CHARACTERIZING MOBILITY OF MANUAL WHEELCHAIR USERS

Rehabilitation Engineering & Applied Research

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Introduction

- The activity of full time wheelchair users can be reflected by wheelchair usage
- Inertial changes, including starting and stopping, should be documented as well as distance traveled
- Bouts of wheelchair movement are defined as volitional transitions between functional activities
- Because bouts of movement embody inertial transitions, they may better reflect physical exertion
- Characterizing wheelchair usage can impact the design, coverage policy and prescription of mobility equipment

Aim

To measure wheelchair usage of full–time manual wheelchair users and to characterize usage patterns

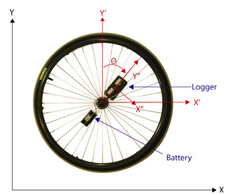
Methods

Subjects

- 28 adults
- 22 to 67 years old (median 34.5)
- Multiple diagnoses (SCI = 20)
- Manual wheelchair used as the primary mobility device

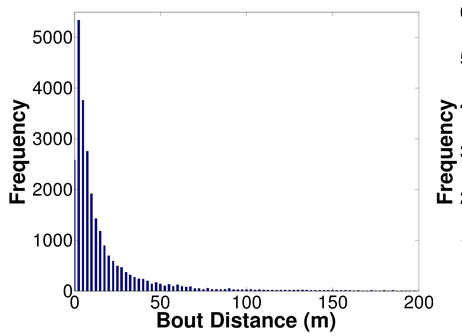
Protocol

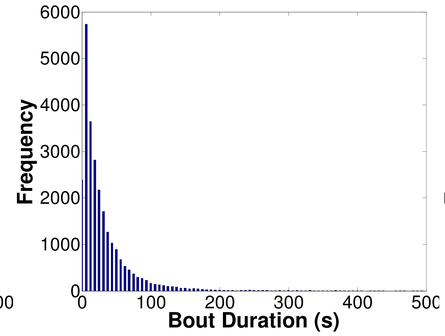
- A solid-state, triaxial, MEMS-based acceleration sensor with a ±2g range was mounted on one of the wheels
- Sampling rate: 10 Hz
- Data collection period varied between 2 & 16 days per subject

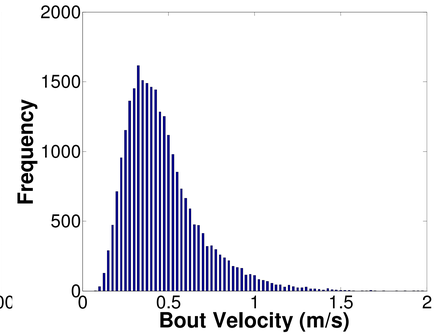


Acceleration logger and battery pack

Results







	Median	Minimum	Maximum
Bouts per day	90	3	235
Daily distance	1.5 km	7.1 m	10.5 km
Daily time moving	54 min	30 sec	208 min

	Median	Minimum	Maximum
Bout duration	21 s	5 s[2]	40.3 min
Bout distance	8.6 m	0.8 m	3,830.0 m
Bout velocity	0.4 m/s	0.1 m/s	2.0 m/s

Data Processing

- Radial & tangential acceleration used for movement detection
- Linear speed was then used to detect wheelchair motion
  - Movement detection accuracy exceeds 90%[1]
- Bouts of wheelchair movement defined as:
  - Wheeling for at least 5 seconds
  - Speed greater than or equal to 0.12m/s
  - Bout ends when wheeling <0.76m within 15 seconds

Record Summary

- 29256 bouts of mobility
- 296 hours of wheeling
- 595 km wheeled
- 342 subject-days

Discussion

- Variation of wheelchair use is great across and within people
- Short bouts of movement dominate wheelchair usage
  - ≈63% of bouts are shorter than 30 seconds & 13 meters
- Because short bouts of mobility are common, starting, stopping and maneuverability are key activities
- This finding can inform research into
  - propulsion efficiency
  - secondary complications of wheelchair use
  - clinical prescription of wheelchairs

(1) Sonenblum, S.E., Caspall, J., et al, "An Analysis Method for Detecting Manual Wheelchair Movement." Presented at the BMES Annual Meeting. 2009. Pittsburgh, PA
(2) By definition, the minimum bout duration is 5 seconds

Acknowledgements

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