**Tracking human motion without markers – opportunities for field testing in sports**

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Marker-based kinematic data collection is used for movement capture in laboratory settings. Inherent problems include adequate marker placement, skin movement artifacts or marker occlusion in certain body orientations. In outdoor settings the use of markers may be limited. A possible alternative are marker-less image-based motion tracking systems. The authors have proposed free-form surface patches to estimate segment orientations (1) as well as global and local morphing techniques (2). Further features include an advanced image segmentation method, dynamic occlusion handling and the inclusion of kinematic chains of higher complexity.

The aim of this study was to apply a marker-less tracking system to full body movements in sports. Marker data was recorded simultaneously to compare resulting kinematics to a commercially available marker-based tracking system.

A digital four camera system was used (Basler A602f, 180 Hz, SIMI motion). Tests were carried out on an outdoor sports field. To attain optimal contrast subjects had to wear tight white full-body suits. On top of the suite dark grey markers were placed on anatomical landmarks according to an existing upper body model (3). Marker data was tracked semi-automatically using SIMI software (Motion 7.0). Joint coordinate systems and joint motion were calculated using a customized Matlab script (The MathWorks 7.1). The marker-less system consists of three steps: segmentation, correspondence estimation and pose estimation as outlined in greater detail in (4). A series of experiments was conducted to compare marker-based and marker-less motion capture data

Average differences between marker-based and silhouette-based joint angles of the upper extremity were less than 2° for flexion-extension, while lower extremity values varied up to 4.8° depending on the movements under investigation.

The differences between the two methods were in the range of repeatability measures for marker-based collection systems (5). Based on the present data it can not be determined which systems better represents true skeletal motion. However, it was concluded that the proposed method gives comparable results to marker-based analyses. The resulting kinematics are or sufficient quality for the computation of e.g. kinetic energy in sports type movements.

References

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