Xournals

Academic Journal of Anthropological Studies

ISSN: 2581-4966 | Volume 05 | Issue 02 | October-2022

3-Dimensional Forensic Facial Reconstruction Techniques: Traditional and Current Developments (A Review of the Comparison Study)

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Available online at: www.xournals.com

Received 25th January 2022 | Revised 28th February 2022 | Accepted 30th June 2022

Abstract:

A frequently used technique in forensic human identification is facial approximation. Facial reconstruction in forensics attempts to recreate the deceased's facial features using the skull beneath to identify and recognize the person. When the standard procedures of investigation are unsuccessful when confronted with a severely decomposed, disfigured, or skeletonized person, facial reconstruction might be employed as a best technique to identify the unknown skeletal remains. The three-dimensional component of facial approximation is the main topic of this review article, which also provides an overview of conventional and automated current development methods. The face is typically sculpted using a traditional approach that can be subjective and time-consuming: physically modelling clay onto a replica of a skull. Researchers may now generate virtual computed models of anatomical structures via three-dimensional (3D) imaging technologies, which enable them to go beyond the use of traditional clay models. As a result of recent technological advancements, better, quicker and more adaptable computer-based procedures are being developed. Nevertheless, the different techniques used in the facial reconstruction and the comaprison study of both traditional and current developments have also been summarized.

Keywords: *Forensic facial reconstruction, Forensic, Forensic Anthropology, Technology, Current development, Traditional, Three dimensional imaging*

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Introduction

Forensic facial reconstruction (FFR) is an attempt to reproduce a likeness of the facial features of an individual, based on the characteristics of the skull, for the purpose of individual identification. FFR is often conducted by a three-dimensional building up of the face, on a skull or a cast thereof, with artistic clay. Standard soft tissue thickness (STT) values and other anatomy-based guidelines are employed for this purpose. The interaction between the soft tissues covering the skull and the underlying bone structures is crucial for creating a face from the skull. STT values are frequently used to estimate how much or how deeply tissues cover specific specified landmarks on the skull. This facilitates face reconstruction by providing a starting point for establishing the original face shape during the initial phases of the reconstruction process **(Cavanagh and Steyn, 2011).**

There are two basic approaches in forensic facial approximation; which are two dimensional and three dimensional. Either a manual or a digital method is used in both techniques. The very first Research work on face repair started late in the 19th century, using different measurements of the cadaver facial thickness .Then came the emergence of other notable approaches for manual rebuilding in three dimensions includes the Russian Anatomical, Anthropometrical Methods (American) and (Manchester) in Combination. Reconstruction is considered as successful if the identification made was based on the models and images. In addition to using traditional clay models, facial approximation professionals can now produce virtual computed representations of anatomical features that is in the form of three-dimensional (3D) imaging and computer modelling **(Decker *et al.*, 2013).**

The method used by Russian anthropologist Mikhail Mikhaylovich Gerasimov in 1920 involved meticulously reconstructing soft tissues from osteological anatomy. Americans Betty Pat Gatliff and Clyde Snow developed a technique to shape the face using tissue depth markers in the late 1960s. Richard Neave and John Prag, from the United Kingdom, combined anatomical reconstructions of the major facial structures with tissue depth data to approximate the facial wireframe in the early 1970s.

These procedures, which came to be known as the Russian, American, and British methodologies, were used in a variety of forensic and historical instances **(Moraes *et al.*, 2014).**

This review article which mainly focuses on the three dimensional aspects forensic facial reconstruction and the conventional and current computerized methods and its comparison.

Different Techniques of Forensic Facial Reconstruction

Traditional Clay Modelling Manual Method

One of the most popular three-dimensional sculpture techniques involves modelling the face over an unidentified skull using clay, wax, or plasticine reconstructions. Several approaches that we can take. However, the first stage in any reconstruction approach is to study the skull to identify the biological characteristics, such as age, gender, race, etc., before obtaining a replica skull to be worked on **(Wilkinson, 2010).** The Russian anthropologist Mikhael Gerasimov, who created the Russian approach based on sculptural ability and anatomical knowledge, was an important and influential pioneer in this subject **(Domaracki and Stephan, 2006)**. The growth of the skull and neck muscles is considered to be of utmost significance in this procedure. First, the primary masticatory muscles are modelled over the head, while being especially careful not to overstate the majority of those muscles. Next, the muscles that circle the mouth and eyes have developed. Further details such as the parotid glands or fatty deposits are later added if required.

To complete the reconstruction, a layer of skin, which can be textured, is applied to it. Some specialists solely conduct the reconstructions depending on the thickness of the soft tissues in the face. Such a technique makes use of tissue depth indicators, like rubber or dowels of various lengths depending on the thickness of the tissue at various anatomical sites on the face. The dowels are cut according to the required thickness and glued to the skull. Betty Pat Gatliff, the Forensic Artist and the physical anthropologist Clyde Snow created this method, commonly referred to as the American or anthropometrical method, based on the works of Krogman. Without respect to the underlying anatomy, soft tissues are added in bulk and strips while making sure that the clay never extends above the length of the dowels. Others favour a hybrid of the two procedures mentioned above, known as the Manchester or mixture approach, which combines tissue thickness measurements from the American

method with the muscle insertion operation from the Russian method to create a more detailed form of the face **(Sharma, 2018).**

Figure No. 1: Frontal, lateral and 3/4 views of Neville's Clay Reconstruction

Virtual IT Face Method

Virtual facial approximations were also produced using two computer-based techniques. FaceIT, created by anthropologist Dr. Stephanie Davy-Jow, is used by law enforcement in the United Kingdom. The project was undertaken in 2007, and virtual clay models of the skull were made using the software programme 3ds Max (v.9, Autodesk). The method's most recent development makes use of Z-Brush 41 and 3ds Max 2012. (Pixologic) **(Decker *et al*., 2013).**

To promote standardization of perspectives, a plane was constructed and placed to represent the Frankfurt Horizontal Plane. The tissue depth markers in the form of pyramids were positioned at 32 craniometric landmarks n the skull. The depths were selected from previously established data sets. Polygonal modelling was used to create the skin's surface. To facilitate comparison with other models, two-dimensional photographs of the final 3D model were created in normal frontalis and normal lateral is views in addition to the 3D model.

Figure No. 2: Frontal, lateral, and 3/4 views of Virtual Reconstruction using the FaceIT Technique

Reface

Reface is a computerized facial approximation software which is currently under the development in conjunction with general electric medical researchers. The FBI's software imports the STL files and creates a deformation mask over the virtual skull based on a database of standard craniofacial features. The software package allows the user to make adjustments to the mask on a sliding scale for age and weight.

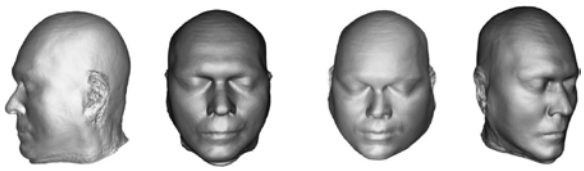

Figure No. 3: Lateral, frontal, overweight and 3/4 views of virtual reconstruction using the FBI's virtual facial approximation software, ReFace, in development

Comparison of Approximation Methods

While taking the comparison of the techniques, to assess the degree of accuracy and detail, **(Decker *et al*., 2013).** The outcomes from the four attempts (clay and virtual) were visually compared to one another and collectively to the actual features of the living human.

Figure No. 4: The in vivo CT image of the target individual (left) in comparison to the approximations (in order: FaceIT, FBI ReFace default, FBI clay)

The CT skin surface model of the living person was then put up against each of the models (with the exception of Faraut's) in virtual space. Only the skin of the real person was visualised because finer details like hair, facial hair, and other textures are not captured by CT scans. Surface-to-surface scan comparison technology from the Mimics software suite was used to do a morphometric comparison of the approximations to the target face (Materialize).The subject's head was used as the reference for registration for each of the approximations. In order to register the scans together in 3D coordinate space, three points are necessary. It was determined that the soft tissue Frankfurt Horizontal plane was not an appropriate choice because of variability in ear placement and inferior soft-tissue orbits in each scan. Alternative points chosen for scan-to-scan comparison were: soft tissue nasion and the deepest points on the left and right lateral orbit walls, as these were identifiable and fairly consistent across all of the facial approximations. The three points were then used to register the subject for translation and rotation, but not

scaling as they were all map representing the degree of agreement was generated to visualize the error range of each approximation. The threshold for comparison was set to+5mm because it visually demonstrated the best distinction in the variation between the test attempts. Thresholding below +5 mm resulted with excess noise in the visualized errors.

Above +5 mm, the software was unable to distinguish the finite errors in the variation need for this study.

1. Traditional technique is subjective and controversial due to the presence of an artistic aspect.
2. Computerized 3D forensic facial reconstruction techniques are rapid, efficient and cost effective.
3. Brought down the degree of error that are previously encountered.

Also, the obtained results always tend to differ between practitioners and also between reconstructions. The Green River serial murderer cases, in which several facial reconstructions of numerous victims were made by various practitioners, provided a clear illustration of this idea. Additionally, because manual procedures are time-consuming, they frequently tend to be confined to a single reconstruction **(Claes *et al*., 2010).**

Discussion

Experts utilize facial restoration as a forensic and archaeological tool in order to help in the process of identifying unidentified human remains. Therefore, the ultimate goal of a facial reconstruction is to achieve the highest degree of similarity to the original facial position of the unidentifiable remains. Despite a few case successes that have been documented in the literature since these methods were initially introduced many years ago, it is challenging to describe the precise accuracy of these methods because it depends on a variety of parameters. Additionally, it hasn't always been able to achieve a satisfactory outcome because of the pre-existing restrictions. Only when attempts are made to completely explore the true structure of the interactions between the soft face tissues and the underlying skull can reliable accuracy rates of reconstruction approaches be established. Unseeing investigations and estimates have been conducted in more recent periods to improve the consistency of face pool recognition, likeness assessments, and anthropometric calculation methodologies. The human face is a tremendously complex structure made up of many different variables, and no renovation technique, whether manual or computer-based, can ever achieve an accurate demonstration. The human face is a very detailed structure, involving a number of variables such as the eyes, ears, nose, and lips; skin colour, hairstyles, the presence of facial hair in men; surface patterns such as tattoos, scars, and moles; ornaments such as rings and glasses; etc. Renovation methods, whether manual or computer-based, can never achieve an exact demonstration. The bony frame cannot provide all the clues for the rebuilding of the soft tissues of the face, hence either system is favored in minor cases.

Conclusion

As time passes, facial restoration procedures become increasingly effective, progressively shifting from a more aesthetic approach to a scientific one. Technology improvement has led to the study of new and trustworthy methods. The primary issue in the near future will surely be to raise the level of accuracy and dependability as it is apparent that facial reconstruction methods now do have some errors that prevent the approaches from becoming standardized. But despite the drawbacks and the obvious reality that a facial reconstruction could not be relied upon for certain identification, there are numerous successful cases that support the use of reconstruction techniques as a last resort technique. Even though it is a long shot, it may be worth trying if other efforts have failed to locate the mystery object. Therefore, it shouldn't be ignored; rather, more research should be done on the elements that are missing, since if it can, at best, restrict the number of suspects, it will have validated all the previous work in this area.

References:

Cavanagh, D., and M. Steyn. “Facial Reconstruction: Soft Tissue Thickness Values for South African Black Females.” *Forensic Science International*, vol. 206, no. 1–3, Elsevier BV, Mar. 2011, p. 215.e1-215.e7. https://doi.org/10.1016/j.forsciint.2011.01.009.

Claes, Peter, et al. “Computerized Craniofacial Reconstruction: Conceptual Framework and Review.” *Forensic Science International*, vol. 201, no. 1-3, 2010, pp. 138–145., https://doi.org/10.1016/j.forsciint.2010.03.008.

Decker, Summer, et al. “Who Is This Person? A Comparison Study of Current Three-dimensional Facial Approximation Methods.” *Forensic Science International*, vol. 229, no. 1–3, Elsevier BV, June 2013, p. 161.e1-161.e8. https://doi.org/10.1016/j.forsciint.2013.03.028. “Chip-off Technique.” iLearnCANA, Accessed on 01 March 2022, Accessed from www.ilearncana.com/details/Chip-off-technique/2208.

Domaracki, Monica, and Carl N. Stephan. “Facial Soft Tissue Thicknesses in Australian Adult Cadavers*.” *Journal of Forensic Sciences*, vol. 51, no. 1, 2006, pp. 5–10., https://doi.org/10.1111/j.1556-4029.2005.00009.x.

Moraes, Cícero André, et al. “Demonstration of Protocol for Computer-Aided Forensic Facial Reconstruction with Free Software and Photogrammetry.” *Journal of Research in Dentistry*, vol. 2, no. 1, 2014, p. 77., https://doi.org/10.19177/jrd.v2e1201477-90.

Sharma, Arpita. “3D Forensic Facial Reconstruction: A Review of the Traditional Sculpting Methods and Recent Computerised Developments.” *International Journal of Forensic Sciences*, vol. 3, no. 1, 2018, https://doi.org/10.23880/ijfsc-16000134.

Wilkinson, C. “Facial Reconstruction - Anatomical Art or Artistic Anatomy?” *Journal of Anatomy*, vol. 216, no. 2, Wiley, Feb. 2010, pp. 235–50. https://doi.org/10.1111/j.1469-7580.2009.01182.x.