

Evaluation of different registration approaches in 3D cephalometric landmark estimation

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Thanks to the development of dedicated CBCT scanners, 3D cephalometric analysis is become a widely used tool for the diagnosis and treatment of dentofacial disharmonies in maxillofacial surgery and dentistry [1].

Traditionally, an expert manually annotates a set of cephalometric landmarks on a CBCT scan. Accuracy and repeatability of this manual approach are limited because of intra- and inter-subject variability in landmarks identification [2].

To improve the manual annotation, we are developing a nearly-automatic method that estimates the positions of a set of landmarks registering a previously annotated reference subject to the patient skull.

In this study, in order to reduce the estimation error, we compare different registration approaches by varying two registration parameters, such as elasticity (affine or elastic) and domain (local or global) of geometric transformation.

The algorithms were tested on 21 CBCT scans of adult caucasian women. To evaluate the outcome of the registration process, Euclidean distances in the 3D space between automatically and manually annotated landmarks were computed.

Finally, for each landmark, accuracy and precision of the annotation process were calculated as the mean and standard deviation of the distances of the analyzed sample.

Results show that the combination of a global affine registration followed by a global elastic registration significantly reduces the annotation error ($p < 0.001$), increasing both accuracy ($p < 0.001$) and precision ($p > 0.05$). Paired Student's *t* tests were used for comparisons.

The obtained results are promising, nevertheless the study should be continued in order to reduce further estimation error.

References

- [1] Hurst et al. (2007) Surgical cephalometrics: applications and developments. *Plast Reconstr Surg* 120(6): 92e-104e.
- [2] de Oliveira et al. (2009) Observer reliability of three-dimensional cephalometric landmark identification on Cone-Beam CT. *Oral Surg Oral Med O* 107(2):256-265.

Keywords

3D cephalometry, Automatic cephalometry, image registration, cephalometric landmarks.