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Using markerless motion capture to identify unsuitable static body postures during work activities

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Abstract: Significant numbers of workplace-related injuries occur despite decades of efforts towards improving activity design and ergonomics interventions. Furthermore, the cause and prediction of most overuse-type injuries remain elusive. Observational techniques have been limited to subjective assessment by clinicians (whether in person or by video), quantitative assessment of simulated activities in a gait laboratory, or invasive and non-scalable techniques such as markers and wearable devices. A continuous and non-invasive measurement of likely contributing factors has not been possible, restricting the ability to correlate injuries with activities.

Recent advances in computer vision and machine learning have enabled markerless motion capture (MMC), which is the use of video images to track the three-dimensional (3D) body posture and movement. CSIRO have developed an MMC system, called "Ergomechanic" (https://go.csiro.au/FwLink/Ergomechanic), that can perform motion capture using input from webcams, security cameras, and off-the-shelf cameras such as GoPros (Harrison et al., 2025). First demonstrations of Ergomechanic have shown its ability to identify body postures and movements that could be of concern for injury, but this could only be assessed using an expert-in-the-loop because threshold values of its output metrics were not known.

Here we introduce a new capability in the Ergomechanic system to use criteria derived from the ISO 11226:2000 standard "Evaluation of static working postures" (Delleman and Dul 2007) from the MMC body posture measurements and therefore identify unsuitable postures automatically. The updated system capability is demonstrated for a range of postures developed in common manual work scenarios. The 3D locations of all body segments were calculated for each time instance of each scenario. Joint angle metrics from the ISO standard were calculated using both traditional optimisation and fast approximate biomechanics modelling approaches to evaluate the accuracy of the latter, which is substantially quicker (Harrison and Cohen 2023). The angles of the torso, shoulders, and neck were the primary focus, where injuries are known to be most prevalent (Safe Work Australia 2015). The calculated metrics were then used to identify which of the sampled body postures would lead to the least and most frequent instances of unacceptable static body posture for each participant, according to the limits described in the standard. Example interventions are suggested from these results. Future work with Ergomechanic should involve real-time deployment into the production work environment and correlate metrics with reported injuries to enable a fully predictive injury prevention system.

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