Mobility Cane

Team 14

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Mentors: Milton Aguirre, Sponsored by Walqer LLC, **All rights maintained**

Customer Background

Most cane options on the market cannot quantify walk data or give feedback to the user. This makes correcting and noticing gait deficits such as knee osteoarthritis, more difficult. Developing a smart cane that can give corrective feedback on walking will help decrease mortality rates and decrease KAM and knee osteoarthritis.

Problem Statement

Our aim of this study is to design and integrate a system of sensors that produces a metric of walking that can quantify and improve walking habits while using a cane.

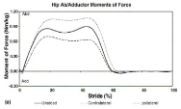


Figure [a]: KAM

Figure [a] shows KAM forces on both knees.

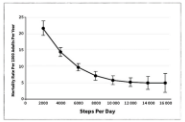


Figure [b]: Steps/day

Figure [b] shows the correlation between steps/day and mortality rate.

Requirements

Requirement	Solution
Collect gait data [HR, force, & position]	HR sensor [beats/min], strain gauge [force 5%-35% BW], accelerometer [step increment up to 10,000]
Charging capability	Lithium Batteries SoC[0-100%]
Data Transfer	Bluetooth + Display [0-4 Walq Score]

Walq Score = [(BW score)(0.6) + (Step score)(0.4) = Weighted score **Max Weighted Score = 4

BW Goal (20%)	Score (out of 4)
19-21%	4
17-19% & 21-23%	3
15-17% & 23-25%	2
<15% or >25%	1

Step Count	Score (out of 4)
10,000+	4
8,000+	3
6,000+	2
4,000+	1

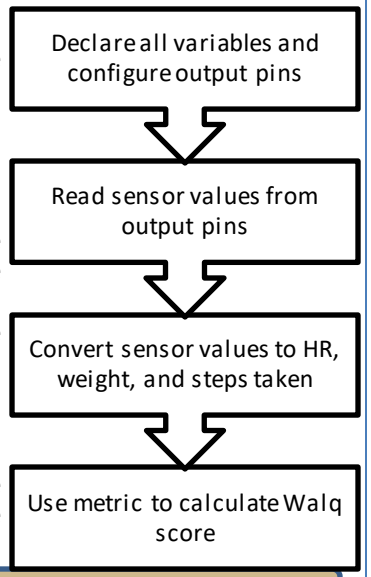
Walq score is composed of two components that influence the overall weighted score. 60% of weight comes from force output and 40% from step count with a maximum weighted score of 4.

Experimentation and Concepts

Accelerometer Calibration: The user walks with the cane and the accelerometer readings from the steps are taken. Every time the cane reaches the top position in the motion a step count is incremented.

Heart Rate Calibration: The user will place their thumb on the heart rate sensor and the raw data values are monitored. Every beat over a 60 second interval is recorded to calculate the users BPM.

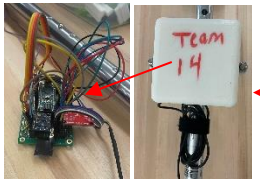
Strain Gage Calibration: Three known weight values were placed on the strain gage. The outputs were graphed to calculate the slope of the line to find the conversion factor from output of the sensor to a force value.



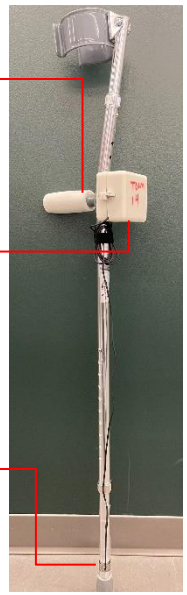
Final Design

Handle: Hollow 3-D print that contains HR sensor & wires and is secured to cane via existing metal tube.

Housing: Contains board[Arduino Nano], Bluetooth module, lithium batteries, and all wires configured for sensors.

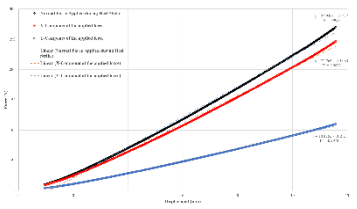


Strain gauge: Contained between two custom-made SS pieces threaded to the strain gauge and contained within the cane shaft



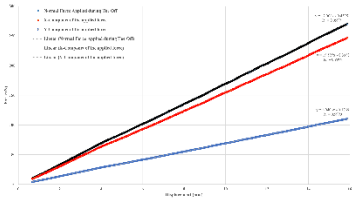
Testing

Heel Strike

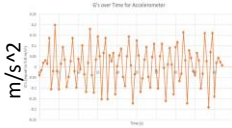


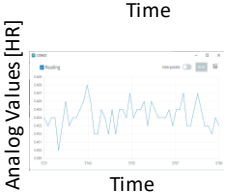
Heel strike: has a large slope indicating a greater stiffness in the heel strike.

Toe-off



Toe-off: has a smaller slope indicating a lesser stiffness in the heel strike.





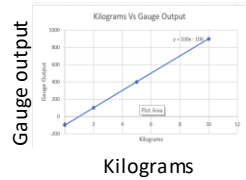


Figure 8 shows the output of the final Walq score which is driven from the plots on the left. The output of figure 5 represents position data. Figure 6 represents HR. Figure 7 represents force data.