The identification of living persons on images: A literature review

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ABSTRACT

Personal identification in the forensic context commonly concerns unknown decedents. However, recently there has been an increase in cases which require identification of living persons, especially from surveillance systems. These cases bring about a relatively new challenge for forensic anthropologists and pathologists concerning the selection of the most suitable methodological approaches with regard to the limitations of the photographic representation of a given person for individualization and identity.

Facial features are instinctively the primary focus for identification approaches. However, other body parts (e.g. hands), and body height and gait (on videos) have been considered in cases of personal identification.

This review aims at summarizing the state-of-the-art concerning the identification of the living on images and videos, including a critical evaluation of the advantages and limitations of different methods. Recommendations are given in order to aid forensic practitioners who face cases of identification of living persons.

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1. Introduction

Personal identification is a crucial issue in forensic anthropology and pathology, consisting of the description, comparison and correct attribution of biological individualizing characteristics. Personal identification is usually divided into two steps: (1) the construction of a biological profile (sex, age, ancestry, stature), and

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(2) comparison of individualizing markers in order to achieve a positive match.

The existing methodology mainly focuses on identifying unknown decedents. However, requests for identifying living persons have become more and more common. The increasing use of digital surveillance systems implies that crimes are nowadays often recorded and as a consequence images and videos have become a crucial part of many criminal investigations. For instance, images of a suspect can be compared with those obtained from surveillance cameras by considering individualizing features that could provide clues for inclusion or exclusion of identity. However, the identification of living persons represented on images and videos presents specific challenges. In these cases, only morphological features visible on the given image are available for evaluation. The numerous, standardized methods for identification of unknown decedents, including DNA analysis, fingerprint analysis, odontological profiles, and individualizing skeletal features cannot or can rarely be applied for personal identification on images. Therefore, there is a need for adapting the existing methods or proposing and adopting new ones. Currently, there are three principal approaches used for identification of living persons on images: (1) comparative analysis of morphological features, (2) metric analysis and (3) superimposition.

A rapidly developing field for personal verification and identification is biometrics, which uses computerized systems for automatic recognition of a person by distinctive features of the human body, including faces, hands, and gait [1]. Although biometric identification is widely used for crime control and security purposes, Lyon [2] pointed out that there is not enough independent research that would confirm claims regarding the accuracy and objectivity of this automated approach. A crucial distinction that needs to be considered is whether the system is used for verification (i.e. verifying the identity of a person within a small number of recorded individuals) or identification purposes. For verification purposes, the system is trained to recognize a finite, relatively small number of persons, while for identification comparisons may be based on huge, and potentially numerous databases. Logically, the accuracy of the method is better in verification than in identification tests, and therefore most studies supporting biometrics are based on results of verification experiments.

In contrast to biometrics, this review focuses on methods that can be used for personal identification in individual forensic cases that involve images and videos. Some of the comparative techniques are similar in principle to those used in biometrics, although each case provides a unique set of variables, and the perception of the examiner plays a crucial role in the process as opposed to the automated biometric analyses.

This literature review aims at giving an overview of studies concerning the identification of the living on images and videos. Focus is given on the applicability and reliability of the published methods, particularly for forensic practice.

2. Methods

A systematic review of the literature was performed. Pubmed (Medline) was searched in November 2014 using key phrases, such as "personal forensic identification", "forensic identification living persons", "personal identification images", "facial superimposition", "facial assessment images", "facial assessment images forensic", "image superimposition", "height estimation images", "height estimation images forensic", and "gait analysis forensic". The search was limited to peer-reviewed studies that were published in English from 1st January 1990 onwards and involved human subjects.

In total, 68 articles were identified without considering duplicates from all the search attempts. The majority of excluded articles focused on genetic or radiographic (including dental comparisons) identification, description of human variation or comparisons of dental profiles before and after orthodontic treatment.

The articles were then divided according to the main topic (face, body height, gait, other features), and the relevant information was extracted.

3. Results

Table 1 provides an overview of the advantages and limitations of the different techniques used for identification of living persons on images. Table 2 shows an overview of the different anatomical regions potentially useful for identification.

3.1. Facial assessment

Intuitively, the human face is considered to be the most suitable body area for identifying an individual. Currently there are three main scientific approaches for facial assessment: (1) the morphological approach (comparing facial shapes); (2) the metric approach (comparing facial size derived from direct measurements or indices); and (3) superimposition approach (combining both shape and size comparisons).

3.1.1. Morphological approach

The first attempts at identification of the living based on facial morphology date back to the end of the 19th century with Alphonse Bertillon, who developed a morphological and metric system for the description of facial features [3].

The morphological methods are based on the classification of different facial features according to standardized schemes and subsequent comparisons of these features between the represented person and the suspect or victim [3–6]. Recent advances in the quality of images allow for more accurate comparisons, as do the existing schemes, which also represent a tool for validation of the assessments. In theory, a clear difference identified in the facial morphology between two individuals may serve as indication for exclusion of identity. However, even with the aid of standards the descriptions of the individual features have been shown to be largely subjective [7]. One study presented intra- and inter-observer mismatch percentages of evaluating facial features with the help of an atlas, which ranged on average from 19% (intra-observer) to 39% (inter-observer) [7]. These mismatch percentages are relatively high for being reliable for personal identification.

There are still several unsolved problems regarding the morphological approach: how many features should be assessed and matched in order to reach a positive identification? What would be the best method to assign an error rate for the comparisons? The few articles dealing with morphological assessment of faces often do not report any error rate, and sometimes they do not take even into consideration the need for quantifying the reliability of the final judgment [8].

Consequently, a correspondence between two morphological facial profiles, even with a large number of matching facial features cannot be quantified with precision. On the other hand, the presence of a clear discordance of facial traits, which cannot be reasonably explained, can provide an exclusion of identification.

In addition, morphological assessment of faces may have also a strong potential for positive identification in cases when morphological comparisons involve facial features characteristic