Modeling Hand Trajectories during Reaching Motions

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We describe a method for modeling hand trajectories during human reaching motions. The method has applications in biomechanics, neuroscience, ergonomics, virtual reality, animation and kinesiology. The method is used to model data collected from an ergonomics experiment designed to understand how factors such as anthropometry, age and gender affect hand trajectories. Motion capture equipment was used to record the 3D hand trajectories of twenty seated subjects reaching to a well-dispersed set of fifty two targets within a simulated industrial environment. The trajectory was parameterized by defining an axis passing through the start and end of the motion. The location of the finger tip over the trajectory is represented using radial deviation from the axis of motion, which is the shortest distance from the location to the axis. In addition, we define the axial velocity, which is the rate of progress of the location along the trajectory projected onto the axis, and the angular deviation, which describes the rotation of the location about the axis. The radial deviation and the axial velocity are modeled using functional regression with a B-spline basis. The angular deviation is a circular response. We present a new functional version of circular regression. We also introduce random effects to model the within and between subject variation.

We find that reaches do not follow a straight line path contrary to some previous claims in the literature. We also find that the trajectories are not particular dependent on anthropometry thus confirming older claims regarding reach trajectories. The relation between the predictors and the hand trajectory are investigated.