Investigation of Hand Posture during Reach and Grasp for Ergonomic Applications

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ABSTRACT

New methods were developed to study the effect of object and task attributes on prediction of hand posture and finger motion during reach and grasp. The results of three studies in young adults showed: (1) Finger motion during reach and grasp for pinching cylindrical objects was described using selected spatial (initial, maximum open, final postures) and temporal parameters (delay and total times) as a function of object properties (e.g., object size and orientation, reach distance). Those parameters were used to predict finger motion using a constrained fourth order polynomial function (R^2 ranging from 0.54 to 1). (2) Two new metrics, openness and flatness, which represent fingertip positioning and finger shape, respectively, were used to describe the effect of object shape on hand posture during reach and grasp. Object aspect ratio and cross-sectional shape caused changes in hand posture. Pinching long objects (e.g., cylinders) resulted in up to 25% greater hand opening than pinching symmetric objects (e.g., spheres). Pinching objects with edges (e.g., cubes) resulted in up to 12% greater hand opening than objects with curved surfaces (e.g., spheres). (3) Different hand postures were observed for reach and pinch than for reach and power-grip. Use of power grasp involved greater hand opening than pinch (the mean difference of finger joint angles ranges from 1.8 to 11.9°), and the effect of grasp type occurred from earlier in the reach for the MCP joints than for the PIP and DIP joints. In summary, we conclude that these methods can be used to reliably predict finger motion for selected jobs and to estimate tendon excursion for studying musculoskeletal disorders in the hand.