Cadence Walker With Alert System

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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, the team will design a device to be attached to a two wheeled walker with the ability to alert users when they move an unsafe distance away from the walker. The walker will also be capable of recording information about user use 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 FM transmitter and receiver, a microcontroller, and a speedometer, in addition to a relevant circuit board, alarm, and display screen. Once this prototype is finished, proper testing regarding accuracy will be conducted. Finally, older adults will be participating as human test subjects to evaluate the overall quality of the walker performance and how well it reminds the user to use their walking aid.

Background

Figure 1. Elderly relying on a two-wheel walker to move around.[3]

- 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 cost $20 billion annually in the US[2]
- 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 1 ft distance
- Gentle, non-startling alarm
- Record cadence and time usage
- Flexible to the user

Final Design

Specifications

- User transmits FM signal form anklet
- Receiver on walker detects user signal
- Alarm sounds when user 1 ft away
- Magnetic wheel revolution counter records speed and distance
- Microcontroller output data array to care provider
- Cost estimate:
  - Based on prices of microcontroller, field strength cirucit, speedometer, and display. In bulk $50 a piece.

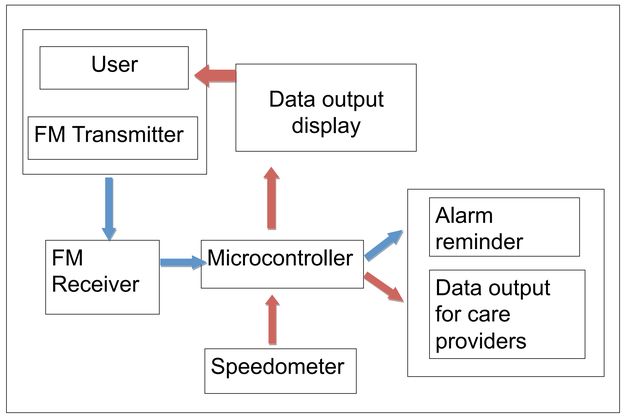

Figure 2. Concept map of the alarm and cadence process on a two-wheel walker.

Transmitter and Receiver

Transmitter

- Makes use of a short range FM transmitter
- Sends out a sinusoidal wave ranging from 87Mhz to 108Mhz
- Powered by two 1.5 V AAA batteries
- Will be attached around users ankle

Receiver

- Incorporates a field strength meter design that measures frequencies across a spectrum of 30Mhz to 2 Ghz
- When transmitter nears antenna AC RMS increases

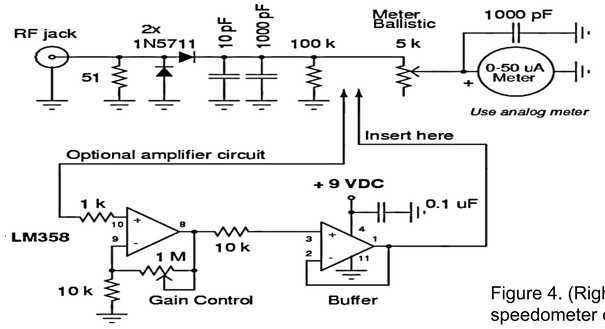

Figure 3. (Above) Schematic of field strength meter circuit.[4]

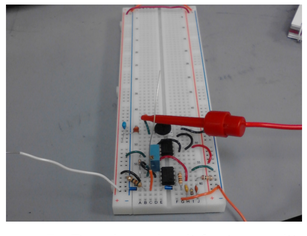

Figure 5. Receiver circuit for transmitter signal with oscilloscope attachments.

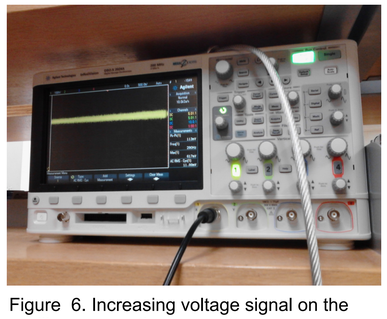

Figure 6. Increasing voltage signal on the oscilloscope as the transmitter moves closer to the antenna.

Speedometer Circuitry

Speedometer

- Four 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 instantaneous speed every second.
- Average speed and total distance traveled are coded
- Data stored in a 2 X 100 array as references for care providers.

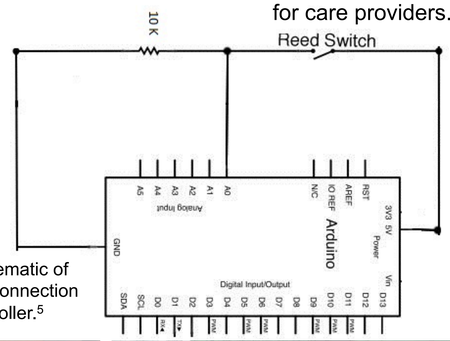

Figure 4. (Right) Schematic of speedometer circuit connection to Arduino microcontroller.[5]

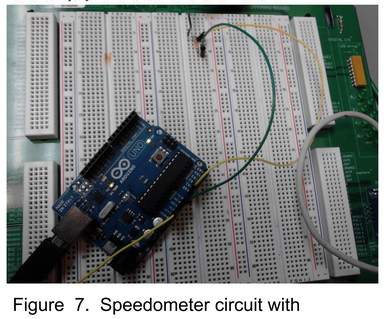

Figure 7. Speedometer circuit with connected Arduino microcontroller.

Testing

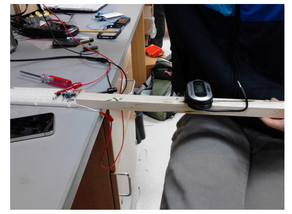

Figure 9. Incrementally moving the transmitter away from the antenna of the receiver circuit for distance signal testing.

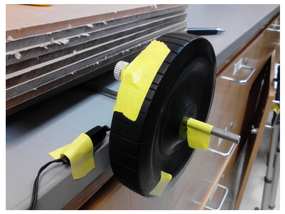

Figure 10. Setup for testing time and speed accuracy of speedometer program on similar wheel.

Table 1. Recorded decibels of the transmitter as it move away from the antenna in 3 in. increments.

Distance (ft)	Average dB (n=3)
0.25	-39.49
0.50	-45.28
0.75	-49.97
1.00	-53.74
1.25	-58.27
1.50	-58.68
1.75	-59.40
2.00	-59.86
2.25	-59.86

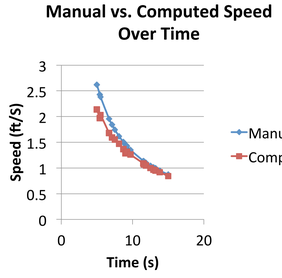

Figure 11. Comparison of speed recorded by Arduino program and manual recordings over time. Time accuracy decreased with higher speed.

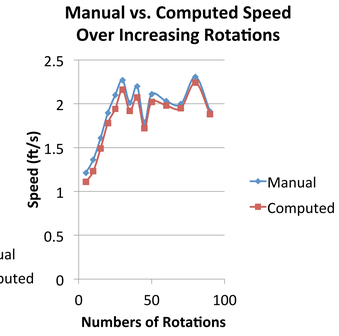

Figure 12. Comparison of speed recorded by Arduino program and manual recordings over increasing rotations. Speed accuracy increased with higher rotations.

Future Work

- Incorporate care provider feedback using microcontroller
- Send out for neatly packaged walker circuit and transmitter circuit
- Incorporate transmitter into ankle bracelet
- Accuracy testing of cadence and alarm on walker
- Complete CITI training and IRB approval for patient testing

Acknowledgements

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References

[1] Anderson, L. (2011). *Dementias and Their Impact on America*. Web. http://health.burgess.house.gov/blog/?postid=240727
[2] Centers for Disease Control and Prevention (2012). *Cost of fall among Older Adults*. Web. http://www.cdc.gov/homeandrecreationalsafety/falls/fallcost.html
[3] Web Image . http://www.psimetracing.com/wp-content/uploads/2011/05/elderly-man-on-walker.jpg
[4] Kassias, A. "Perspective Study of Tracheopulmonary Complication Associated with the Placement of Narrow-bore Feeding Tubes." *Critical Care*. 1998.
[5] Seidel, H. *Mosby's Guide to Physical Examination*. New York: Mosby,1999.