Review Article

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Facial Reconstruction: A Review

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Abstract

Human face is most valuable tool for detecting and recognizing. It is also important in understanding of digital photographs. Facial reconstruction is one of the techniques available to recognize a face which is mutilated and helpful in the identification of forensic remains. In this paper, we present a facial reconstruction approach that ûts an anatomy-based virtual head model, incorporating skin and muscles, to a scanned skull using statistical data on skull/tissue relationships.

Keywords: 3D reconstruction; Facial asymmetry; Classical methods.

Introduction

A mutilated dead body is often identified by DNA analysis of teeth, hair, x ray analysis & by dactyloscopy. Generally a dead person's identity is matched with his previous records of dental visits and hence it requires a comparative data. Most of the DNA analysis is done with the existing data bases which are matched with the current records. If at all, the patient doesn't have a history of dental visits; it is highly difficult to correlate with his past dental data. Now the morphological data has to be used for the identification purposes. Generally a forensic autopsy offers details of the patients age, sex, race and his personal habits.[1] The facial features which has been lost of the cruelty, trauma, animal attacks etc, is highly impossible to make the correct picture. But a facial photograph of a mutilated dead body can be remade by photo graphic means and it can serve as a valuable tool for identification by means of digital processing. Ten percent of victims of the Tsunami and fifty percent of victims of the Bali bombing of 12 October 2002 were wrongly identified by facial recognition (Lain *et al* 2003). A proper technique of facial reconstruction can help resolve many cases within identification investigations. Herein we present a review on the methods of facial reconstruction and the most recent trends applicable for the same.

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Historic Perspectives

Paul Broca (1824–1880) is often considered to be the first who had begin searches in the field of correlations between shape of the skull and shape of the face. He described the different proportions of the skull and

proportions of the face for several types of populations. W. His was one of the first researchers to obtain informations about tissue depth measurements. In 1895, he examined twenty eight cadavers using a double-edged knife technique. A sharp needle was inserted into the facial tissue at nine anthropological points in the median plane and six lateral points on the profile of the face. The distance between the needle point and a special rubber disc fitted onto the needle was measured to obtain facial thickness depths. Mikhail Gerasimov was an anthropologist, archeologist and ethnologist and had been a pioneer in facial reconstruction. In 1935, he had become fairly adept at taking a skull and reforming it into a face. Much of his work paved way for todays work in this aspect.[2]

In recent years, there has been a significant increase in studies on the determination of facial soft-tissue thicknesses for forensic reconstruction. Research on facial-tissue depth has been performed in children, adolescents (Wilkinson; Utsuno *et al*, 2005)[3] and mainly adults (El-Mehallawi & Soliman).[4]

The various methods of facial construction are:[1]

Manual reconstruction

2D reconstruction

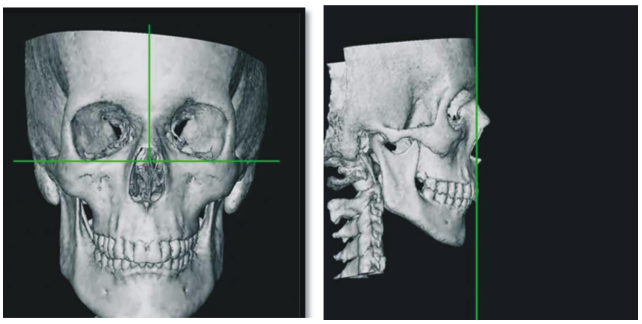
3D reconstruction

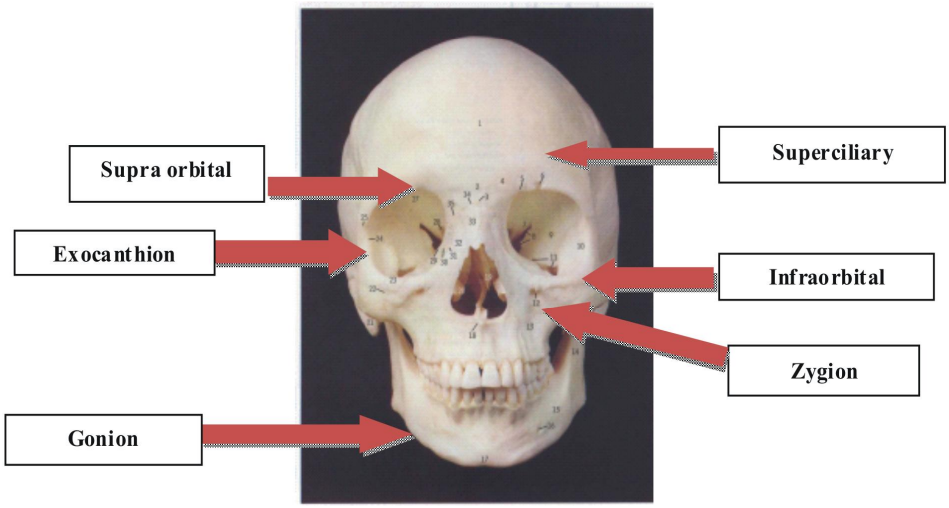
Manual Reconstruction

This is basically done by clay modelling. The skull and post-cranial remains are examined to suggest the most likely population of origin, sex and age and if present, evidence from the scene can also suggest body weight, hair shape and colour. Plaster cast is also used for this and it reduces the risk of damage to the skull. The muscle attachments and the bony landmarks are manipulated more or less similarly, its acceptance is good. But the main disadvantage is that a fine artistic skill is required to duplicate the facial features.[5]

Cranial Super Imposition

The major cephalic landmarks considered in reconstructing a face are superciliary, supra orbital, exocanthion, infra orbital, zygion & gonion.[6] A most commonly used method used in criminology is forensic super imposition. This method of the human face recognition is done by obtaining the negative of the original face photograph and marking the cephalometric landmarks on it. The same marking is done in a skull photograph also. Both the negatives are finally overlapped to obtain a positive picture. Once the skull-face overlay is achieved, the decision making stage has to be tackled. The straightforward approach would involve measuring the distances between every pair of landmarks in the face and in the skull. Nevertheless, this is not advisable because errors are prone to be accumulated during the process of calibrating the size of the images. The methods described in the following are usually called in the literature as computer-aided craniofacial superimposition. This was generally done by an identification conclusion by using distances between landmarks from the superimposed images.[7,8]





Automatic 3D Face Reconstruction from Single Images or Video

P. Breuer et al have proposed an algorithm for 3D reconstruction that can be applied either to single still images or to raw monocular video streams, involves zero user interaction & produces close-to-photorealistic 3D reconstructions. Two well-known techniques: Support Vector Machines (SVMs) and Morphable Models have to be used. The processing steps of their algorithm are:

1. Face Detection using SVM
2. For video data: selection of a frontal view
3. Facial component detection using regression and classification
4. Selection of the most plausible combination of components based on Gaussian distributions
5. Selection of the most plausible nose position based on a Morphable Model
6. 3D reconstruction, initialized with the components

First the face is detected and a suitable face detection system is selected. The detector is used to catch a face from a video or from a photograph and cropped around the face upto 200 x 200 pixels.[9]

Dalong Jiang et al have proposed a new photometric method of facial construction where an analysis-by-synthesis framework for face recognition with variant Pose, illumination & expression(PIE) was done. Photometric methods assume that the faces have similar geometries; as a result, if the pose of an unknown face is not the same as that of the known face or it is not aligned well, the synthesized faces will not be realistic. First, frontal face detection and alignment are utilized to locate a frontal face and the facial feature points within an image, such as the contour points of the face, left and right eyes, mouth and nose. Then, the 3D face shape is reconstructed according to the feature points and a 3D face database. After that, the face model is texture-mapped by projecting the input 2D image onto the 3D face shape. The only input to this system is a frontal face image with normal illumination and neutral expression. The outputs are images with variant PIE for recognition.[10]

Conclusion

Forensic facial reconstruction is a vast and exploring method where research is still under process to find out a novel method which can be implemented for easy identification of the deceased person. Various methodologies which are actually complicated have been proposed. Still a vast number of studies have to be carried to find a simple, convenient and the exploring field has to find a way in India also, so that forensic odontologists can also think of a simpler way of identification other

than teeth.

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