VALIDATION OF MICROSOFT KINECT TO MEASURE LUMBAR SPINE MOTION

Wantuir C. Ramos Junior[1], Eric Bourdon[1], Ryan B. Graham[1]
[1]School of Human Kinetics, University of Ottawa, Ottawa, ON

Introduction: To assess risk of low back pain, researchers and clinicians frequently observe patients' movements and movement quality in pre-determined tasks [1] using technically challenging and expensive devices [2]. The financial and time burden of these devices limits their use in clinical settings. As an inexpensive and less time-intensive alternative, the utilization of depth sensors has been validated for analyses of gait, postural control and motor function [3-5]. The purpose of this work was to validate depth sensors for spine motion analysis.

Methods: 13 healthy young adults (6M, 7F) were recruited to perform 35 cycles of a repetitive flexion/extension task at a rate of 15 cycles/min. Reflective marker clusters were placed over the T_{10}-T_{12} spinous processes and sacrum, and motion capture data were recorded simultaneously by one Kinect v2 camera (Microsoft, WA, USA) and a 10-camera V5 system (Vicon, Oxford, UK). To determine 3D marker trajectories, Vicon data were labelled and reconstructed with Nexus, whereas Kinect data were processed by custom Matlab (The Mathworks Inc., MA, USA) scripts that applied computer vision techniques and algorithms to track the same marker clusters. For both datasets, right-handed coordinate systems and lumbar spine joint angles (flexion/extension, lateral bending, axial rotation) were extracted using Euler rotations of the low back cluster relative to the pelvis. Using the ensemble average of the 35 cycles for each participant under each condition, Root Mean Square Error (RMSE) between the two systems was calculated. Maximum, minimum and mean angles were calculated for each axis, and Intraclass Correlation Coefficients (ICC 2,1) were applied to determine the absolute agreement between the systems.

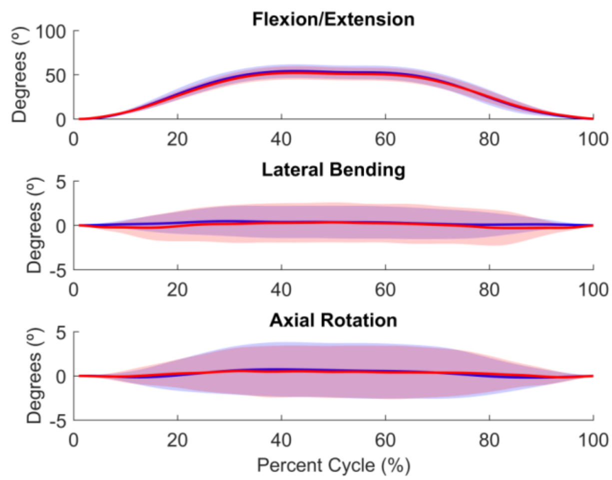

Figure 1: Vicon vs Kinect means and standard deviations across all movement axes

Results: Data matched visually, RMSE indexes were low for all trunk movement axes, and ICC's were excellent for each dependent variable (Figure 1, Table 1).

Discussion/Conclusion: We have validated Kinect v2 as a quantitative tool to measure 3-D lumbar spine motion during a sagittal movement task using infrared reflective markers. Future research will investigate the reliability of the device during movements involving lateral bending and axial rotation.

References: [1] Graham & Brown (2014), J Biomech Eng, 136(12); p. 121006. [2] Bonnechère et al. (2016), J Biomech, 49(13); p. 2561–2565. [3] Clark et al. (2012), Gait Posture, 36(3); p. 372–377. [4] Eltoukhy et al. (2017), Gait Posture, 51; p. 77–83. [5]. Otte et al. (2016), PLoS ONE, 11(11); p. 1–17.

Table 1: Vicon vs. Kinect ICC's and RMSE for flexion/extension, lateral bending and rotation of the low back.

		Flexion/Extension	Lateral Bending	Rotation
ICC	*mean*	0.980	0.947	0.961
	max	0.977	0.935	0.91
	min	0.965	0.934	0.956
RMSE		2.05° ± 0.97°	0.65° ± 0.37°	0.84° ± 0.38°