

Automated Dental Identification System (ADIS)

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Law enforcement agencies have exploited biometrics for decades as key tools in forensic identification. With the evolution in information technology and the huge volume of cases that need to be investigated by forensic specialists, automation of forensic identification became inevitable. Postmortem (PM) identification requires use of biometric characteristics that resist early decay of body tissues as well as withstand severe conditions usually encountered in mass disasters. Dental features are the best candidates for PM identification.

The Criminal Justice Information Services Division (CJIS) of the FBI includes in its strategic plan the creation of an Automated Dental Identification System (ADIS), with similar goals and objectives to its Automated Fingerprint Identification System (AFIS) but using dental/teeth characteristics instead of fingerprints. ADIS will provide automated search and matching capabilities for digitized radiographs and photographic images.

Research teams from West Virginia University (WVU), Michigan State University (MSU), and University of Miami (UM) are developing, in coordination with CJIS, a research prototype of ADIS. To this end, we are not only looking at automating the steps taken by forensic experts to examine dental radiographs of subjects. But we are also looking at intelligent analysis of radiographs in order to utilize underlying image structures that are often difficult to be assessed merely by visual examination. In order address the challenges imposed by ADIS, we introduce and use state-of-the-art techniques from a multitude of areas that include -but not limited to- digital image processing, pattern recognition, soft-computing and internet technology [2].

Prototype Architecture:

The architectural design of our ADIS research prototype is discussed in further detail in [2][10] and [11]. The main components of the prototype are:

1. The Potential Matches Search component: this component is being developed by the research teams at MSU and UM and is primarily responsible for archiving and retrieval of dental records based on high-level dental features. These features include the number/position of teeth and shape properties of teeth among other features. Realization of this component requires implementing adequate techniques for:
 - a. Dental film classification [9], [10]
 - b. Teeth segmentation [4], [5], [6], [7], [8], and [10]
 - c. Extraction of teeth contour [4], [5], [7], and [10], and
 - d. Feature indexing.
2. The Image Comparison component: this component is being developed by the research team at WVU and is responsible for low-level comparison of the radiographs of a subject case against those of candidate reference cases. Realization of this component follows a pyramidal architecture for image matching [1], [2], and [10]. Image comparison is carried out in the following steps:
 - a. Preprocessing of images, where enhancement, segmentation and alignment are achieved to correct for possible geometric and/or intensity transformations [1], [2], [8], and [10]
 - b. Decision making, where low-level features are extracted from corresponding regions in the subject and the reference radiographs and used as basis for

computing a probability of match between the subject record and a reference record [1], and [10].

3. The Digital Image Repository (DIR): this is the image and feature database component and is being developed by WVU and UM [6].

Given a subject dental record, ADIS should retrieve a short list of archived reference records that possess high similarity to that subject record. Retrieval of the short match list is carried out in two stages:

- Potential search matching, where high-level dental features are used to generate an “initial” candidate list, then
- Image comparison matching, where dental images from the subject record and the candidate list are examined at a fine-scale in order to produce a ranked short match list.

Finally, the short match list is presented to a forensic expert who examines the radiographs of the subject against those of each record in the short match list.

A Web-based Environment:

In developing ADIS we employ Internet/Intranet technologies in order to build a web-based environment that facilitates remote access to ADIS servers. The web-based environment also provides a tool for assessment of the performance of ADIS and its components, thus allowing collaborating researchers to examine integrity between their components.

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