Design and Verification of an Autonomous Gait Monitoring Device

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Summer Undergraduate Research Experience and Clare Boothe Luce Scholarship

Rationale

- Canes are common, low impact, devices used by a large number of individuals to prevent fall injuries.
- Over 4 million patients in the U.S. use a cane, and 82% of these patients do not receive proper training.[1-2]
- There is very little research on the quantitative effect of cane usage for physicians to reference and there are no means of monitoring the patients cane usage.
- Our goal is to create a self monitoring cane that can collect gait speed, frequency, and weight that it is bearing to inform physical therapists of dangerous habits before an injury.

Methodology (Creation)

- VL53LOX: Time of Flight Distance Sensor used to verity position within gait cycle.
- 2 Force Resistive Touch sensors used to verity the user holding the cane as well as record the weight being placed onto the cane.
- BNO080: Inertial Measurement Unit used to record cane positioning and speed.

Image 1: VL53LOX Time of Flight Distance Sensor.

Image 4: Feather M0 Processor

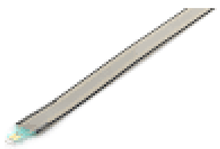


Image 2: Force Resistive Sensor

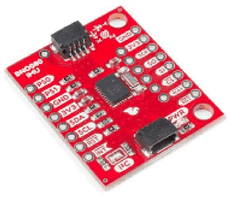


Image 3: BNO080: Inertial Measurement Unit

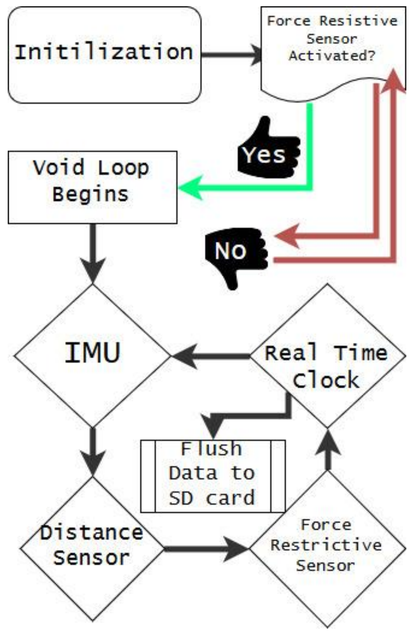


Figure 1: Flow chart of code used to extract data from the cane.

Verification and Results

IMU Verification

- A servo motor with a rotational range of 0 to 180 degrees was set to a 10 rpm frequency.
- The IMU then recorded the angles from the servo motor with less than 1% error.

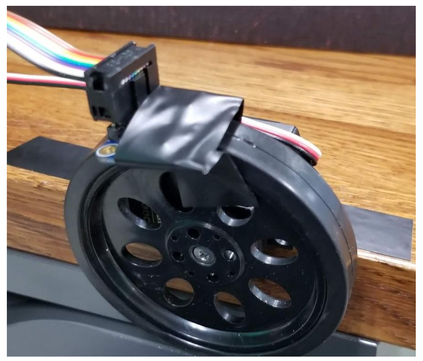


Image 5: Set up for IMU verification test

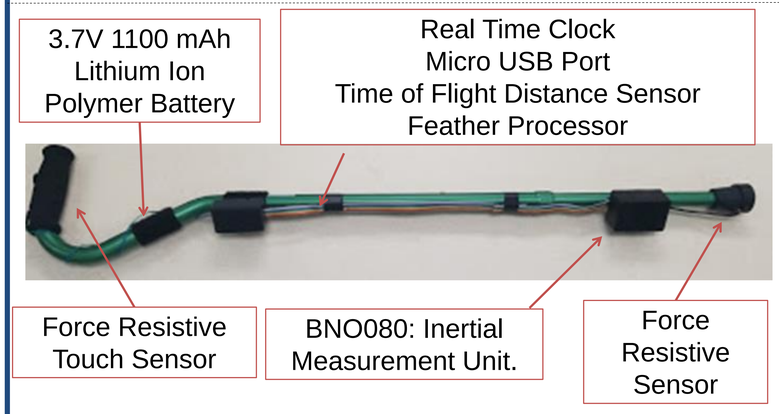


Figure 2: Cane Prototype V.1

Load Cell Verification

Initial hardware included a load cell in the foot of the cane to calculate the weight put onto the cane by the patient. The average error was found to be ±21%, when comparing to data gathered from a 40x60” Bertec force plate at the University of Dayton Motion analysis laboratory to the load cell.

We are now exploring the use of a lighter fore resistive sensor instead.

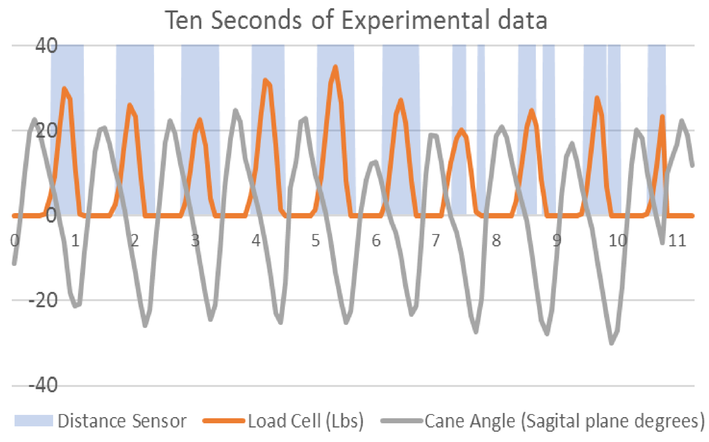
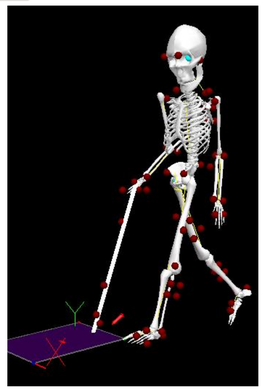


Figure 3: First prototype experimental data.

Conclusions

- Removal of load cell significantly decreased cane weight and subsequent momentum.
- Future work will be completed to determine if the device can properly replicate a laboratory setting.
  - Use of Motion Analysis laboratory at the University of Dayton to further research.



Acknowledgements and References

This work was funded through the University of Dayton Summer Undergraduate Research Experience Program and Clare Boothe Luce Research Scholarship

1. Winston Wu, et al. The SmartCane System: An Assistive Device for Geriatrics, 2008
2. Rebecca Routson, et al. Smart Cane with Vibrotactile Biofeedback Improves Cane
3. Loading for People with Knee Osteoarthritis, 2014