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Estimating joint kinematics from skin motion observation: modelling and validation.

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Modelling of soft tissue motion is required in many areas, such as computer animation, surgical simulation, 3D motion analysis and gait analysis. In this paper, we will focus on the use of modelling of skin deformation during 3D motion analysis. The most frequently used method in 3D human motion analysis involves placing markers on the skin of the analysed segment which is composed of the rigid bone and the surrounding soft tissues. Skin and soft tissue deformations introduce a significant artefact which strongly influences the resulting bone position, orientation and joint kinematics. For this study, we used a statistical solid dynamics approach which is a combination of several previously reported tools: the point cluster technique (PCT) and a Kalman filter which was added to the PCT. The methods were tested and evaluated on controlled human-arm motions, using an optical motion capture system (Vicon(TM)). The addition of a Kalman filter to the PCT for rigid body motion estimation results in a smoother signal that better represents the joint motion. Calculations indicate less signal distortion than when using a digital low-pass filter. Furthermore, adding a Kalman filter to the PCT substantially reduces the dispersion of the maximal and minimal instantaneous frequencies. For controlled human movements, the result indicated that adding a Kalman filter to the PCT produced a more accurate signal. However, it could not be concluded that the proposed Kalman filter is better than a low-pass filter for estimation of the motion. We suggest that implementation of a Kalman filter with a better biomechanical motion model will be more likely to improve the results.

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