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Marker-less monitoring protocol to analyze biomechanical joint metrics during pedaling

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Marker-less systems are becoming popular to detect a human skeleton in an image automatically. However, these systems have difficulties in tracking points when part of the body is hidden, or there is an artifact that does not belong to the subject (e.g., a bicycle). We present a low-cost tracking system combined with economic force-measurement sensors that allows the calculation of individual joint moments and powers affordable for anybody. The system integrates OpenPose (deep-learning based C library to detect human skeletons in an image) in a system of two webcams, to record videos of a cyclist, and seven resistive sensors to measure forces at the pedals and the saddle. OpenPose identifies the skeleton candidate using a convolution neural network. A corrective algorithm was written to automatically detect the hip, knee, ankle, metatarsal and heel points from webcam-recorded motions, which overcomes the limitations of the marker-less system. Then, with the information of external forces, an inverse dynamics analysis is applied in OpenSim to calculate the joint moments and powers at the hip, knee, and ankle joints. The results show that the obtained moments have similar shapes and trends compared to the literature values. Therefore, this represents a low-cost method that could be used to estimate relevant joint kinematics and dynamics, and consequently follow up or improve cycling training plans.

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