CANWHEEL
Power Mobility Workshop June 9-10, 2011

The McGill Wheelchair Simulator: Presentation and First Results.

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Rationale

- There are an estimated 200,000 wheelchair users in Canada; amongst these, 20-30% are power wheelchair users (Statistics Canada 2006).
- A power wheelchair is essential for the accomplishment of daily living tasks.

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Rationale

- Driving a power wheelchair is not without risk. Accidents can include: collision against a bystander, collision against an obstacle, remaining stuck, falls, etc
- It is strongly believed that providing training decreases the risks of accidents.

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Power wheelchair training

- Training not only leads to safer driving, but also to a greater or more optimal use of the power wheelchair: not only in moving from one location to another, but also in accomplishing more tasks and handling different environments in the wheelchair. This may increase social participation.
- However, due to limitations in space, budget and/or personnel, training is often deemed to be insufficient.
- One method to complement training: **simulator or virtual reality**

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Virtual Reality

- Two types: Immersive or non-immersive

Advantages of Virtual Reality

- Possibility of practicing complex tasks in various settings.
- Provides a safe environment
- Task parameters can be controlled
- Performance can be measured, recorded
- Can be motivating for participant

Virtual reality and transfer of learning

- Do skills learned in a virtual environment transfer to a real situation?

➡Studies generally show that this is the case, for various motor and cognitive tasks (car driving, attention and concentration, etc.) (Shechtman 2009; Erran-Wolters 2007).

- It is important that tasks practiced in the virtual environment be similar to the real ones.

Sense of presence

- Feeling of "being" in the virtual environment, of momentarily forgetting the real space.
- It is thought that a high sense of presence can facilitate learning and skill transfer (Persky 2009).

Hypotheses

- First study of driving performance in the simulator in two groups of healthy participants:
  - Driving performance will be similar in the simulator and for a real power wheelchair
  - Driving in the simulator will generate a strong sense of presence.

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- Tasks based on the WST
- Runs on an ordinary computer (Windows PC): non immersive
- First person view (non stereoscopic)
- Controlled through a joystick similar to those used for wheelchairs (P&G)

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Simulator development

- Based on the « Unreal Development Kit », a 3D graphics engine.
- Provides high quality graphics, with realistic physics.
- Development platform well recognized by programmers and 3D graphics artists.
- Includes an editor to create the virtual scenes (maps) and program the interactions.

UDK UNREAL DEVELOPMENT KIT

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Methodology: participants

Simulator group
- n = 15
- 6 men, 10 women
- Age: 20-28 years

"Real" group
- n = 13
- 6 men, 7 women
- Age: 20-32 years

•All were right-handed
•No prior experience with power wheelchairs

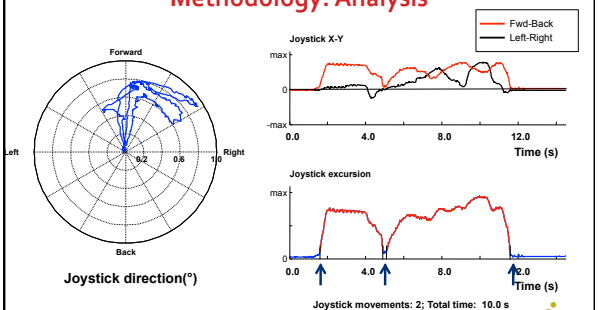
Methodology: Tasks

- Tasks based on the *Wheelchair Skills Test* (www.wheelchairskillsprogram.ca)
  - Moving forward, backward
  - 90 and 180° turns
  - Move through doorway, on inclined planes
  - Activities: transfers, pick up objects
- 22 of the 32 tasks are reproduced in the simulator
  - Some tasks that are not reproduced: transfers, activate tilt, recharge battery, etc.

Methodology: Data recording

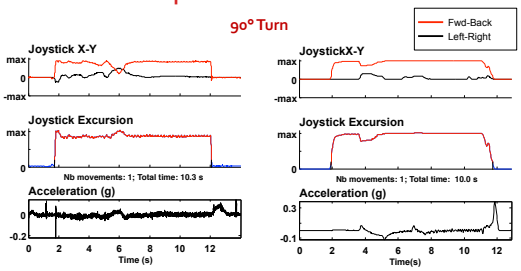
- Control of joystick and motion of the wheelchair
- The simulator software records these variables
- For the real wheelchair: recorded using a data logging system installed on the wheelchair (Boissy 2008).
- Simulator group: questionnaire on the sense of presence (IPQ)

Methodology: Analysis



Comparison of performance in real and simulated power wheelchair

90° Turn



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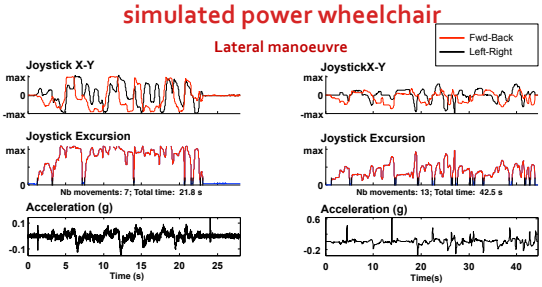
Comparison of performance in real and simulated power wheelchair

Lateral manoeuvre



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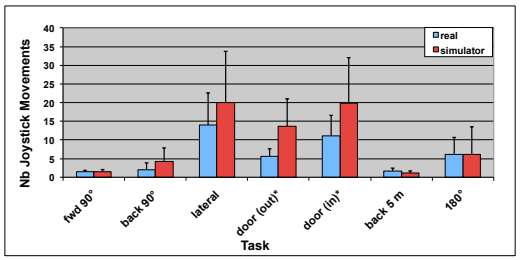
Comparison of performance in real and simulated power wheelchair



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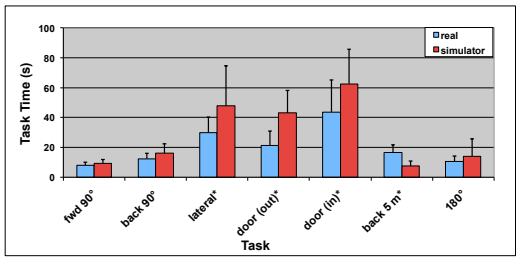
Comparison of performance in real and simulated power wheelchair



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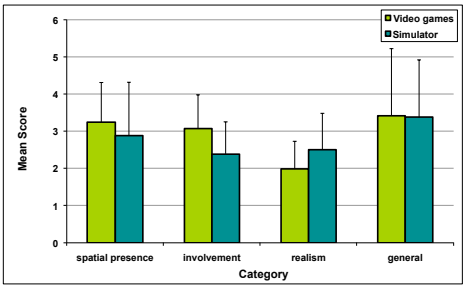
Presence



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Discussion

- The simulator generates a good sense of presence compared to videogames, except for the "Implication" aspect.
- For the easier tasks (turns), performance in the simulator was equivalent to that of a real power wheelchair.
- For the complex tasks (door, lateral manoeuvre), simulator driving seemed more difficult. This may be due to:
  - Feedback: only visual
  - Limited field of view
  - Simulation not completely the same

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Limit: Field of view (100°)

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What's next?

- Tasks analysis, to see if strategies are the same
- Adding sounds (motors, braking, collisions)
- Developing new maps, representing complex tasks
- Adding virtual characters
- Evaluate the simulator for the assessment and training of power wheelchair users
- Adding an interface for hand interaction (Wiimote or other).

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