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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.



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.

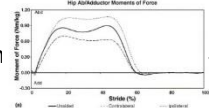


Figure [a] shows KAM forces on both knees.

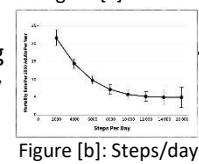


Figure [b] shows the correlation between steps/day and mortality rate.

Requirements

Requirement	Solution
Collect gait data [HR, force, & position]	HR [HR sensor], force [strain gauge], position [accelerometer]
Charging capability	Lithium Batteries
Data Transfer	Bluetooth + Display

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.

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

Experimentation and Concepts

Figure [c] displays the logic used for the HR sensor

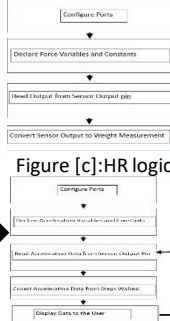


Figure [d] displays the logic used for the accelerometer

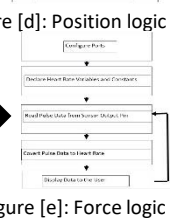


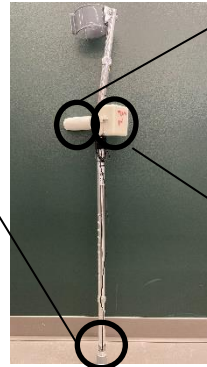
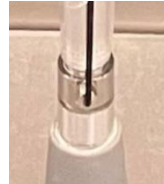
Figure [e] displays the logic used for the strain gauge

Cane testing: The user was instructed to take ten exaggerated steps and apply a relatively light force to the cane on each step. The user maintained their finger position on the cane handle for the HR sensor. Data was sent via Bluetooth device and referenced for accuracy.

Instron testing: The first configuration [heel strike] was tested by loading the heel at a rate of 10N/s until 270N was reached. This was repeated three times and these steps were completed for the second configuration [toe-off] as well.

Final Design

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



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



Housing: Contains board and all wires configured for sensors.

Testing



Figure [1]



Figure [3]

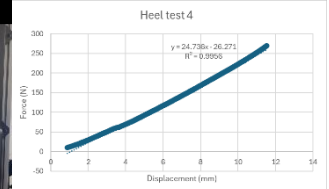


Figure [2]: Heel strike

Figure [2] has a large slope indicating a greater stiffness in the heel strike

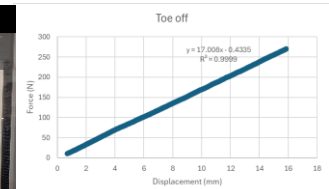


Figure [4]: Toe-off

Figure [4] has a smaller slope indicating a lesser stiffness in the heel strike.



Figure [5]

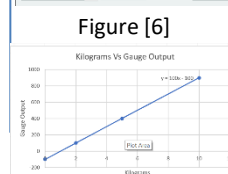


Figure [6]



Figure [7]

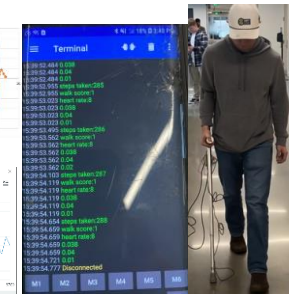


Figure 8 shows the output of the final Walq score which is driven from figures 5, 6 & 7. The output of figure 5 represents position data. Figure 6 represents HR. Figure 7 represents force data.