A66 Nose Approximation From Cone-Beam Computed Tomography (CBCT) Using a New Computer-Assisted Method

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Learning Overview: After attending this presentation, attendees will have gained knowledge on an automated landmarking method for the nasal substrate and the production of accurate statistical models, which are optimized with the inclusion of ancestry, sex, and age, for estimating nasal shape among two South African groups. Automatic landmarking, in addition to reducing errors, achieved better precision for Facial Approximation (FA), enabling a convenient prerequisite for geometric morphometrics and the future possibility of including more samples and populations with ease.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by contributing a novel 3D approach to FA methods in South Africa. Recent developments in computer science and advances in medical imaging techniques, such as surface, Magnetic Resonance Imaging (MRI)-, Computed Tomography (CT)-, and CBCT-scanning resulted in large databases of 3D representations of hard- and soft-tissues of the crania of living people. Researchers in the field of FA can utilize these technologies to develop alternative computer-based techniques to improve objectivity of approximations for both criminal investigations and unidentified persons.[1,2]

South Africa is in a humanitarian crisis with vast numbers of unidentified persons buried in paupers' graves or incinerated each year. Because of socio-political and historical circumstances, the unidentified are often from impoverished communities with reduced access to medical and police services. Creative approaches are therefore required to improve identification of decomposed and skeletonized remains. FA techniques are often employed in these situations to communicate with the public, as the face is often the sole means from which a person is remembered and recognized. Main critiques of FA methods are inherent subjectivity, lack of standardization, few reference samples, and poor correlations between hard and soft tissues. In light of the great demand for the identification of unknown remains in South Africa, a need exists to establish reliable FA techniques that will not only take into account sex and age, but most importantly be specific for South Africans. The purpose of this study was to provide an automated computer-assisted method to create accurate statistical models for predicting nasal soft tissue from information about the underlying skull substrate using CBCT scans.

A total of 200 CBCT scans of 100 Black (67 male, 33 female) and 100 (35 male, 65 female) White South Africans were selected from the Oral and Dental Hospital, University of Pretoria, and the Life Groenkloof Hospital, Pretoria, South Africa. The acquisition and extraction of the 3D-relevant anatomical structures (hard and soft tissue) was performed by an automated 3D method based on an automatic dense landmarking procedure using MeVisLab® v. 2.7.1 software.[3] An evaluation of shape differences attributed to known factors (ancestry, sex, size, and age) were performed using geometric morphometrics, and statistical models of prediction were created using a Projection onto Latent Structures Regression (PLSR) algorithm. The accuracy of estimating soft tissue of the nose was evaluated in terms of metric deviations on training and on untrained datasets. Variability in the hard and soft tissue of the nose was noted for sex, age, and allometry among the two population groups. When using the landmark-to-landmark distances, prediction errors ranged between 1.769mm and 2.164mm for Black South Africans at the tip of the nose and the alae, and between 2.068mm to 2.175mm for White South Africans. The prediction errors on untrained data were slightly larger, ranging between 2.139mm and 2.833mm for the Black South Africans and 2.575mm to 2.859mm for White South Africans.

Global advances in 3D research into human variation and skeletal anatomy will improve creation of biological profiles and FA methods ,which will be of particular relevance to identify unknown persons in disadvantaged groups in Africa. This study demonstrated the utilization of an automated 3D method as a convenient prerequisite for providing a valid and reliable nose prediction model independent of any artistic interpretations.

Reference(s):

1. Vandermeulen D., Claes P. Computerized craniofacial reconstruction using CT-derived implicit surface representations. *For Sci Inter*, 2006, 159, S164–S174.
2. Claes P., Vandermeulen D., De Greef S., et al. Bayesian estimation of optimal craniofacial reconstructions. *For Sci Inter*, 2010, 201(1-3), 146–152.
3. Ridel A.F. 2019. *An automated computer-assisted approximation of the nose in South Africans from CBCT (Cone Beam Computed Tomography) scans.* PhD Thesis. University of Pretoria, South Africa.

Statistical Models, Shape Variation, Automatic Landmarking

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