Automatic cephalometric landmarks estimation in Cone Beam CT

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Forensic medicine, craniofacial surgery and orthodontics make wide use of cephalometric analysis in identification, diagnosis and surgical planning. In order to measure linear distances, angular apertures and geometric features of the individual skull bones, an expert usually annotates by hand a set of cephalometric landmarks onto two-dimensional radiographic images or three-dimensional surface renderings of CT or Cone Beam CT volumes. Currently, the development of CBCT scanners has led the 3D cephalometric analysis to become a normal procedure, due to the improvement in the evaluation of three-dimensional morphology of subjects.

Accuracy and repeatability of this manual approach are limited by intra- and inter-subject variability in landmark identification, even if an expert user takes care of the task. In order to improve the manual annotation, we propose a nearly-automatic method that gives the user an estimate of the positions of nine selected landmarks and a confidence region for each point, using as reference an accurate, manually annotated, single-subject CBCT volume. The method is based on intensity-based registration, on segmentation and on surface extraction of the CBCT target volumes.

The confidence regions for each landmark have been preliminary estimated by testing the method on 21 CBCT volumes and by calculating Euclidean three-dimensional distances between the automatically annotated point and a standard manual cephalometric annotation done by an expert user. The obtained results are promising, annotation errors are acceptable for most points and the algorithm has good performances even in the presence of metal artifacts. Method improvements and a strong validation are currently in preparation.