

3D Anthropometry and Physical Interaction Modeling for Persons with Arthritis

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Abstract

Advances in pain management have given persons with arthritis the ability to move and function more readily. This increase in movement allows for greater daily interaction of handheld products and devices. Many handheld products and devices are not shaped for persons with arthritis. The Cornell Simulation and Human Engineering in Design (SHED) Laboratory has completed a series of 3-D upper extremity measurement studies of persons with arthritis using optical scanning and electromechanical measurement tools. The first study captured 3-D landmark data and created linear dimensions of persons with advanced arthritis (stages III or IV) using an electromechanical measurement (digitizing) system. This study considered new measurement techniques and modified 3-D landmark definitions due to unique surface landmark features of persons with advanced arthritis. A second study investigated persons with advanced arthritis measured by an optical/light-based scanning system (Human Solutions) and an electromechanical measurement tool (Faro Technologies). Results from this study showed that combining these measurement methods supported the arthritic population by capturing the unique morphology of the skin surface and digitizing upper extremity landmarks in relation to the skin surface morphology. The third study investigated physical interaction modeling (PIM) for persons with arthritis. Participants were asked to hold basic Plexiglas shapes of cylinders, spheres, rectangular plates, and cones of various sizes. Each participant was scanned using the Human Solutions scanning system. The results were compared with age-matched persons (control group) that did not have arthritis. This study demonstrated the unique grasping, pinching, and opposition techniques for persons with arthritis. The final study measured persons with arthritis using products (complex shapes) commonly encountered in everyday use (i.e. toothbrush, medicine bottle, cup). Participants were asked to mimic the use of these products and selected postures were collected using the Human Solutions scanner and the Faro Technologies electromechanical digitizing device. Results will be used to understand PIM for future design improvements of products and devices for persons with arthritis.

Keywords: Anthropometry; Optical/Light-based 3-D Scanning; Electromechanical 3-D Scanning; Arthritis; Physical Interaction Modeling.