



# Cadence Walker



Rachel O'Connell, Yu Liu and Jared Ness  
Advisor: Thomas Yen, Ph.D.  
Client: Jane Mahoney, M.D.

## Abstract

Older adults who are dependent upon walking aids may harm themselves from falling when they forget to use their aid. In order to achieve fall prevention through increased walking aid usage, the team created a device to be attached on a two-wheeled walker with the ability to alert users when they move an unsafe distance away from the walker. The device is also capable of recording information about the user regarding time usage, distance traveled, and cadence. This data will be reported to care providers for clinical observations and evaluations. The key components to achieve these features include using a coupled proximity transmitter and receiver, a microcontroller, and a speedometer, in addition to a relevant circuit board, power source, and storage device. The prototype was tested for accuracy in recording speed and distance. Lastly, human test subjects used the walker and device over a two-day period to determine that the alarm system increased usage of the walking aid. In the future, this device will need IRB approval to test on elderly adults. It will also need to be patented and slightly modified for mass production and commercial use.

## Background



Figure 1. Elderly relying on a two-wheel walker to move around. (<http://www.psimetracing.com>)<sup>3</sup>

- Falls are the leading cause of death and injury in elderly adults
- 1 out of every 3 adults over the age of 65 will experience a fall annually
- Fall risk increases with dementia, which affects 60% of the population 85 or older
- Falls can occur when an adult leaves their walking aid behind while walking<sup>1</sup>
- Falls cost \$20 billion annually in the US<sup>2</sup>

- The University of Wisconsin Center for Health Enhancement Systems Studies (CHESS) aims to incorporate technology into the health care system.
- Dr. Mahoney runs the Stepping On program which aims to teach the elderly falls prevention.

## Problem Statement

Our client, Dr. Jane Mahoney, would like our team to fabricate a walker system that alerts the user when they begin to walk away without their aid. The system should also record daily usage data that can be sent to the care provider. The walker system should:

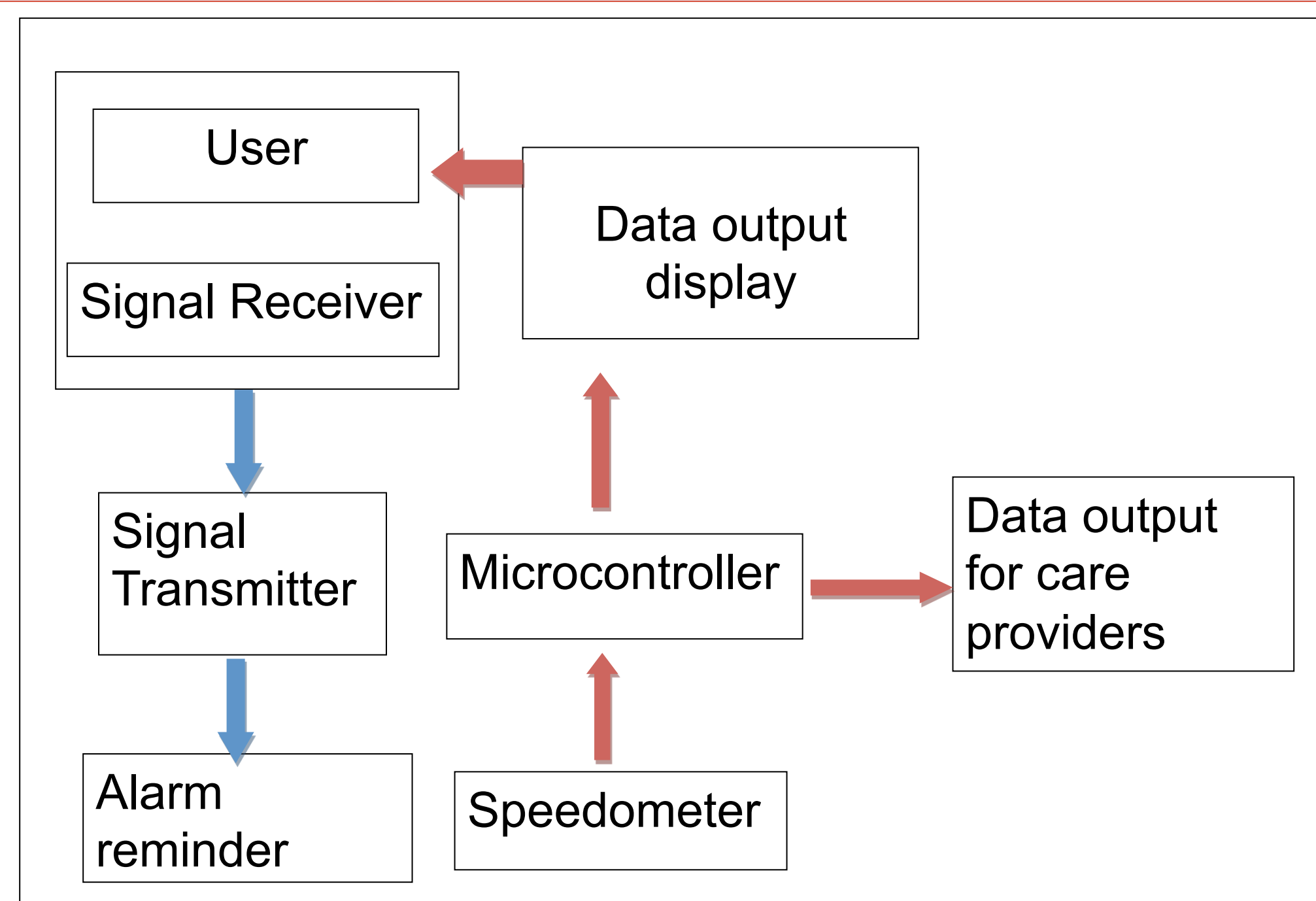
- Alarm at a 5 ft distance
- Gentle, non-startling alarm
- Record cadence and time usage
- Flexible to the user

## Final Design

### Specifications

- Transmitter on walker sends out signal
- User receives signal from waist clip on and sounds alarm when out of signal range
- Alarm sounds when user >4 ft away
- Magnetic wheel activates reed switch to record speed, distance and time
- Microcontroller stores data to SD card for use by care provider
- Total cost = \$263.37
- Single device cost estimate ~ \$70

Figure 2. Concept map of the alarm and cadence process on a two-wheel walker.



## Testing

### Accuracy

- Used to determine all recorded data was within 5% accuracy range
- 10% accuracy acceptable for speed because error is from human timing

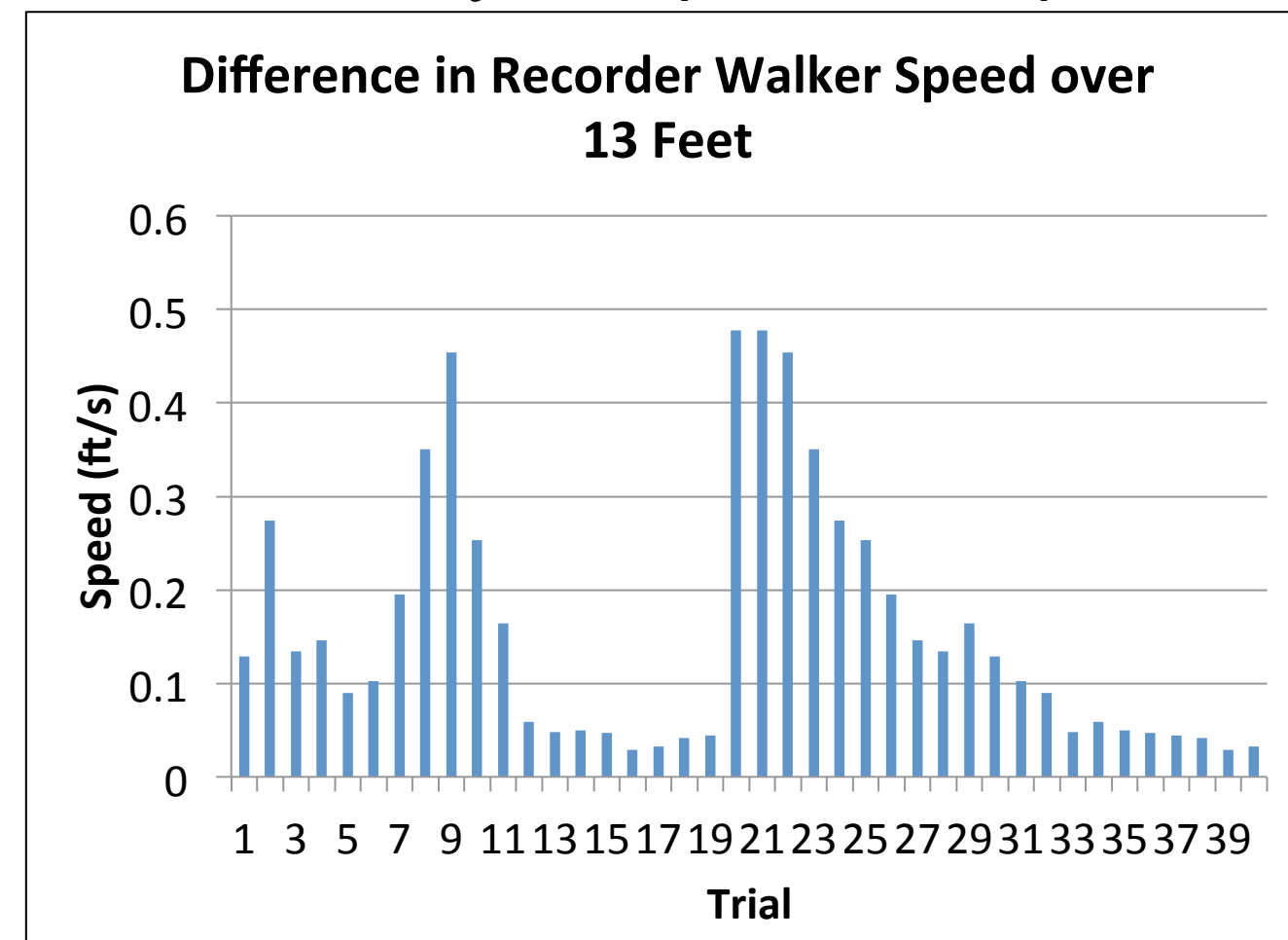


Figure 3. 40 trials showing the difference between device recorded speed and manual recorded speed for a constant 13 ft.

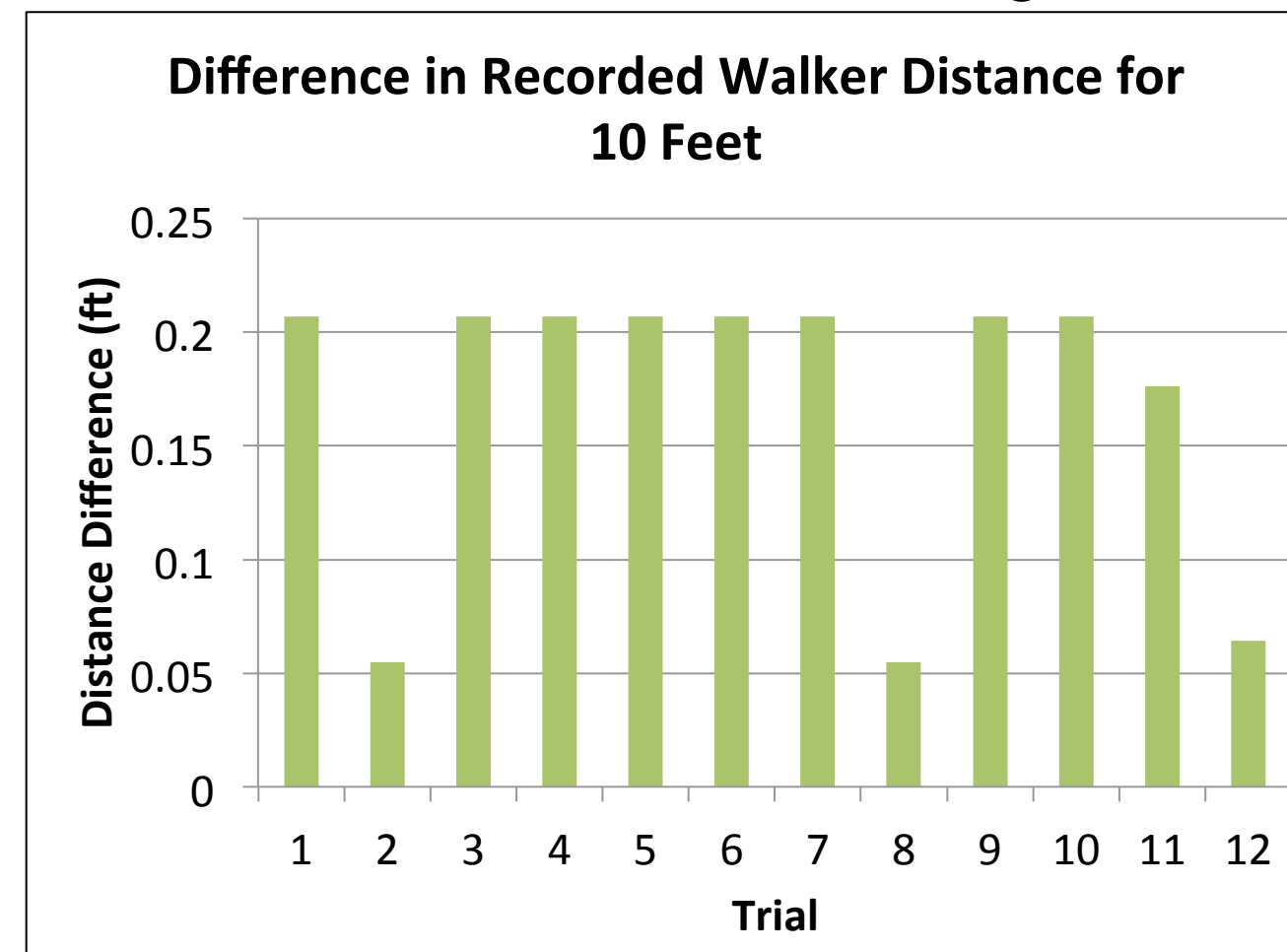


Figure 4. 10 trials showing the difference between device recorded distance and manual recorded distance.

### Human Subjects

- 3 subjects used walker for 2 non-consecutive days
- Subjects – 21 years old, 2 female/1 male, non-walker users
- Day 1: only usage recording portion of device in use
- Day 2: alarm system added

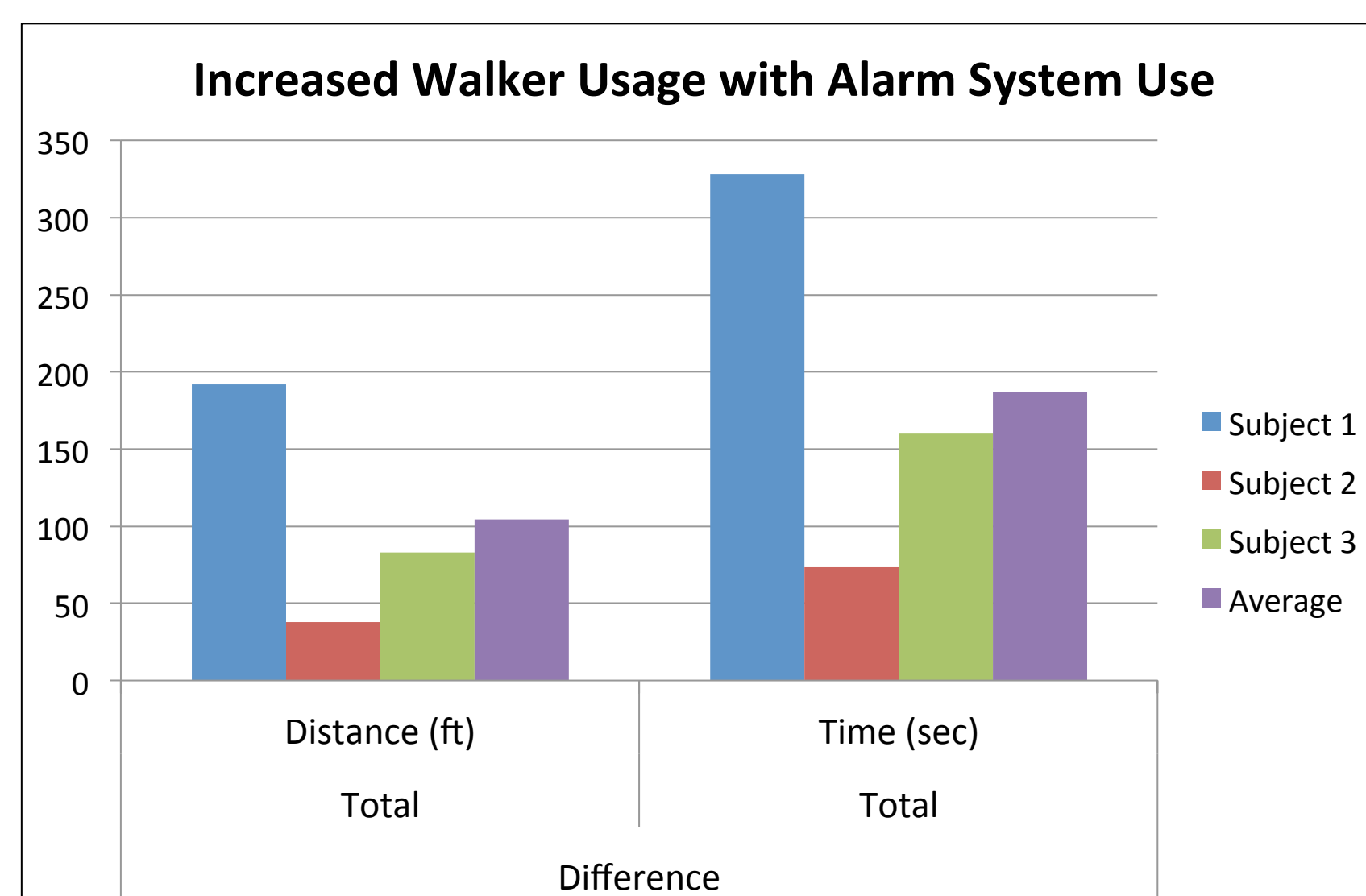


Figure 5. Difference in distance and time the walker was used between the alarm system and base usage values.



Figure 6. Human subject testing the device.

Trial	Alarm Distance (ft)
1	4.33
2	4.08
3	5.29
4	3.62
5	4.96
6	3.92
7	4.71
8	4.25
9	4.25
10	4.58
ave	4.40
stdev	0.50

Table 1. Table of trials to determine reliability of alarm distance.

### Staff Survey

- Talked to staff at cognitive assisted living facility
- Took a survey to evaluate device demonstration

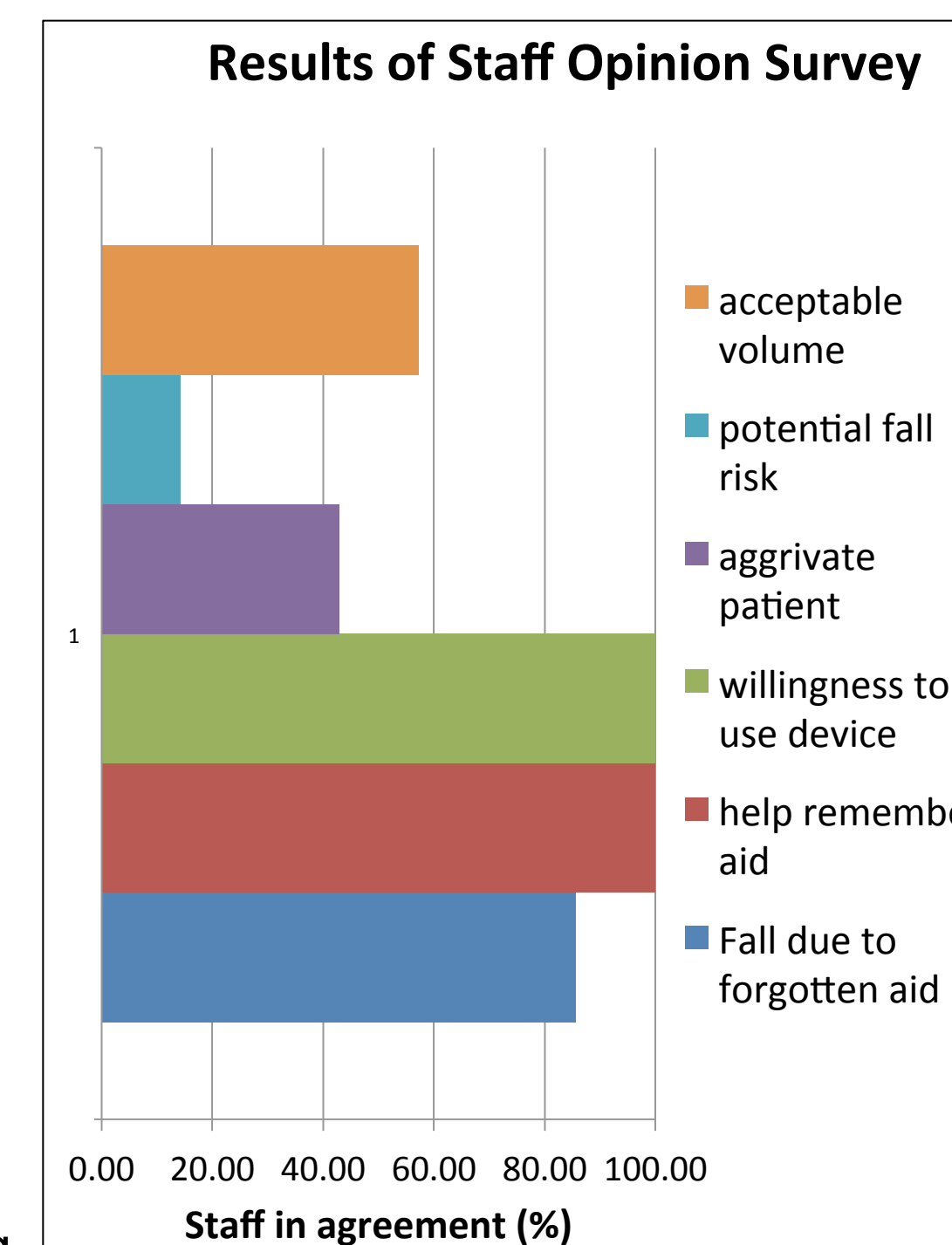


Figure 7. Survey results from seven staff members at an assisted living facility for cognitive impairments.

## Prototype

### Speedometer

- Five magnets mounted on one wheel of the walker
- Receives signal of pulses when getting near the reed switch
- Corresponding time intervals are recorded
- Arduino microcontroller outputs average speed between stops
- Average speed and total distance traveled are coded
- Data stored in an excel file on an SD card for care provider usage



Figure 8. Microcontroller with SD card and battery modifications in mountable box.

### Proximity

- Commercially available Bluetooth sensors
- Clip-on receiver sounds alarm at >4 ft distance
- Alarm stops when user comes back within signal range
- Transmitter designs can be used to condition users to their walkers
- Adjustable alarm distance depending on patient needs

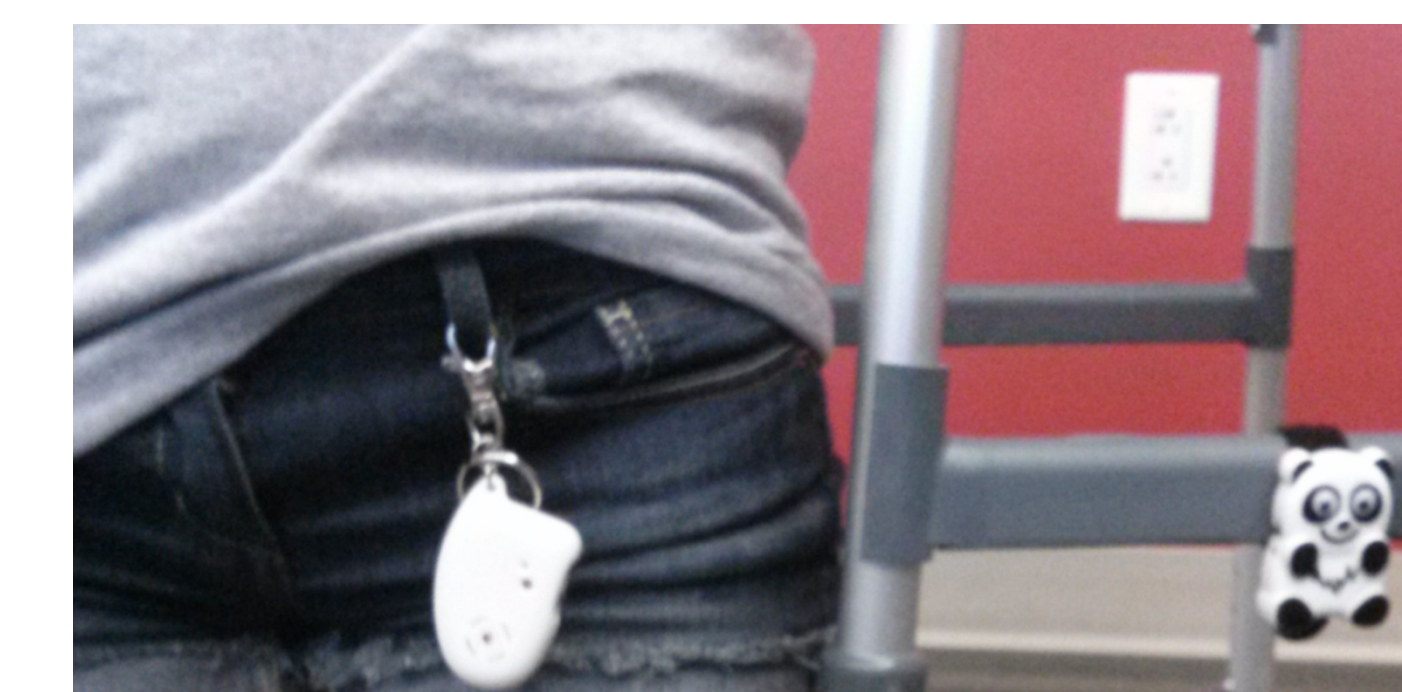


Figure 9. Receiver worn by user and transmitter attached to the walker.

## Future Work

- Construct proximity sensor with adjustable alarm distance down to 1 ft.
- Create a personalized voice alarm to replace the beeping
- Have speedometer device commercially produced to decrease size
- Make the device attachment more stable in case of collisions with corners or walls
- Get IRB approval for testing with elderly users

## Acknowledgements

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## References

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