PROPELLING A MANUAL WHEELCHAIR ON A HAPTIC SIMULATOR: INSIGHTS ON THE INFLUENCE OF VISUAL IMMERSION ON PROPULSION MOMENTS

[1,2,3]Félix Chénier, [1,2]Mikaël Dallaire Côté, [1,2]David Labbé, and [1,2,3]Rachid Aissaoui
[1]Laboratoire de recherche en imagerie et orthopédie, Centre de recherche du CHUM, Montréal.
[2]École de technologie supérieure, Montréal.
[3]Institut de réadaptation Gingras-Lindsay de Montréal, Université de Montréal.
email: felix.chenier@etsmtl.ca

INTRODUCTION

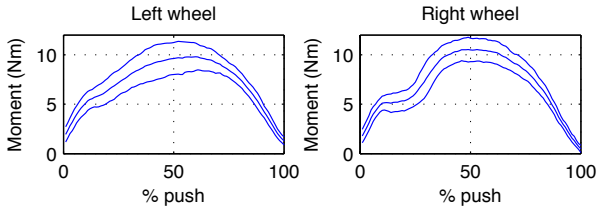
Biomechanical analysis of manual wheelchair propulsion can be performed on a haptic wheelchair simulator. Such a device aims to reproduce the reaction forces at the wheels when performing straight or turning maneuvers, as if the user was propelling on the ground [1]. However, without visual feedback, the virtual trajectory of the wheelchair is difficult for the user to interpret. The influence of such feedback on the propulsion technique is still unknown [2]. We hypothesized that propelling in an immersive environment causes the user to modify his propulsion moments to take his trajectory into account.

METHODS

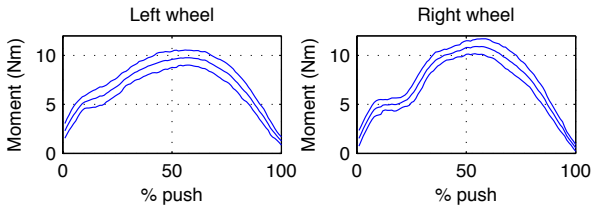
An immersive environment consisting of an endless corridor was added to a haptic simulator [1], and was presented to the user through a 46" 16:9 screen placed in front of the simulator at 80 cm of the subject's eyes. One able-bodied subject (31 years old, height of 175 cm, weight of 72 kg) propelled at a self-selected speed during one minute. Then, the screen was turned off and the subject propelled for one more minute while trying to keep the same speed and stay in straight line. Propulsion moments were acquired bilaterally at 240 Hz. After data collection, 30 consecutive pushes were selected for each trial (with and without immersion). Average, standard deviation and coefficient of variation (CV) of the propulsion moments were calculated.

RESULTS AND DISCUSSION

Propulsion moments are shown in Fig. 1. Average CV was of 17.1 %, 16.4 % (left, right) with visual immersion, and 13.8 %, 13.7 % without visual immersion. The variation of propulsion moments was higher with the visual immersion. In this case, the user needed to correct the wheelchair trajectory when it deviated, which may have contributed to this variability. When the screen was turned off, the user could not correct his trajectory, which would explain why the propulsion moments were then more repeatable from one push to another. It is still unknown if these results generalize to other users, and to what extent the variability of propulsion moments is related to the fidelity of the wheelchair conditions reproduced by the simulator.



(a) With visual immersion



(b) Without visual immersion

Figure 1: Propulsion moments (mean ± s.d.).

CONCLUSIONS

Propelling on a haptic wheelchair simulator resulted in a higher variability of propulsion moments when visual immersion was provided. This may be related to the need to correct the wheelchair trajectory and thus may be more representative of real propulsion.

REFERENCES

1. Chénier F, et al. *IEEE/ASME Trans Mechatronics*, 19-1, 321–328, 2014.
2. Harrison C, et al. *Assistive Technology*, 22-1, 20–31, 2010.