Redliner: An Activity Monitor for Manual Wheelchair Users

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Background

- Wheelchair users have a need for daily activity monitoring
  - Manual wheelchair users are highly susceptible to repetitive stress injuries [1]
  - Propulsion forces over 80% of maximum capacity often result in injuries [2]
- Typical existing activity monitors (Fitbit®, etc) **don't work** with manual wheelchair users
- SmartWheels are the gold standard [3, 4]
  - Prohibitively expensive for consumers
  - Require chair modification (replacing the wheels)

Figure 1: A SmartWheel instrumented wheelchair wheel.

Objective

- Create an **inexpensive** activity monitor for **manual wheelchair users** which continuously monitors the following:
  - 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

Figure 2: Original Redliner prototype, assembled using breakout boards

- Utilize Newton's laws of motion to estimate propulsion force using kinematic data
- Create a simple prototype to perform the measurements for analysis
- Collect and compare synchronous propulsion data between SmartWheel and Redliner across varied terrain:
  - Linoleum
  - Grass
  - Gravel
  - Pavement

Results

By capturing the

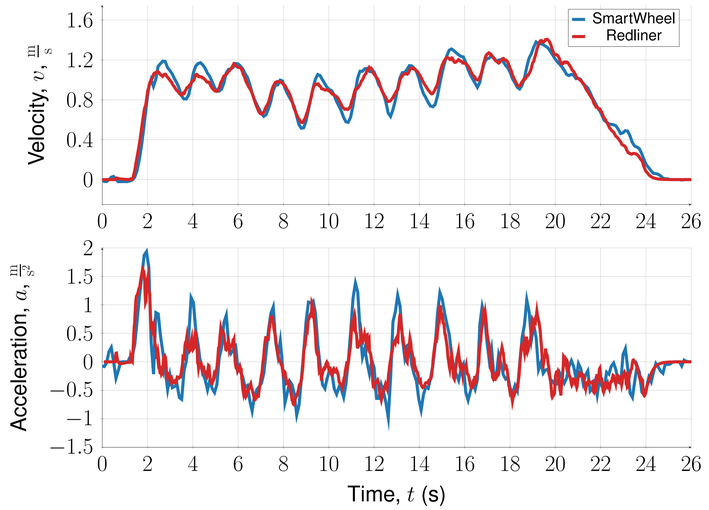


Figure 3: Velocity and acceleration traces for both SmartWheel and Redliner for 10 pushes on rough gravel.

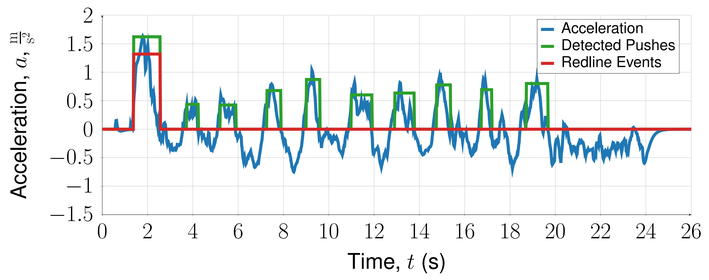
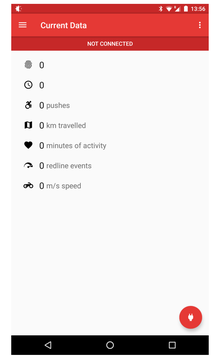


Figure 4: Acceleration, detected pushes, and redlines of 10 pushes on gravel as measured by Redliner.

Conclusions

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



(b) Android app developed to interact with Redliner and upload data to a cloud dashboard.

Figure 5: Ongoing commercial development of Redliner

- 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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