Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Technik & Architektur
FH Zentralschweiz

Swiss
Paraplegic
Research
Swiss Paraplegic Research
Group „Shoulder Health & Mobility"
Guido A. Zäch Str. 4, 6207 Nottwil

Bachelor-Thesis Medizintechnik

Real-life measurements on pressure relief performance and shoulder loading activities in manual wheelchair users

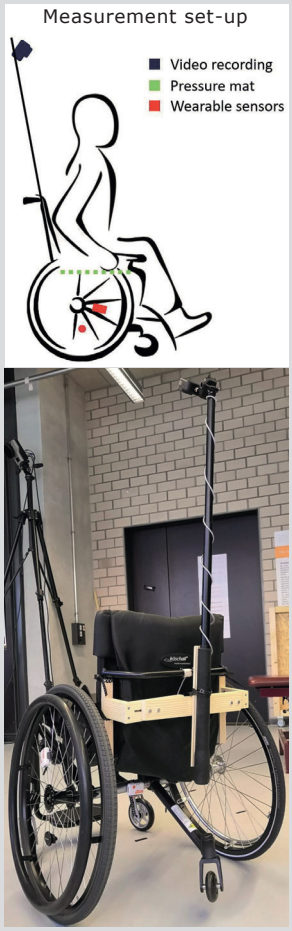

Figure 1: Measurement set-up
Shows the with sensors, pressure mat and GoPro equipped wheelchair.

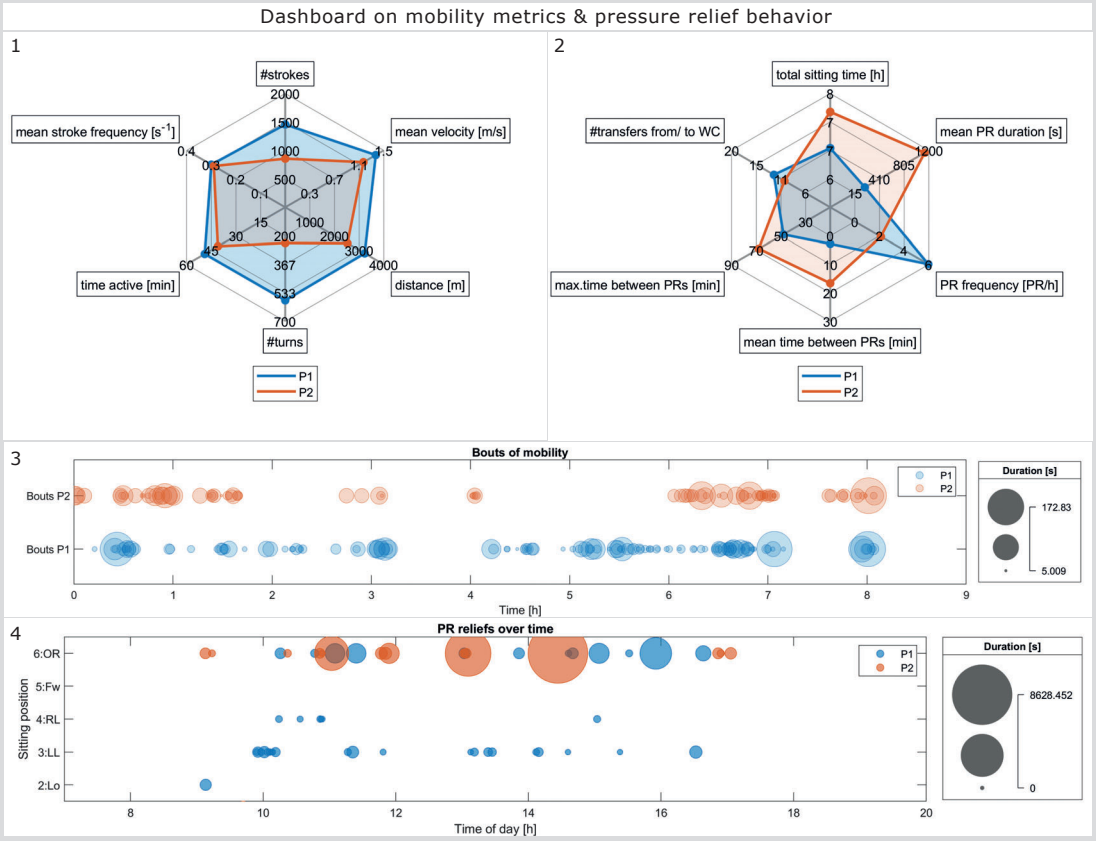

Figure 2: Dashboard on mobility metrics & pressure relief behavior
The Dashboard summarizes important values of interest for participant 1 (P1) and participant 2 (P2). Area 1 shows mobility metrics, area 2 shows pressure relief (PR) metrics. Area 3 illustrates the distribution of bouts over the measurement period. Bouts are defined as active periods of >5s. Area 4 shows the distribution of PR activities per technique (2:Lo=lift-off; 3:LL=left lean; 4:RL=right lean; 5:Fw=forward lean; 6:OR=own relief activity) over the day. The bubble sizes illustrate the duration of each bout respectively PR in seconds.

Problem & aim
Pressure injury and shoulder complaints (pain, pathology) are two of the most common secondary health problems in manual wheelchair users with a spinal cord injury (SCI). They are closely related to each other by the way a pressure relief (PR) for pressure injury prevention is performed. Shoulder loading activities in daily life (SL-ADL) are regarded as the driving force in the development of shoulder complaints.
As very little is known about the mobility and PR behavior of manual wheelchair users a measurement set-up for real-life measurements should be developed and tested.

Methodology
Firstly, a measurement set-up for real-life measurements was developed (Figure 1). The set-up consisted of two Movesense sensors to record acceleration, angular velocity and the magnetic field to generate mobility metrics. As backup Shimmer sensors were used. One sensor of each type was attached to the wheelchair frame and one to the wheel. Further a pressure mat (Sensomative) detecting the sitting respectively PR position and a GoPro for validation of the data measured and also for the identification of other activities of daily life were used.
Secondly, about 8h of working day of two manual wheelchair users were measured and analyzed in MATLAB.

Results
A great number of values of interest for researchers, clinicians but also wheelchair users, such as distance propelled, velocity, inclination, magnitude of turns, number of pushes, number of transfers and PR performance could be gathered during the measurements (see Figure 2). The used equipment withholds requirements of life and participants' feedback showed that the sensors and the pressure mat are no burden for the participant. GoPro measurements were okay for one day but would be disturbing for longer measurements.
Considering mentioned aspects, it can be concluded, that the measurement set up is feasible for real-life measurements.
For the connection of the results to shoulder loads sensors on the trunk and the arm should be added. This is, however, momentarily not possible due to problems in the Bluetooth connection when using more than two Movesense sensors. Therefore, future development aims should include improving the Bluetooth connection stability of the Movesense sensors or the development of alternatives.
The limitations of this project are, that it was a small-scale pilot study that included measurements of ~8h of workday of two participants only. Therefore the results do not allow conclusions to be drawn about the entire population of wheelchair users with SCI and are not representative. However, since so far very little is known about a typical day of a wheelchair user, this pilot study already gives an interesting insight in how the mobility behavior of manual wheelchair users with SCI could be measured and contributes at filling the research gap on SL-ADL.

Stirnimann Anja
Supervisor:
Prof. Dr. Fabian Ille