Inertial Measurement Units for Wrist Posture Measurement: A Pilot Study

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ABSTRACT

Introduction: Precise and objective direct measurement methods are critical to establishing the relationship between exposure to physical risk factors (e.g., non-neutral working postures) and musculoskeletal health outcomes. Inertial measurement units (IMUs) are a promising technology for directly measuring human motion in field-based environments due their small size and low cost. The accuracy of IMUs has been evaluated for various body segments with mixed results. To date, the accuracy of IMUs has not been evaluated for measuring postures of the wrist.
Purpose: The purpose of this ongoing pilot study is to estimate wrist flexion/extension and ulnar/radial deviation measurement errors in comparison to a "gold-standard" optical motion capture system.
Methods: A simulated milking cluster attachment task common to dairy parlor work and a simulated manual material handling task was completed by one participant to evaluate the accuracy of an IMU system in a laboratory setting. The cluster attachment task required the participant to bend forward to grasp a milking cluster and then lift and secure the cluster to the teats of an artificial cow udder. The manual material handling task consisted of lifting a plastic crate from the ground to waist height. Eight trials of each task (10 repetitions per trial) were performed once every hour for eight hours. Orientations of IMUs worn on the forearm and hand were tracked using an eight-camera optical motion capture system. Wrist posture was calculated using the orientation of the IMU worn on the hand relative to the orientation of the IMU worn on the forearm.
For each task, differences in the IMU and optical motion capture estimates of wrist posture were quantified as sample-to-sample root-mean-square deviation across the10 repetitions of each of the eight trials.
Results: Root-mean-square deviation [mean degrees, (SD)] observed between the IMU system and the optical motion capture system are shown in the table below.

Task	Flexion/Extension	Ulnar/Radial Deviation
Cluster Attachment	11.4 (2.2)	6.3 (1.4)
Material Handling	10.1 (1.9)	4.8 (1.9)

Conclusions: In general, these preliminary data suggest that IMUs may be useful for measuring wrist posture in controlled laboratory settings. Additional data collection is planned for this pilot study, and further research on the use of IMUs for assessing exposure to non-neutral postures of the wrist is in field-based settings is ongoing. Important issues to address include the accuracy of IMU-based posture measure under highly dynamic motion and in the presence of localized magnetic field disturbances.

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