Detecting Near Falls from Accelerations during Perturbed Treadmill Walking

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INTRODUCTION

Falling is a relevant health problem, especially for many elderly, resulting in serious health, social and financial problems. Many intrinsic (e.g. muscle mass) and extrinsic factors (e.g. environment hazard) have been identified as risk factors contributing to falls. Stumbles and slips are considered to be main risk factors accounting for 59% of the falls [1]. Currently, it is unknown if a higher incidence of near falls contributes to the high fall risk in elderly. To adress this question it is necessary to measure the near fall incidence during daily life. Accelerometers have shown to be appropriate for continuous, unobtrusive and reliable monitoring of human gait [3]. The current study investigates whether accelerometers can be used to detect stumbles during treadmill walking.

METHODS

Sixteen healthy young (25±4yrs) and eight healthy older (63±4yrs) subjects walked on a treadmill while wearing a triaxial accelerometer (Xsens, f=100HZ) at the level of the sacrum. Stumbles were induced unexpectedly by briefly blocking a cord which was attached to the right leg of the subjects. Actual falling of the subjects was prevented by a safety harness. Subjects walked three different speeds; preferred [range 1.18-1.76m/s], slow (40% of the preferred speed) and fast speed (20% of the preferred speed). In each individual 30 stumbles were evoked, 10 at each walking speed. Data was collected and processed with Matlab. A threshold technique was used to detect the stumble events from the vertical acceleration data. Sensitivity of the algorithm was determined via comparison with simultaneous obtained video data.

RESULTS AND DISCUSSION

The accelerometer was able to detect 88% of the evoked stumbles (fig 1). The non-recognized stumbles were mainly stumbles compensated by an elevating strategy. This suggest that this strategy causes less disturbance in gait which can be due to the fact that subjects actually walk further by lifting up the affected leg. Obviously the disturbed leg is 'catching' the perturbation.

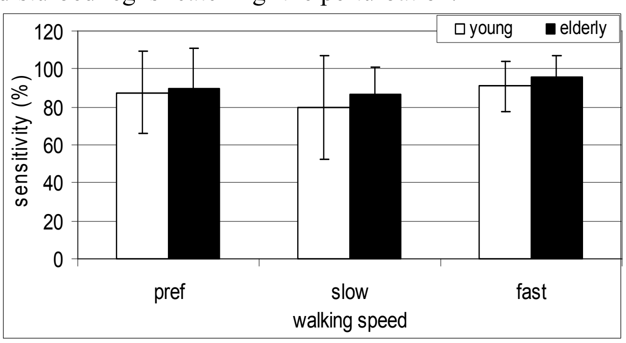

Figure 1: Sensitivity [%] of the accelerometer to detect stumbles at different walking speeds.

Although not significantly, the sensitivity of the accelerometer was slightly higher in older (91%) than in younger (86%) subjects which can be due to a more pronounced reaction of elderly to recover from a stumble. In both age groups, the sensitivity increased with walking speed, but not significantly. This suggests that response to disturbances is more pronounced and therefore easier to detect when walking at higher speeds.

The total amount false positives [stumble detection which is not related to any irregularity in gait pattern while no stumble was evoked] corrected for the amount stumbles evoked was slightly higher in young subjects (6.4%) than in elderly (5.4%). However these differences were not significant (table 1).

Table 1: Amount false positives as % of the total evoked stumbles per walking speed for young and older subjects (SD).

	preferred	**slow**	**fast**
young	12.6 (31.3)	3.1 (7.0)	3.8 (7.1)
old	8.8 (18.1)	5.0 (10.7)	1.4 (3.8)

CONCLUSIONS

The algorithm to detect stumbles from accelerometer data during treadmill walking is sensitive enough to be applied in ADL settings. Improvements are required to increase the sensitivity and to reduce the amount false positives. Other detection algorithms are still considered. Future research is required to investigate the suitability of the accelerometer to detect stumbling in daily life.

REFERENCES

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