Redliner: An Activity Monitor for Manual Wheelchair Users

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Background

- Wheelchair users have a need to monitor daily activity
  - Manual wheelchair users are highly susceptible to repetitive stress injuries [3]
  - Propulsion forces over 80% of maximum capacity often result in injuries
- Typical existing activity monitors don't work with manual wheelchair users
- SmartWheels (as shown in Figure 1) are the gold standard, but are a very expensive clinical tool [1, 2]
  - SmartWheels require modifying a user's chair (replacing the wheels)
  - There is a need for an affordable consumer-grade tool for activity monitoring

Figure 1: SmartWheels are accurate clinical tools for measuring wheelchair performance. Unfortunately their cost and the requirement to modify the user's wheelchair make them ill-suited for daily activity monitoring.

Objective

The objective of this work was to create an inexpensive activity monitor for manual wheelchair users capable of measuring the following data without modifying the user's chair:

- Number of propulsion strokes
- Average travel velocity
- Amount of time spent active
- Estimated distance travelled
- Number of "redline events"[1]

[1] *redline events* are instances of when the user's propulsion force exceeds 80% of the maximal propulsion force they can generate, thus indicating potential for injury

Method

- Redliner uses a novel unintrusive sensor design which attaches to the side of a user's regular wheel
- A simple prototype was created to perform the measurements for analysis, see Figure 2
- The system

Figure 2: Original Redliner prototype, assembled using breakout boards

Results

As you can see in Figure 3, derp.

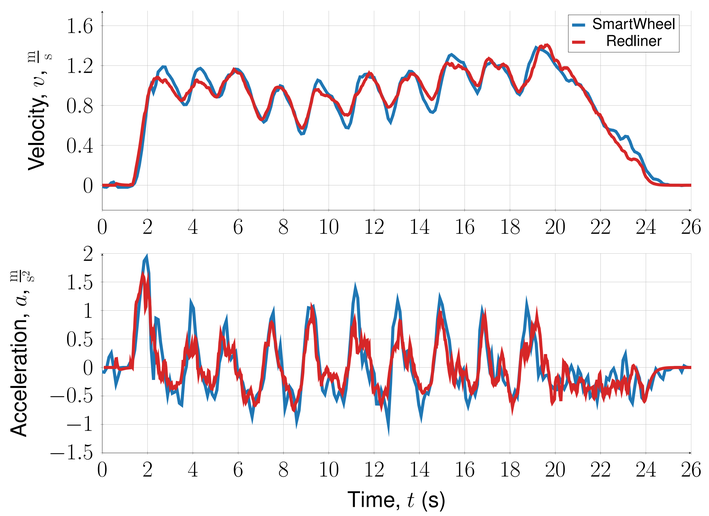


Figure 3: Velocity and acceleration traces for both SmartWheel and Redliner for 10 pushes on rough gravel. Despite the rough terrain, the traces are in close agreement—allowing Redliner to reasonably estimate the velocity and distance travelled by the wheelchair while also detecting over-exertion events.

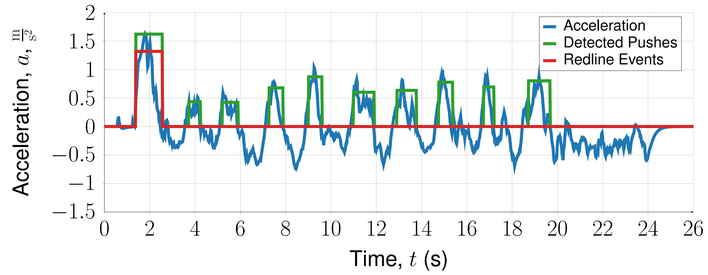
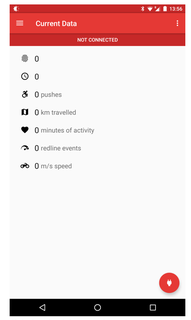


Figure 4: Acceleration, detected pushes, and redlines of 10 pushes on gravel as measured by Redliner. An algorithm was developed to detect pushes from this acceleration data while also monitoring redlining events.

(a) Second Redliner prototype version using a custom PCB built for further testing.



(b) Android app developed to interact with the device over Bluetooth Low Energy and upload data to a cloud dashboard.

Figure 5: Simulation results

Conclusions

- Redliner is a new activity monitor for manual wheelchair users
- Redliner has been validated against expensive SmartWheel devices
- Redliner is moving forward as a commercial entity to produce and sell the devices

References

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Acknowledgements

Funding for this work was provided for by the University of Alberta, Telus, the Government of Canada, and Redliner Inc.