Smart Walker

Aidan Burich, Henry Salita, Carolyn Randolph, Nial Donohoo, Nicholas Maldonado

Client: Dan Kutschera, PT Advisor: Dr. Duc-Huy Nguyen

Abstract

- Traumatic brain injury (TBI) patients often rely on a walker for mobility
- Tasked with fabricating a device that attaches to walker to measure pressure exerted, distance, and speed
- These metrics will allow therapists to clearly evaluate rehabilitation progress
- Designed electronic circuit and code that reads and displays data from lidar and pressure sensors

Problem Definition

- Physical therapists often utilize walkers in rehabilitation of patients with TBI
- Practitioners often struggle to show patients that they are improving, as well as documenting improvement for insurance purposes.

Figure 1: 2024 Final Design and Assembly

- Today, these metrics are gathered manually and cannot quantify load making measurements inconsistent and difficult to track
- Previous designs altered the structural integrity by cutting into the legs making it unusable in a clinical setting
- Our design aims to be minimally invasive while still demonstrating patient improvement

Design Criteria

- Records pressure, speed, and distance accurately and consistently
- Reliable for at least 10 meters of travel and 30 minutes of use
- Removable and compact attachments that do not interfere with the walker and compatible with existing two-wheeled walkers
- Easily sanitized between patients
- Supports up to 140 kg (≈300 lb) of patient weight [1]
- Follow all ISO/FDA legal standards [2][3]

Final Design

Circuitry Design

Arduino Uno Rev 4 Wi-Fi
- Microcontroller for system
- Has Wi-Fi and bluetooth capabilities

LiDAR Lite V3
- Emits a 905nm single-stripe laser
- Used to measure distance and speed
- 1000 µF capacitor to maintain a level voltage

Load Cells
- Change electrical resistance when deformed due to pressure which is measured and converted to voltage
- HX711 Amplifier to amplify small analog signals from load cells and convert to digital output
- Load Cell 50 kg each
  - 75 kg overload capacity

End Cap 3.0
- Replaces rear leg end caps and houses load cells
- Material: Thermoplastic Polyurethane (TPU)
- Dimensions: 1.9 in diameter, 3.35 in height

Electrical Housing
- Material: Polylactic Acid (PLA)
- Dimensions: 7.825 x 3.150 x 3.343 in
- LiDAR scope for improved range

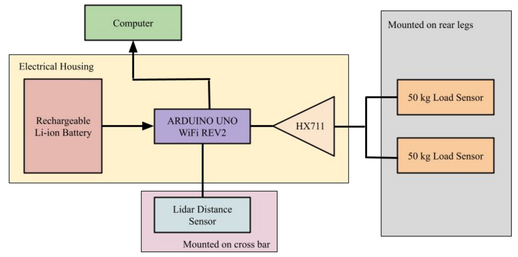

Figure 2: Circuitry Block Diagram

Figure 3: 2025 Final design and Assembly

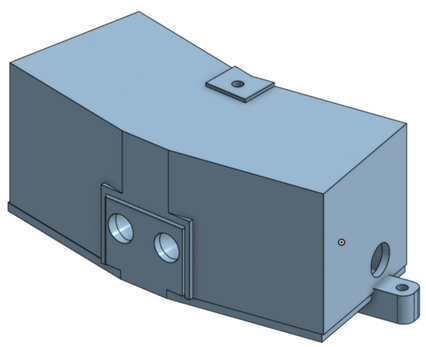

Figure 5:Electrical Housing CAD Model

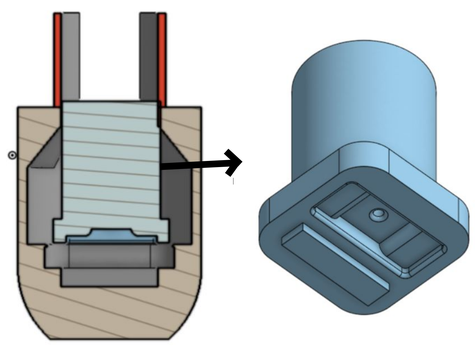

Figure 4: End Cap 3.0 and cork piece CAD Model

Testing & Results

Load Cell Validation

Figure 6: Load Cell Validation Testing

- 19 different weights ranging from 22 lbs to 220.5 lbs were successively place on the load cells
- The load cells remained accurate until 165 lbs when the readings leveled off
- The result was an average error of 5.51%, but only 1.68% error up to 165 lbs

LiDAR Validation

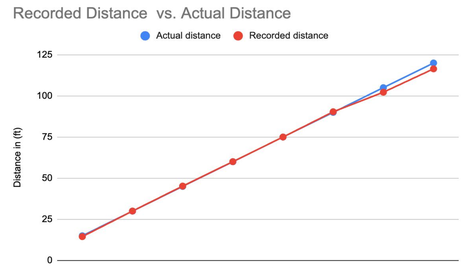

Figure 7: Lidar Validation Testing

- The LiDAR was tested at distances from 0 to 120 feet
- Trials consisted of moving the walker towards a wall a known distance away and recording the distance and speed traveled
- The results were 1.24% error with regard to distance and 1.38% for speed

Future Work

- Do further testing with battery and other electronic components
- Implement a fall detection system
- Improve user interface and install display on the walker
- Add a method to easily export data with secure HIPAA approved connection

Acknowledgements

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References

[1] Ladd, Kevin. "What Is the Maximum Weight Capacity for a Medical Walker?" TheMedSupplyGuide.Com - Medical Supply Company Directory. Accessed: Sep 24, 2025. [Online]. Available: www.themedsupplyguide.com/weight/.

[2] International Organization for Standardization, ISO 11199-1:2021 — Assistive products for walking — Walking frames — Requirements and test methods. Geneva, Switzerland: ISO, 2021. Accessed: Sep 24, 2025. [Online]. Available: https://www.iso.org/standard/76651.html