Recognizing Human by Matching Between Skull and Face Shape: A Survey

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***Abstract* - In today's world, security is the major restlessness in the world. Biometrics is very helpful and it's easy to implement for high security purposes. Especially Skull based Authentication is more secured than Finger Print, Face, Iris, Retina, Signature verification and Voice Matching of a person. In Skull based Human Recognition, nobody can change the shape of the skull, when the human is alive, and hence it increases security in Biometrics. Many algorithms and techniques have been proposed for Skull based Human Identification. This paper discusses the concept of Craniofacial Superimposition and Craniofacial Reconstruction for Recognizing Human by matching between Skull and Face shape.**

Keywords- Biometrics, Skull Recognition, Finger Print, Iris, Retina.

I. INTRODUCTION

Biometric is the powerful tool for reliable automated person's identification and there exist several established biometrics-based identification techniques including fingerprint, geometry methods, speaker identification, and face recognition and iris identification[1]. These techniques have been broadly applied to access system, security system and other occasion needing identity witnesses.

Skull based Human Recognition is an advanced research in Biometrics. In recent years, the applications about security issues such as individual identification, access control and security application attract is much important in this field. For the convenience of users, a skull recognition system is suitable rather than a traditional personal password or an ID card, and has better interaction between human beings and machines. It is still a difficult problem because of the high cost and great difficulties in the skull imitation; the research on the skull recognition technology becomes very important in this area. Besides, the structure of human skull is very complicated, with exclusive size and shape for each individual, containing abundant information. So the recognition system based the skull is feasible and significant.

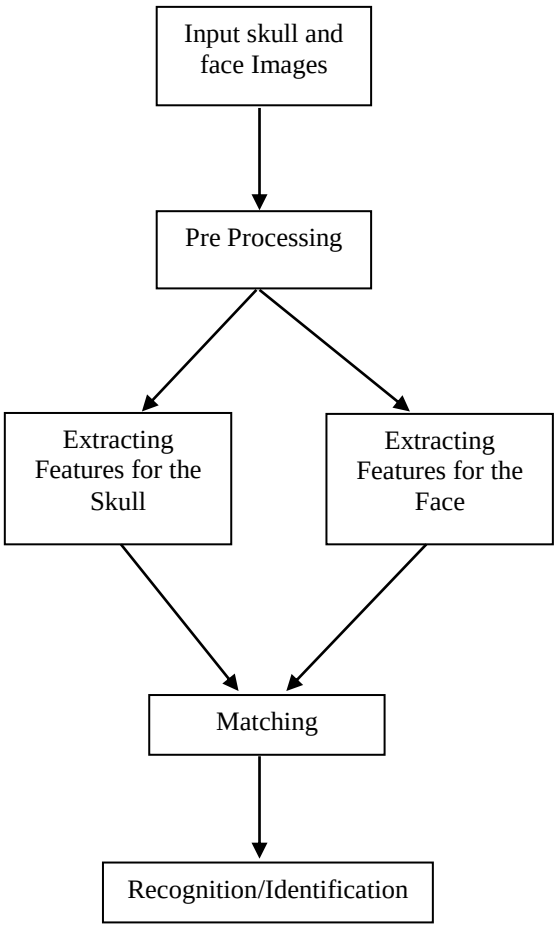


Fig. 1: Dataflow diagram for Skull and Face Matching

At present, the researches on skull mostly belong to three aspects [2]. The first is used for clinical diagnosis and medicinal treatment [3-5]. The second is for human origin, geological distribution, ethnic characteristic, and so on [6-8]. The third is for the identity recognition or identification with the help of computers. To the third class, one of the methods is to choose some symbol features based on the 2-D skull Image; the second is to reconstruct 3-D or 2-D face image from the skull utilizing certain methods and technology, then calculate the similarity degree between the image and the picture ready.

With the development of digitization technologies such as CT, 3D scanners etc., data acquisition becomes

easier and easier, and human identification by skulls has been an interdisciplinary research focus of informatics, anthropology, forensic sciences, and so on.

The skull images are obtained may have different orientations mostly, which will badly influence the recognition in some algorithms. So we must find a method that is not sensitive to the skull deflection. There are some similarities between the skull and the face recognition.

Now, several methods and techniques are available in Face and Skull Matching. The following section represents the survey of some techniques in Face and Skull Matching.

II. REVIEW OF SOME TECHNIQUES

In SHUI Wuyang, et.al[12], presented an approach of the craniofacial reconstruction of Chinese people.

In 2011, O'scar Iba'n'ez, et.al[10], developed shows how the fuzzy-set-based approach clearly outperforms the previous crisp solution. Finally, the proposed method is validated by the comparison of its outcomes with respect to those manually achieved by the forensic experts in nine skull–face overlay problem instances.

In 2014, Fuqing Duan, et al[11], proposes a novel skull identification method that matches an unknown skull with enrolled 3D faces, in which the mapping between the skull and face is obtained using canonical correlation analysis.

In 2010, P.T.Jayaprakash et al.[9], described the Computer Aided Video Superimposition Device (CAVSID) fabricated and the manpower generated in the Health Campus, Universiti Sains Malaysia – research ventures that would place Malaysia among the countries elsewhere pioneering in human identification in forensic science.

III. EXISTING METHODOLOGIES

A. Craniofacial superimposition

Craniofacial superimposition [12] is a forensic process where photographs or video shots of a missing person are compared with the skull that is found. By projecting both photographs on top of each other (or, even better, matching a three-dimensional skull model obtained scanning an unidentified human skull against the face photo/series of video shots), the forensic anthropologist can try to establish whether that is the same person. This skull–face overlay (SFO) process is usually done by bringing to matching some corresponding anthropometrical landmarks on the skull and the face.

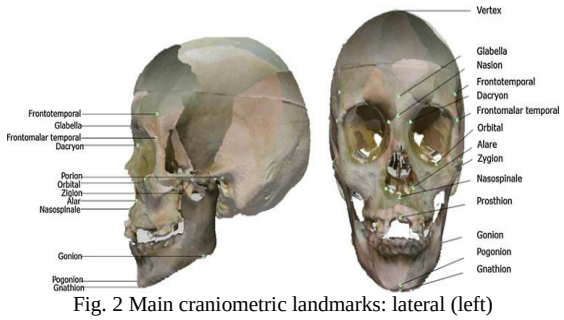


Fig. 2 Main craniometric landmarks: lateral (left) And frontal (right) views

Fig. 3 Main facial landmarks: lateral (left) and frontal (right) views

Unidentified human remains [9] encountered in criminal and civil circumstances include recovery of skeletonized remains, decomposed or dismembered bodies as found during homicide or unnatural death investigations, bodies subjected to shearing forces as in explosions, burnt or charred remains in mass disasters such as air crashes, tsunami etc. This method continues to be popular as it relies on the use of commonplace evidence, face photographs of missing individuals for comparing with the skulls recovered from human remains. After the premier acceptance of skull-photo superimposition based identification as evidence in the court of law in England, this method had gained legal acceptance in most of the countries.

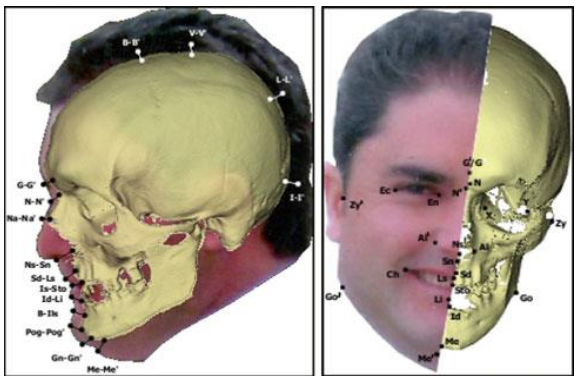


Fig. 4 Correspondences between facial and craniometric landmarks: lateral (left) and frontal (right) views

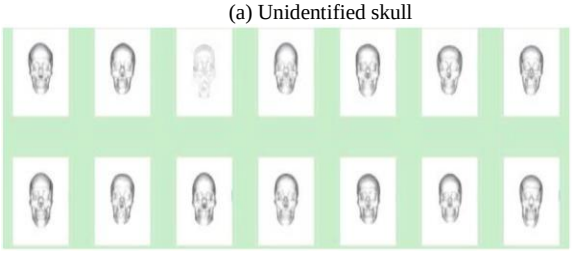
Whenever blood relatives of the suspected dead individuals cannot be located due to lack of tentative identity and hence DNA based identification becomes impossible or DNA is not retrievable, skull-photo superimposition becomes the major alternate scientific method since face photographs are commonly available The problem of

unidentified dead bodies has been well documented in forensic science and skull-photo superimposition has been indicated as a possible solution by recent workers.

B. Craniofacial reconstruction

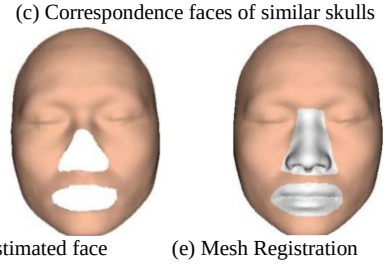
Craniofacial reconstruction aims to estimate an individual's face appearance from its skull using the relationship between soft tissues and the underlying bone structure. It can provide a clue and trigger recognition by the victim's relatives, so that further identification evidence can be collected on a restricted list of candidates.

(a) Unidentified skull



(b) Skulls of Subclass Database

(c) Correspondence faces of similar skulls



(d) Estimated face (e) Mesh Registration

Fig.5. Craniofacial reconstruction

Currently, craniofacial reconstruction is implemented manually by anatomists or artists. They physically model a face by adding clay or plasticine to a skull replica, relying on their experience. The reconstruction procedure is time consuming and prone to subjectivity. Most early computerized reconstruction methods [19], [20] obtained the face of the unknown target skull by deforming a craniofacial reference. They deform the reference skull to the target skull according to some skull features, and subsequently apply an extrapolation of the skull deformation to the reference face to obtain the reconstructed face. They assume that the reference and the unknown target individual have similar tissue thickness distributions. A model bias or unrealistic reconstructions always appear when an inappropriate reference is chosen [18]. Recent methods use statistical learning techniques, such as statistical shape models [14], [15], regression models [16], [17], etc., to explore the relationship between the skull and face, and the reconstruction is based on the learned relationship. However, the obtained statistical models depict only the craniofacial variation in a statistical sense and cannot reflect the personal variation. Thus, most reconstructed faces are not sufficiently accurate for identification.

IV. CONCLUSION

In this paper, an overview of skull-face matching is illustrated and the different functionalities employed in superimposition and reconstruction methods are discussed. Both methods extracted and represent an intrinsic relationship between the skull and face in terms of the morphology, but still it is not so defined accurately. In future, the new method will be proposed to overcome these problems by combining craniofacial superimposition and craniofacial reconstruction methods.

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