VALIDATION OF AN AUTOMATIC HARD TISSUE SEGMENTATION FOR CONE BEAM CT DATA

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INTRO

Cone beam CT (CBCT) is now emerging as imaging technique due to its low radiation dose, image quality and accessibility. In particular, CBCT scanners are widely used in maxillo-facial surgery and dentistry. Applications of 3D surface models derived from CBCT include pre-operative surgical planning, bone volume assessment and performing cephalometric measurements [1]. The segmentation process is generally performed by manual thresholding, making this process strongly operator dependent. In this study, an automatic segmentation approach is evaluated in order to make the hard tissue segmentation process operator independent.

SEGMENTATION ALGORITHM

In this study, 30 CBCT scans of adult healthy women were retrospectively selected from the database of the SST Dentofacial Clinic, Italy. To create 3D skull surface models, the images were segmented using two different methods, manual and automatic thresholding. The manual thresholding was performed by an experienced operator with more than 3 years of experience in morphometric evaluation. The automatic thresholding was performed using a segmentation algorithm previously developed by our research group. This algorithm automatically calculates the threshold values using a clustering approach, which classifies a subsample of slices in 4 different clusters. For each slice it calculates the minimum intensity value belonging to the most intense cluster and finally calculates the global threshold as the 10^{th} percentile of the population of slice minima [2]. An example of the segmentation outcome is depicted in Figure 1.

VALIDATION

Manual and automatic segmentation threshold values were compared. Due to the normality of data distribution, Student's t test and Pearson's correlation coefficient were used for statistical analysis. Moreover the volume of the segmented structures was calculated. Wilcoxon rank test and Spearman correlation coefficient were used for statistical analysis. P value was set at 5%.

RESULTS

Results showed no significant difference ($p > 0.05$) in threshold values between manual and automatic segmentation. For the manual segmentation, the average threshold value (SD) was 453 (80) HU, while automatic segmentation had an average value of 460 (76) HU. High correlation was found between the two segmentation methods ($R = 0.97$), as shown in Figure 2. Regarding volume values, the comparison showed no significant difference ($p > 0.05$). Volumes median (interquartile range) value was 0.243 (0.119) dm3 for manual segmentation and 0.242 (0.105) dm3 for automatic segmentation. High correlation was found also for volumetric data ($\rho = 0.98$).

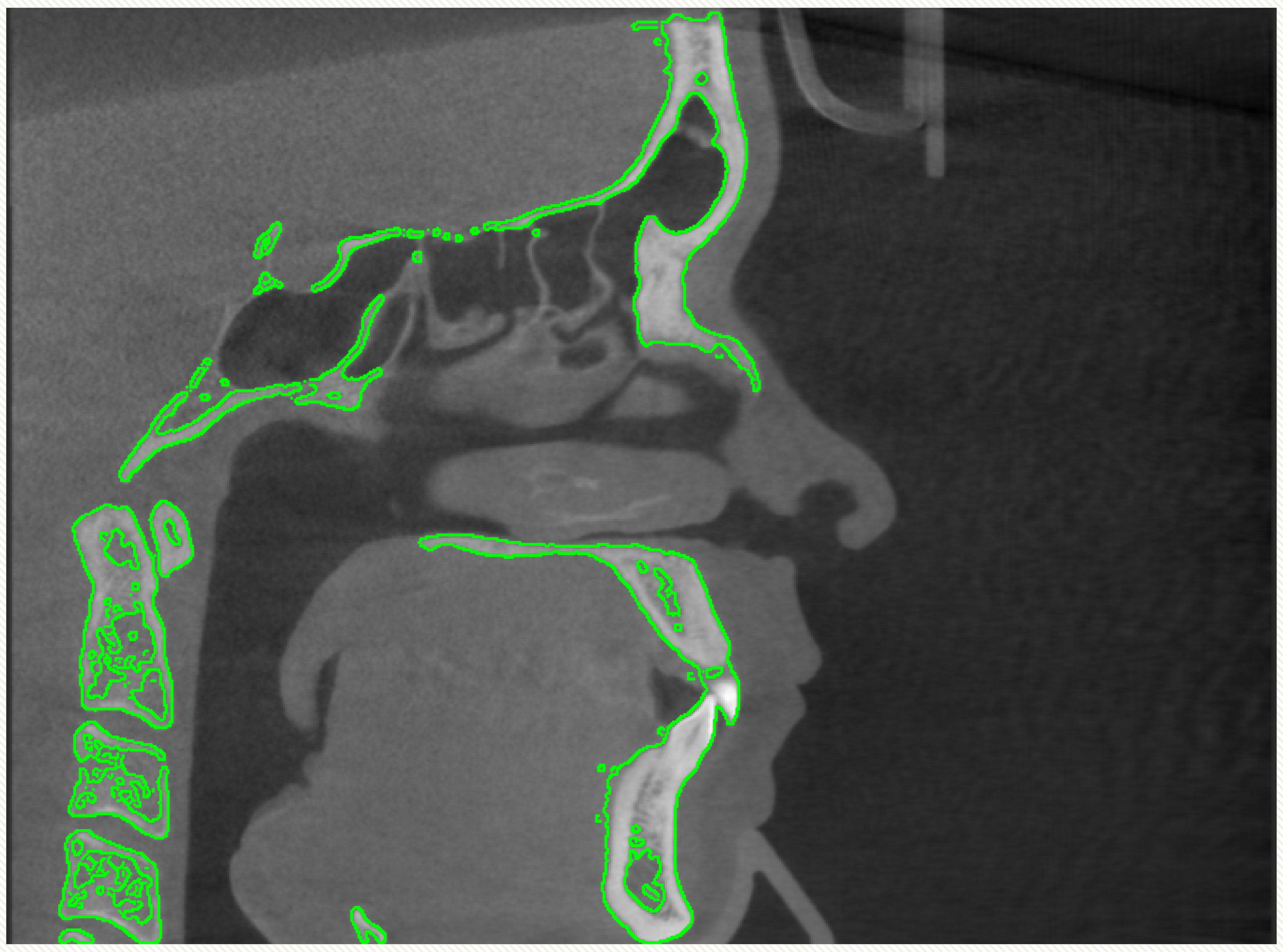

Figure 1: Example of segmentation process outcome, green lines hightlight the hard tissue structures segmented

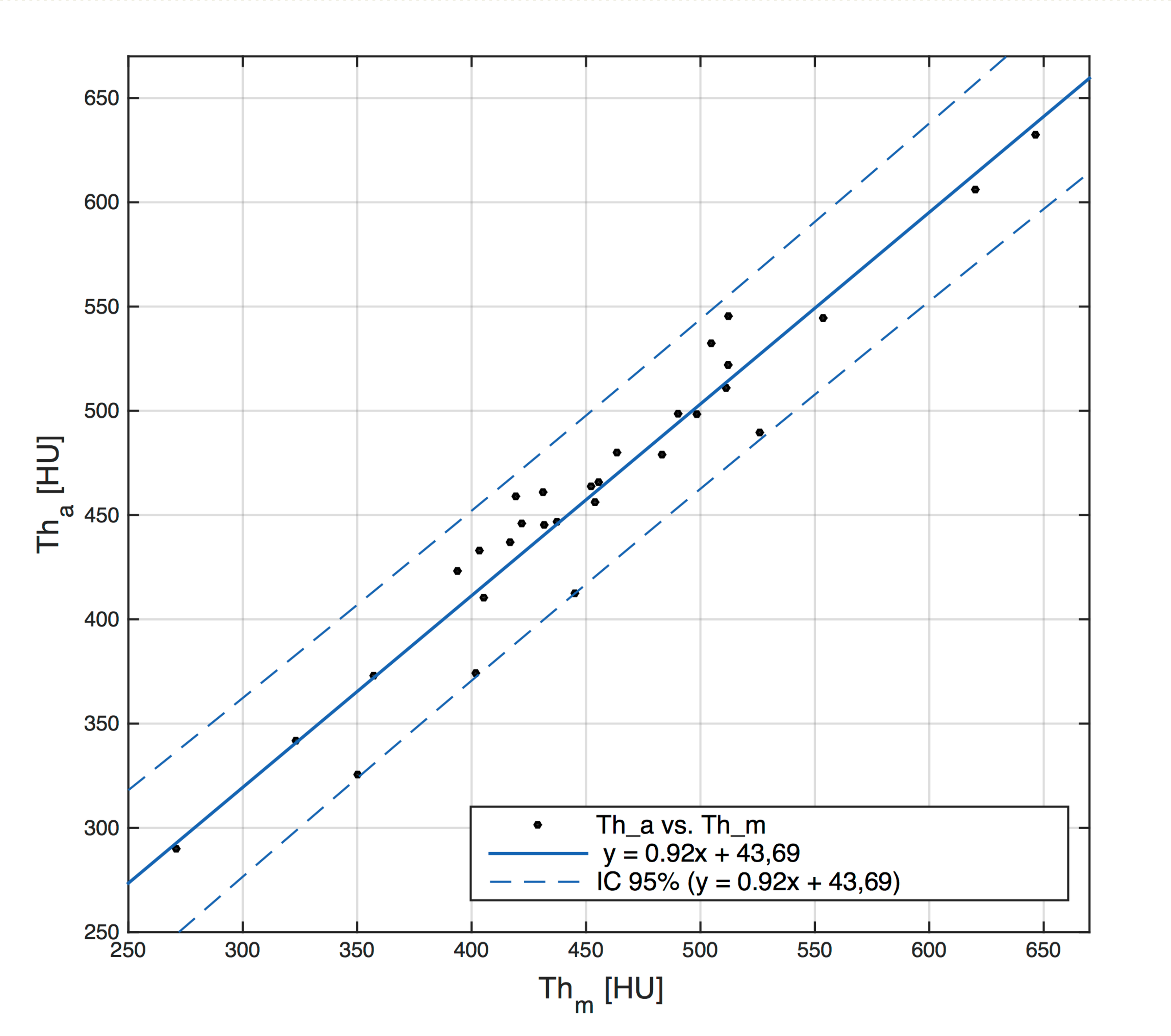

Figure 2: Linear correlation between manual (Thm) and automatic (Tha) threshold values. The straight line represents the linear fit model; dashed lines represent the boundaries of the 95% confidence interval.

DISCUSSION

Thresholds and volumes obtained with the automatic algorithm showed high correlation with manual ones and significance tests revealed there were not significant differences between them. From all these results, the segmentation made by the automatic algorithm results accurate compared with the manual one. Moreover, it allows to eliminate the dependance from the user, which is often timeconsuming and prone to errors due to various inter or intra-operator variability(Despotovic, Goossens and Philips 2015). Results are promising; nevertheless further evaluations are necessary to test the robustness of the approach with different data sets.

1. Z. Fourie, J. Damstra, R. H. Schepers, P. O. Gerrits, and Y. Ren, "Segmentation process significantly influences the accuracy of 3D surface models derived from cone beam computed tomography," *Eur. J. Radiol.*, vol. 81, no. 4, pp. e524–e530, 2012
2. M. Codari, "Semi-automatic estimate of cephalometric landmarks in three-dimensional Cone Beam CT", Politecnico di Milano, 2013.