JOURNAL OF
Medical
Engineering
&Technology

http://informahealthcare.com/jmt
ISSN: 0309-1902 (print), 1464-522X (electronic)

J Med Eng Technol, Early Online: 1–7
 DOI: 10.3109/03091902.2014.909540

informa
healthcare

INNOVATION

Comparative abilities of Microsoft Kinect and Vicon 3D motion capture for gait analysis

Alexandra Pfister[1], Alexandre M. West[1], Shaw Bronner[2] and Jack Adam Noah*[3]

[1]ADAM Center, Long Island University, Brooklyn, NY, USA, [2]Department of Physical Therapy, Movement and Rehabilitation Sciences, Northeastern University, Boston, MA, USA, and [3]Psychiatry, Yale University, 300 George St, New Haven, CT, USA

Abstract

Biomechanical analysis is a powerful tool in the evaluation of movement dysfunction in orthopaedic and neurologic populations. Three-dimensional (3D) motion capture systems are widely used, accurate systems, but are costly and not available in many clinical settings. The Microsoft Kinect™ has the potential to be used as an alternative low-cost motion analysis tool. The purpose of this study was to assess concurrent validity of the Kinect™ with Brekel Kinect software in comparison to Vicon Nexus during sagittal plane gait kinematics. Twenty healthy adults (nine male, 11 female) were tracked while walking and jogging at three velocities on a treadmill. Concurrent hip and knee peak flexion and extension and stride timing measurements were compared between Vicon and Kinect™. Although Kinect measurements were representative of normal gait, the Kinect™ generally under-estimated joint flexion and over-estimated extension. Kinect™ and Vicon hip angular displacement correlation was very low and error was large. Kinect™ knee measurements were somewhat better than hip, but were not consistent enough for clinical assessment. Correlation between Kinect™ and Vicon stride timing was high and error was fairly small. Variability in Kinect™ measurements was smallest at the slowest velocity. The Kinect™ has basic motion capture capabilities and with some minor adjustments will be an acceptable tool to measure stride timing, but sophisticated advances in software and hardware are necessary to improve Kinect™ sensitivity before it can be implemented for clinical use.

Keywords

Biomechanics, gait, kinect, vicon

History

Received 24 September 2013
Revised 20 March 2014
Accepted 23 March 2014

1. Introduction

Biomechanical analysis is used in sports medicine, athletic training, rehabilitation and treatment for motor impairments. Three-dimensional (3D) motion capture systems are widely used, accurate systems, but are costly and thus not available in many clinical settings. Alternatives include two-dimensional (2D) video cameras with analysis software, electrogoniometers, pressure sensitive mats or accelerometers to assess gait timing and alignment. Although these systems are more affordable than 3D motion capture systems, shortcomings exist; they are less accurate, may deteriorate with time, may not allow for full body motion capture and data processing may be labour intensive. Microsoft recently released the Kinect™ sensor, a video gaming device developed to track the movements of a player interacting with a game. The Kinect™ consists of an infrared (IR) light projector, an IR camera, and a RGB video camera. Reflected IR light is converted into depth data and is calibrated with RGB data to distinguish shapes [1], enabling the Kinect™ to track and record 3D human motion without using controllers or markers. The Kinect™ is simple to operate and is less than or equal to the price of 2D video analysis software. The Kinect™ has potential to be a useful biomechanics analysis tool, but its spatial and temporal motion capture abilities have not yet been fully analysed with respect to gait.

Previous studies investigating Kinect™ motion capture have addressed Kinect™ hardware sources of error [2–4], postural control [5], dance gesture recognition [6], frontal gait biometrics for surveillance [7] and gait measurements for fall risk (walking speed, stride time and stride length) [8,9]. These studies indicate that the Kinect™ can perform basic motion capture functions, but system error exists that compromises accuracy [2]. For most aspects of static postural tests the Kinect™ is reported to accurately measure angular and lateral displacement [5], but Kinect™ accuracy in stride motion tracking is not great enough to predict fall risk [8,9]. In addition to stride measurements, lower limb angular displacement and intra-limb mechanics are also very important aspects of gait analysis that assess various types of movement disorders, such as stroke, Parkinson's disease and cerebral palsy (CP) [10–14] and to assess change during rehabilitation after stroke or partial spinal cord injury [15,16].

*Corresponding author. Email: adam@adamnoah.com