Can a Computer-Vision Tool Cast Light on Ladder Hazards?

Field Tool for On-Site Biomechanical Analysis During Ladder Climbing

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Overview

Falls from ladders are a leading cause of injury and death among construction workers. Biomechanical factors that influence climbing behavior often result in lost balance, lost handgrip, and missed/slipped footing. Climbing can be studied in research laboratories using video cameras and computers that track markers attached to workers' bodies, but these methods are not suitable for studies at actual job sites. Computer vision tools, now widely used in robotics, transportation, security and games, do not require attaching markers and can utilize existing video cameras found in surveillance systems or smart phones. The study goals were to test the ability of vision-based motion data to collect information during ladder climbing in a laboratory; to study forces on hands and feet to predict forces from video; to develop software capable of translating vision-based motion data into available file formats used by existing biomechanical computer programs; and to develop a tool for use in the field.

Key Findings

- The authors tried using multiple cameras, as well as a stereo-lens camera, to produce three-dimensional images of the skeleton.
- The measurements had acceptable average errors for length of body part and for joint position, although there were practical problems viewing hand movements, because they are frequently in motion or may be covered from view by the body.
- The authors developed a program that was able to convert vision-based data into files that could be directly used by existing computer programs evaluating biomechanical stressors. The processing was successfully repeated for biomechanical evaluation both at rest and in motion.
- Hand and foot forces used during ladder climbing were measured in test subjects and the information was used to predict forces used by the same individuals when working with the same loads.
- The authors report that during ladder climbing, the greatest hazard is due high joint moments generated at wrists and elbows. This hazard is greatest for vertical ladders that are often attached to equipment or fixed structures. They suggest that interventions to reduce musculoskeletal stresses on upper extremities be implemented to prevent ladder-related injuries.
- Future research is needed to develop additional force prediction models that can be used with motion tracking data to estimate joint loads for various climbing styles and to test the tool in active worksites.

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