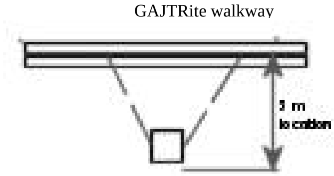
VALIDATION OF THE GAITRITE WALKWAY SYSTEM USING 2-DIMENSIONAL MOTION ANALYSIS

C. Wilson, **C. Lorenzen and N. Lythgo**
Australian Catholic University

INTRODUCTION

Research has begun to use the GAITRite walkway system (GRS) to measure spatio-temporal aspects of human gait (Cutup, Mancinelli, Huber & DiPasquale, 2000; McDonough, Batavia, Chen, Kwon & Ziai, 2001). This system consists of an electronic walkway or mat that measures spatiotemporal aspects of gait through pressure sensitive transducers. Recent comparisons of gait data simultaneously (same walking trial) collected by a GRS system and a 2D video-based motion analysis system (MAS) have reported large differences in measures (e.g., step length) derived from spatial data (Cutup et al., 2000; McDonough et al., 2001). For example, Cutup et al. compared spatiotemporal data collected by a GRS to the equivalent data (same trial) collected by a MAS for a series of slow, neutral and fast walking trials. Although they found strong correlations for the spatio-temporal data (e.g., step length, step period), a significant step length difference ($p = .0001$) was found (up to 3.44cm). The authors suggested this was due to the GRS data acquisition processes. Interestingly, MeDonough et al. has similarly reported large differences in step length data extracted from a GRS and a MAS. Further comparisons of these data collection methods to a paper and pencil method (PP), however, revealed little difference in the PP and GRS data but large differences in the PP and MAS data.

The authors of this study propose that the large differences found by previous studies in the MAS and GRS/PP spatial measures are primarily due to perspective error (PERROR) contained in the spatial data collected by the motion analysis systems. P_{ERROR} is directly associated with (1) movement away from a 2D measurement plane (e.g., walking base) and (2) the location of the camera from the plane (Lythgo, 2002). In the previous work, cameras were located about 5m (figure 1) from the 2D measurement plane (or centre- line of the walkway). A recent study (Lythgo, 2002) has shown significant reductions in measurement error (P_{ERROR}) with increasing camera location. For example, a 5m location produced mean absolute errors in data representative of footfalls (≈2.3 cm) about 3 times the magnitude of a 10m location. Maximum absolute errors of up to 4cm were reported.



/Figure 1. Superior view of a 5m camera location from a 2D measurement plane (centre of GAITRite walkway).

The aim of this study was to re-examine the accuracy of the GRS system by comparing its data to equivalent data extracted from film (PEAK Motus Measurement system) captured by a *50* Hz camera (at varying location *(5*, *7.5* and 10m).

METHOD

Ten healthy participants were recruited for this study. Individuals with gait and/or neurological disorders were excluded.

A procedure similar to Cutup et al. (2000) was employed where participants walked at self selected, fast and slow speeds in random order. One representative trial at each speed and camera location was measured. As the participant walked across the mat, the GRS software and the MAS simultaneously recorded individual footfalls.

For the purpose of this study the camera was positioned *5*, *7.5* and 1 Om from the centre of the walkway (field of view =3 in). A 2m calibration rod was placed along the centre of the walkway and in the middle of the field of view and then filmed (shutter rate 1/120 Hz). Film of each trial was digitised by the same individual. This involved digitising images of the heel and toe markers for both the foot-strike and toe-off phases of the gait cycle for each foot contact.

RESULTS

No significant differences were found between the MAS and GRS for either spatial or temporal data across the three camera locations. Figure 2 shows a decreasing trend for the (1) mean difference – the absolute difference between the mean step length of the GRS and MAS data, (2) maximum error – maximum absolute error recorded between each step length trial of the GRS and MAS data, and (3) mean absolute error - mean of absolute step length differences between each trial for the GRS and MAS data. The mean differences for step length at the respective camera locations of *5* m, *7.5* m and 10 m were 2.3cm, 1.2cm and less than 0.2cm.

DISCUSSION

A 2-dimensional video based analysis system was used to ascertain the validity of the GAITRite system. Similar to Cutlip et al. (2000) the two systems were closely matched for temporal parameters (step period, stance duration and swing duration). Statistical differences were not found in the temporal measures.

Cutlip et al. (2000) reported a mean difference of 3.44 cm for step length. This study, however, found a mean difference of 2.3cm at the same 5m camera location used by Cutlip et al.. Figure 2 shows this error reduces with increasing camera location. At *7.5* m the mean difference was 1.2 cm while at 10m the mean difference fell below 0.2cm. The later finding supports the PP study by McDonough et al. (2001).

In conclusion, the findings of this study show: (1) the GAITRite system is a valid tool for the measurement of spatial and temporal parameters; and, (2) camera location significantly affects the accuracy of spatial data (particularly variables such as step length) collected by motion analysis systems.

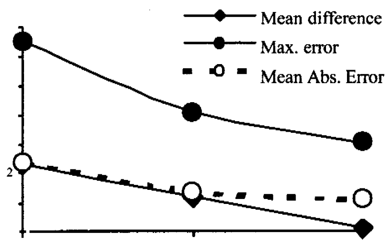


Figure 2. Mean differences, maximum absolute error and mean absolute error determined by GAITRite and video analysis for combined walking speeds.

REFERENCES

Cutlip, R. G., Mancinelli, C., Huber, F., & DiPasquale, J. Gait & Posture 12 134-138, 2000.

Lythgo, N. (2002). Unpublished doctoral dissertation. Victoria University, Melbourne.

McDonough, A., Batavia, M., Chen, F., Kwon, S., & Ziai, J. Archives of Physical Medicine & Rehabilitation, 82 419-25, 2001.