

Estimation of Finger Joint Center of Rotation Using Finger Motion Data

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ABSTRACT

The present study compared various existing techniques for estimation of finger joint center of rotation (CoR) using 3D reconstructed CT motion data. The existing techniques included Principal Component Analysis (PCA) method, Reuleaux method, Bone Curvature method and Delonge-Kasa linear algebraic circle fitting method. PCA method and Reuleaux method determine the instantaneous joint CoR from 2 distinct postures. Bone Curvature method and Delonge-Kasa method identify the fixed joint CoR based on the convex shape of bone head and the motion of adjacent bone respectively. To examine finger motion, 10 frames of a hand CT scan data were captured in different postures. Those 10 postures are selected during natural hand motion starting from a hand flat posture and ending with the fist posture. As result, the consistencies of estimated joint CoRs by various techniques were identified and compared in terms of mean distance between 2 distinct estimated CoRs. The mean consistency of estimated instantaneous CoRs of all joints by PCA method and Reuleaux method is 0.45 ± 0.35 mm and 0.46 ± 0.37 mm respectively. To compare both PCA and Reuleaux method with Bone Curvature and Delonge-Kasa method, fixed joint CoR was evaluated by evaluating the centroid from the cluster of instantaneous joint CoRs using K-means clustering technique ($K=1$). The mean consistency of estimated centroid CoR by PCA and Reuleaux method to the CoRs by other techniques is 0.64 ± 0.25 mm and 0.42 ± 0.29 mm. For Bone Curvature and Delonge-Kasa method, the mean consistency is 0.54 ± 0.19 mm and 0.44 ± 0.29 mm respectively. From all techniques, Reuleaux method and Delonge-Kasa method shows higher consistency compare to PCA and Bone Curvature method. As future study, the consistency of estimated joint CoR based on bone length and hand size should be analyzed.

Keywords: Finger joint center of rotation, circle fitting method, PCA, Reuleaux, Bone curvature, Delonge-Kasa