>Similar weight to conventional cane.</td>
<td>About 2 kg of weight added</td>
</tr>
<tr>
<td>Able to mechanically withstand up to 222N</td>
<td>New PBC model is able</td>
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Acknowledgements and Questions

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