Simulation of Human Reach Motions for Ergonomics Analyses

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Ergonomics experts tend to concentrate on the potential adverse affects of force, posture and repetition when analyzing a task, as these appear to be traditionally recognized risk factors in the workplace. Recent work has indicated that this pragmatic approach may be overly simplistic, and thus miss prediction of risk factors associated with certain motions. In addition, if realistic motion patterns can be simulated in CAD systems then not only can improved ergonomic assessments be performed, but job designers can visualize how different individuals could perform a manual task and how much time or effort would normally be required.

This paper reviews some of the research underway in the University of Michigan’s Human Motion Simulation Laboratory. This Laboratory was funded initially by five US Automotive Companies. The US Army has joined this consortium recently. The objective of the work in the Laboratory is to produce human motion models and simulation software. Over 37,000 motions of 100 men and women from 18 to 78 years in age have been measured with a motion capture system employing both optic and magnetic motion sensing systems. The motions are typical of people reaching and moving light to moderate load objects while either seated or standing. A 17 link kinematics model has been developed to resolve the dynamics of the motions, producing a set of angle and coordinate data depicting the movements of the 45 degree-of-freedom human kinematics system.

These extensive data are being analyzed by using both statistical functional regression models to fit the data sets, and optimization methods for choosing motions with attributes that are common to those motions desired in a new or novel motion. Thus far initial motion algorithms have been developed that capture well over 95% of the between subject variability in such motions. These algorithms have been provided to commercial digital human simulation programs (i.e., 3DSSPP, Jack and Ramsis) to improve their motion animation and ergonomics analysis capabilities. The motion prediction models are also being used to study how shoulder anatomy and ability of people to maintain balance affects reaching behaviors. Advantages and limitations of the methods and data being used will be discussed and illustrated.

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