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CT Images Based Dense Facial Soft Tissue Thickness Measurement by Open-source Tools in Chinese Population

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Abstract : Objectives: Facial soft tissue thickness (FSTT) data could be obtained from CT scans by measuring the face-to-skull distances at sparsely distributed anatomical landmarks by manually located on face and skull. However, automated measurement using 3D facial and skull models by dense points using open-source software has become a viable option due to the development of computed assisted imaging technologies. By utilizing dense FSTT information, it becomes feasible to generate plausible automated facial approximations. Therefore, establishing a comprehensive and detailed, densely calculated FSTT database is crucial in enhancing the accuracy of facial approximation. Materials and methods: This study utilized head CT scans from 250 Chinese adults of Han ethnicity, with 170 participants originally born and residing in northern China and 80 participants in southern China. The age of the participants ranged from 14 to 82 years, and all samples were divided into five non-overlapping age groups. Additionally, samples were also divided into three categories based on BMI information. The 3D Slicer software was utilized to segment bone and soft tissue based on different Hounsfield Unit (HU) thresholds, and surface models of the face and skull were reconstructed for all samples from CT data. Following procedures were performed unsing MeshLab, including converting the face models into hollowed cropped surface models amd automatically measuring the Hausdorff Distance (referred to as FSTT) between the skull and face models. Hausdorff point clouds were colorized based on depth value and exported as PLY files. A histogram of the depth distributions could be view and subdivided into smaller increments. All PLY files were visualized of Hausdorff distance value of each vertex. Basic descriptive statistics (i.e., mean, maximum, minimum and standard deviation etc.) and distribution of FSTT were analysis considering the sex, age, BMI and birthplace. Statistical methods employed included Multiple Regression Analysis, ANOVA, principal component analysis (PCA). Results: The distribution of FSTT is mainly influenced by BMI and sex, as further supported by the results of the PCA analysis. Additionally, FSTT values exceeding 30mm were found to be more sensitive to sex. Birthplace-related differences were observed in regions such as the forehead, orbital, mandibular, and zygoma. Specifically, there are distribution variances in the depth range of 20-30mm, particularly in the mandibular region. Northern males exhibit thinner FSTT in the frontal region of the forehead compared to southern males, while females shows fewer distribution differences between the northern and southern, except for the zygoma region. The observed distribution variance in the orbital region could be attributed to differences in orbital size and shape. Discussion: This study provides a database of Chinese individuals distribution of FSTT and suggested opening source tool shows fine function for FSTT measurement. By incorporating birthplace as an influential factor in the distribution of FSTT, a greater level of detail can be achieved in facial approximation.

Keywords : forensic anthropology, forensic imaging, cranial facial reconstruction, facial soft tissue thickness, CT, open-source tool
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