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A review on the Latest Innovations in Facial Imaging

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Abstract:

The term "facial imaging" refers to techniques that utilize facial photographs to aid or make it easier for people to identify. Age progression and regression using face-only methods, the creation of facial graphics from eyewitness memory (including composites and artistic sketches), facial depiction, face mapping, and recently created molecular photo fitting techniques are all included in this. Facial approximation and photographic superimposition are two techniques used for craniofacial identification that make use of skulls and faces. Each of these face imaging fields, though not all of them have historically been classified as such, belongs to the field of physical anthropology because they are all concerned with the human body's physical attributes. This presents helpful chances to apply tried-and-true techniques from one field to others that are more commonly considered to be physical anthropology specialties (e.g. facial approximation, craniofacial superimposition and face photo-comparison). It is crucial to keep in mind that the majority of face imaging techniques are currently not utilized for identification but rather to help law enforcement authorities focus or steer investigations so that other, more effective, methods of identification can be used. This publication offers a theoretical overview of these methodologies' goals, the state of the science around them.

Keywords: *Facial Imaging, face photo-comparison, facial approximation, artistic sketch, craniofacial identification, photographic superimposition.*

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Introduction

Facial images are one of the most valuable pieces of evidence for identification and it is possible in a very high proportion of cases wherein subjects recorded in photographs or on videotapes needs to be identified by means of comparison with images of persons of known identity **(Stavrianos *et al.*, 2012)**. Utilizing images to explain and record findings for forensic and diagnostic applications is known as forensic imaging **(Zhang, 1)**. "Facial imaging" approaches are those that contribute in human identification by analysing or providing facial graphics. Thus, facial imaging includes approximation of the face and photographic superimposition, as well as include age progression and regression, the formation of facial graphics from eyewitness memory (such as composites and sketches), facial depiction, face mapping, and newly invented techniques of so-called "molecular photo fitting **(Stephan *et al.*, 2018)**."

Methods for facial imaging are essential in many situations. In other circumstances, they offer standard police investigation techniques and crucial evidence in cases that would not have been solved otherwise. The majority of the aforementioned techniques—with the exception of automatic facial recognition systems—succeed by getting the public's and the media's attention on the rebuilt image of a face. This is true even if there are times when the successful outcome is not directly related to the picture of the face (e.g. the Instead of the estimated facial morphology itself, recognition of other things such as personal clothing like ties, spectacles, hats, necklaces, or shirts exhibited with the face **(Stephan *et al.*, 2018)**.

It is advantageous to maximize their capacity to identify people based on facial morphology. Applying science to test or enhance approaches used in the field and in the lab are beneficial. As Regardless of how lofty they may seem, advancements that produce any technique to be so trustworthy that it can be applied for Identification methods used alone are optimum, and shouldn't be completely disregarded in some situations. This provides maybe novel techniques and Possibilities for identification and distinctive opportunities for forensic anthropologists in training increase and contribute to forensic anthropology input. As more forensic professionals become aware of its benefits, the application space for forensic imaging has also expanded. This method has also been applied in other forensic fields, such as forensic anthropology, forensic odontology, forensic ballistics, and animal forensics, among others, in addition to forensic pathology **(Zhang, 1)**. FaceGAN is a network type that consists of a generator, a discriminator, a deep face recognition model, and a deep age estimation model. The discriminator is taught in a multi-task learning environment, distinguishing between genuine and synthetic samples and categorizing real and synthetic photos into matching age ranges at the same time. Numerous tests using the UTKFace dataset have shown that Face- GAN can produce photo-realistic face images at various ages for both face ageing and rejuvenation while effectively maintaining individual identification **(Zeng *et al.*, 302).**

Facial Approximation

The terms "facial approximation" and "facial reconstruction," which combined two opposing theories of face prediction known as "facial approximation" and "facial reconstruction," are used interchangeably **(Stephan *et al.*, 2018)**. In the closing remarks of The Lateral Craniographic Method of Facial Reconstruction, George initially suggested "facial approximation" as a more descriptive phrase for face prediction against the background of conventional science **(Stephan, 2015)**. The estimation of a face only based on a dry skull is known as facial approximation. Face estimation can be done using a wide range of methods, such as a two-dimensional (2D) representation of the face over a skull photo, a three-dimensional (3D) manual construction of the face in clay or mastic over the skull or a cast of the skull, computerised sculpting of the face using haptic feedback devices and a 3D scan of the skull, and computerised construction of the face using more sophisticated computer automated 3D routines **(Stephan *et al.*, 2018).**

Photographic Superimposition

An antemortem photograph must be made life-size for the photographic superimposition technique, and the skull must be taken from the same angle **(Chee and Cheng, 1989).**

Age Progression/Regression

Face ageing and rejuvenation, also known as face age progression (i.e., prediction of future looks) and regression (i.e., estimation of previous looks), tries to generate face photographs with or without the "ageing" effect while keeping preserving unique aspects of the face (i.e., personality). It has a

significant impact on a variety of applications, such as age-invariant verification, entertainment, and face prediction of wanted or missing people **(Zhang *et al.*, 2017).**

Creation of Facial Images based on eyewitness accounts (e.g. composites and sketches)

Based on an eyewitness account or description, create a face image of a person of interest. The designed facial graphic is distributed to the public in the hope that someone may recognise the face and suggest new lines of inquiry. To create faces from eyewitness descriptions, there are three basic categories of techniques:

1. Police and forensic drawings based on information from interviews
2. Composite "kit" systems, in which the interviewee or the interviewer constructs the face using drawings or images of facial components drawn from facial feature libraries
3. More sophisticated computer-assisted techniques that provide face estimations holistically by employing "facial evolution" algorithms **(Stephan *et al.*, 2018).**

The ability to recognise a person consistently, across various encounters, is the defining characteristic of accurate identification. Additionally, it was mentioned that the majority of eyewitnesses only create rudimentary cognitive representations of a target, which prevents accurate identification. The capacity of individual eyewitnesses to act on a target repeatedly should, in turn, reveal information about the level of familiarity they have developed with this individual and may therefore serve as a potential indicator of eyewitness accuracy **(Russ *et al.*, 2018).**

Facial Depiction

The foundation for facial depiction is postmortem facial records (often pictures), where distracting elements like blood or dirt, trauma, or taphonomic changes like swelling or discolouration are removed and a live position is given (e.g. open eyes and closed mouth). Traditionally, a forensic artist would make these corrections when sketching the subject's face for a postmortem portrait. Image editing programmes like AdobeVR PhotoshopVR are used in computer assisted facial depiction. The analyst frequently extracts facial traits from a databank of facial photos to help in face reconstruction **(Stephan *et al.*, 2018).**

Face Mapping (Photo-comparison)

Facial mapping involves the use of antemortem photographs and comparison with the postmortem skull. Imagery analysts use this method to compare faces found in images and comment on how similar or different they are. This kind of evidence is acceptable anywhere. Forensic photography and morphological anatomy are two primary visual disciplines that must be used in order to map the face. In a small percentage of cases, facial mapping techniques like morphological comparison, photoanthropometry (photogrammetry), and photographic superimposition cannot result in a positive identification, but they can conclusively lead to the dissociation of the current identity from a potential identity. However, because to the ease in contrast, the usage of specialised computer programmes has expanded the application of facial mapping today **(Stavrianos *et al.*, 2012)**.

Molecular Photofitting

This method is used to estimate facial appearance from a person’s DNA. This method involves sequencing specific sections or places of DNA that are known to encode particular physical traits and face form in order to obtain information about a person's facial appearance. Utilizing correlations between genes and the morphology of the human face, a facial graphic is digitally synthesised in 3D computer space, frequently using principle component descriptions of its variation or some other optimised metric (e.g. bootstrapped response-based imputation modelling) **(Stephan, 2015).**

Conclusion

Any technique that uses face photographs in a forensic setting is referred to as "facial imaging." Several facial imaging techniques are employed for this goal such as facial approximation, facial mapping, facial depiction, face age progression/regression, photographic superimposition & construction of facial graphics according to eyewitness description etc. but some of them are more effective than others. As computer processing capacity has increased, methods that enable numerical analysis and more in-depth research into anatomical structure are now applied for this purpose. Referring to the few facial imaging techniques covered in important forensic anthropology texts, these developments not only expand the forensic anthropology field's previously accepted applications, but they have also improved earlier craniofacial

identification techniques, elevating them to the level of emerging scientific endeavours.

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