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Short communication

Analysis of accuracy in optical motion capture – A protocol for laboratory setup evaluation

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ABSTRACT

Validity and reliability as scientific quality criteria have to be considered when using optical motion capture (OMC) for research purposes. Literature and standards recommend individual laboratory setup evaluation. However, system characteristics such as trueness, precision and uncertainty are often not addressed in scientific reports on 3D human movement analysis. One reason may be the lack of simple and practical methods for evaluating accuracy parameters of OMC.

A protocol was developed for investigating the accuracy of an OMC system (Vicon, volume $5.5 \times 1.2 \times 2.0\ m^3$) with standard laboratory equipment and by means of trueness and uncertainty of marker distances. The study investigated the effects of number of cameras (6, 8 and 10), measurement height (foot, knee and hip) and movement condition (static and dynamic) on accuracy. Number of cameras, height and movement condition affected system accuracy significantly. For lower body assessment during level walking, the most favorable setting (10 cameras, foot region) revealed mean trueness and uncertainty to be −0.08 and 0.33 mm, respectively.

Dynamic accuracy cannot be predicted based on static error assessments. Dynamic procedures have to be used instead. The significant influence of the number of cameras and the measurement location suggests that instrumental errors should be evaluated in a laboratory- and task-specific manner. The use of standard laboratory equipment makes the proposed procedure widely applicable and it supports the setup process of OCM by simple functional error assessment. Careful system configuration and thorough measurement process control are needed to produce high-quality data.

1. Introduction

Entertainment (Bregler, 2007), biomechanics (Sutherland, 2002), ergonomics (Wang et al., 2012) and sports (Bini et al., 2010) are possible fields of application of optical motion capture (OMC). Validity and reliability as scientific quality criteria have to be considered when using OMC in research. Miller and colleagues reported that the functional characteristics, namely accuracy, repeatability and resolution, had to be determined to report data with confidence (Miller et al., 2002). Accuracy, the systematic and random instrumental error, is often unspecified in scientific reports about 3D human movement analysis. One reason may be that manufacturers only provide rough accuracy specifications due to the fact that accuracy is influenced by many factors, such as camera setup, measurement and calibration volume, camera resolution, lighting conditions, etc. (Windolf et al., 2008). Windolf et al. reported that accuracy of OMC strongly depends on their individual setup and that accuracy and precision should be determined for an individual laboratory installation (Windolf et al., 2008). Published studies addressing the lack of accuracy information included examinations on system comparison (Ehara et al., 1997; Richards, 1999), accuracy in angular (Vander Linden et al., 1992) and linear (Ehara et al., 1997) measurements and setup parameter influence (Windolf et al., 2008). Varying definitions of accuracy and precision limit the comparability between studies, but mostly accuracy was defined as mean absolute error and precision as mean standard deviation. This article follows the standards ISO 5725-1:1994 and JCGM 200:2012 which define the terms trueness, precision and uncertainty to quantify accuracy. Examination methods most often included special reference

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