Analysis Of Dental Image Processing For Human Identification

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Abstract

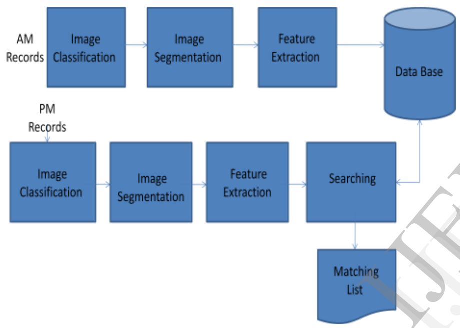
Dental X-ray has played an important role in human identification. Particularly, in cases of severe accidents, plane crash, earthquake, etc. Wherein other identification clues like fingerprint, iris, etc. are not available for identification of missing or unidentified persons and moreover dental features remain more or less invariant over time. The purpose of dental image processing is to match the post-mortem (PM) radiograph with the ante-mortem (AM) radiograph based on some characteristic or feature of the radiograph. The dental images acquired may be of poor quality and contrast. Hence it is important to first enhance the quality of image and thereafter various segmentation algorithms are applied to the enhanced dental image. Various features of individual tooth are being extracted and identification is performed based on matching of these feature vectors of PM images with those of AM images. This paper gives an overview of various enhancement, segmentation and feature extraction, matching technique for human identification using dental radiographs.

Keywords-Antemortem (AM) radiographs, Postmortem (PM) radiographs, segmentation, Human identification, Dental images.

1. Introduction

Automated dental identification system (ADIS) was developed for extraction of the distinctive features of tooth images [9]. They were then compared automatically to each other and searching for the best candidates in the database to identify the unknown person. The main process of this system contains of image classification, teeth segmentation, feature extraction and pattern matching. Fig. 1 shows the process of this scheme.

The first step in human identification is dental image classification which is based on the way dental features are captured. They are classified as bitewing, periapical and panoramic dental images [10] as shown in figures (2) to (5). Bitewing images include the features of both jaws signifying bite. While periapical images include only a single jaw either upper jaw called upper periapical image or lower jaw called lower periapical image. Panoramic images include features of both jaws including sinuses, nasal area, etc.



The main process of ADIS [9]

However, for most dental processing bitewing images are used [10]. The dental radiograph can be divided into background area in lowest intensity, Bone areas in average intensity and teeth areas in highest intensity. In some cases, the intensity of bone area and teeth area are nearly same. So, they should be separated for fruitful feature extraction. The next step is radiograph segmentation which includes separating upper and lower jaw and thereafter separating each individual tooth. Feature Extraction process follows tooth segmentation wherein some specific features are defined (like curve, shape, texture, etc.) which is further used for matching PM images with AM images.

The next step is matching of AM and PM radiograph. A matching distance is found for each pair of PM-AM images based on matching technique. Depending on the matching distance, the images from the database are ranked. The minimum matching distance image is found as the best match of given PM image. The accuracy rate of algorithm is found from the rank obtained by the most genuine AM image. Ex more the number of PM query images having lower rank of the genuine image, higher is the accuracy rate. For comparing various techniques we have defined percentage of genuine images ranked as first as follows:

% Perf=A * 100 /P

Where % Perf=performance index; A=no. of geniune AM images retrieved having Rank 1 &P=no. of PM query images on which technique was implemented.

Fig. 2. Bitewing dental image [10]

Fig. 3. Upper periapical dental image [10]

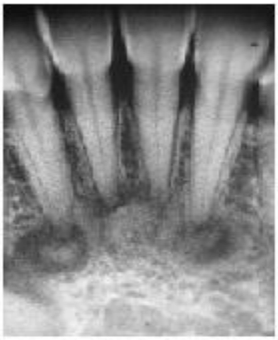


Fig. 4. Lower periapical dental image [10]

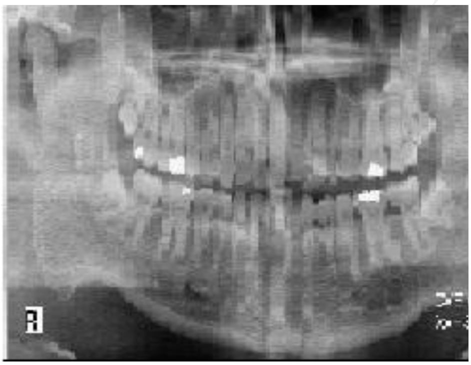


Fig. 5. Panoramic dental image [10]

2. REVIEW ON VARIOUS MATCHING TECHNIQUES

Thresholding based methods can easily be used for segmentation of teeth but they usually fail to classify between teeth and bone areas as their intensities are more or less similar in cases of uneven exposure. Anil K. Jain have suggested Tooth Contour Extraction for Matching Dental Radiographs[1].

Automated Dental Identification System (ADIS) requires not only identification of the subject but also maintaining the system such as updating reference records, updating techniques and substandard performance [2]. In order to overcome the difficulty arising due to poor quality of image, in [2004], M. Mottaleb et.al using iterative and adaptive thresholding. Thereafter horizontal and vertical integral projection is used for separating the jaws as well as individual tooth. The case in which jaws are not aligned along a horizontal line the image was rotated in a small range of [-20,20]degrees and the angle which produces minimum horizontal projection is found. A set of salient points from object contour is selected & a signature vector that captures information of each salient point is generated. Each element in Signature vector is the distance between the salient point and point on the contour. Matching distance is then found from the signature vector & ranking based on minimum matching distance is performed. Best matching AM tooth correspond to minimum matching distance. This technique was not successful in matching images due to poor quality of images;

shape of teeth could have changed with time as PM images were taken after a long time AM images were captured and handling view variance in both AM & PM images. The %Perf achieved by this method is 72.41%.

In [2005], H.Chen and A.K.Jain at aligning the partial contour in case of occluded image is addressed and contours of tooth as well as shapes of dental work are used for identification. Upper and lower jaw as well as individual tooth is separated using horizontal and vertical integral projection as in [2]. Difference between contour of teeth and difference between contours of dental work are combined via likelihood estimates for better similarity results. Matching is done by computing the matching distance between one PM and all AM images & then image to subject distances are averaged over all images to obtain matching distance. From the distance between PM image & all subjects in AM database, ranking generates a list of candidates. However, this technique was not capable to produce desired results in cases of poor image quality; subjects with missing teeth and it moreover it required a larger database for evaluating the algorithm.

In [2006], O.Nomir and M. Mottaleb at suggested a hierarchical chamfer matching methods for contour matching. At using segmentation method starts by applying iterative thresholding followed by adaptive thresholding to segment the teeth from both the background and the bone areas [4]. After thresholding, horizontal integral projection followed by vertical integral projection is applied to separate each individual tooth. Here used by edge matching algorithm that uses the Hierarchical Chamfer Matching. It is a technique for finding the best match for a given image by minimizing a predefined matching criterion in terms of the distance between the contour points of two images. To increase the accuracy of matching, reduce the search space and computational load. The advantage of this technique is that the matching is applied using multiresolution algorithm. The %Perf achieved by this method is 80%.

In [2007], O. Nomir and M. Mottaleb by exploring the appearance and shape-based features [5]. Here, the image is first enhanced by binary image masking & thereafter adaptive thresholding is applied. After adaptive thresholding, horizontal integral projection followed by vertical integral projection is performed to separate individual tooth. The contour is extracted by Fourier descriptors are powerful for two-dimensional shape description. It used by force field energy function. Matching is done using both L1 norm (absolute distance) and L2 norm (Euclidean distance).In both the cases, majority voting is used to obtain the best matching image, because in some cases, there is a large distance between one or two corresponding PM and AM teeth for the same person due to poor image quality, which increases the total matching distance resulting in incorrectly extracted contours of same teeth. The %Perf achieved by this method is 86%.

In [2008], S. Kiattisin proposed algorithm for 2 features of teeth for code matching namely labial view (having one root) and mesial view pattern (having two roots). Brightness Adjustment; Binary image Conversion were used for image enhancement[6]. Chain code method was used for decoding a direction code from binary images based on special features of teeth. Special features of teeth were extracted as a feature. Matching is done by comparing the decoding code with the statistical code. However, the resulting chain of codes tends to be quite long and moreover, any small disturbances along the boundary due to noise or imperfect segmentation causes change in code that may not be related to the shape of the boundary. The %Perf achieved by this method is : code match=90% for same code & 50% for different code.

In [2009], P. L. Lin and Y. H. Lin propose a dental classification system to effectively classify molar teeth from premolar teeth in dental bitewing radiographs [7]. In system include a novel image enhancement method that combines homomorphic filtering technique to reduce the uneven exposure problem, both adaptive contrast stretching and adaptive morphological transformations based on homogeneity to accentuate the texture differences between teeth and gums and between teeth and pulps. The shapes of teeth and pulps play important roles in accurate classification. After using horizontal integral projection is first applied to separate the upper and lower jaw followed by vertical integral projection to each jaw. This paper [7] only classification is performed.

In [2011], C.K. Modi in a proposed feature extraction technique for dental X-ray images based on multiple features [10]. In system include a good quality enhancement method then after radiograph segmentation. Feature extraction is used prior to matching the AM and PM images. The contour is extracted by Fourier descriptors are powerful for two-dimensional shape description and other combination method of gray level co-occurrence matrix (GLCM). Matching is done using both Euclidean distance and Hausdorff distance. It is done by finding the mean square error (MSE) between the query and database images. The retrival accuracy of multiple features (shape and texture) using Mean Square Error and Euclidean distance is 40%.All the methods discussed above are summarized in table 1.

3. Conclusion & Future Work

From the review of above papers, the main challenge in developing an automated dental identification system is to deal with poor quality of images, teeth overlap, imaging angle, teeth shape change consideration due to aging, etc. Then after matching of AM and PM images in dental radiograph. From the performance index found in the previous section, it is clear that the algorithm suggested by [2007], O. Nomir and M. Mottaleb by best using techniques among other techniques. Here one works to find a fast and better novel approach to enhance and segmentation method for dental radiograph and thereafter matching of PM image with AM images for better similarity results.

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Reference	Enhancement Technique	Segmentation Technique	Feature & Extraction	Matching Technique	Accuracy
M.Mottaleb	Binary image masking	Iterative & Adaptive Thresholding; Horizontal & Vertical integral projection	Signature vector from tooth contour	Absolute distance matching	Out of 29 PM query images, Rank I-21, 4 out of 5PM images correctly retrieved.
Anil K. Jain	Assumed good quality images were used	Horizontal & Vertical integral projection	Contour of Teeth & Shapes of Dental work	Computation of image distances matching	Out of 11 PM query images,Rank-I-72%,Rank-IV-91%, Rank-VII-100%
O. Nomir & M. Mottaleb	Binary image masking	Radiograph Segmentation: Iterative & Adaptive thresolding; Horizontal & Vertical integral projection	Tooth Contour	Hierarchical Chamfer Matching Algorithm	Out of 50 PM query images, Rank I -40,Rank II-3, Rank III-2, Rank V-4, Rank VII-1 Images.
S. Kiattisin	Brightness Adjustment; Binary image conversion	Chain code Decoding	Special features of teeth	Absolute matching between decoding & statistical code	Same code match=90 %(same pattern); 50 %(different pattern).
P. L. Lin & Y. H. Lai	Homomorphic Filtering;Adaptive contrast stretching & Adaptive morphological transformations	Thresholding; Horizontal & Vertical integral projection	Relative length/width ratio of a teeth, Relative crown size	Only classification is performed	94.9% for molars & 95.6% for premolars.
S. Shah & A. Ross	Assumed good quality images were used	Global(Corner Detection)& Local (Teeth Isolation) Segmentation	Teeth Contour	Only teeth contour is performed	Contour extraction procedure is extremely fast app. 0.16sec/tooth.
C. K. Modi	Assumed good quality images were used	Radiograph Segmentation	Fourier Descriptors & Gray –level co-occurrence matrix(Shape & Texture)	Absolute & Euclidean distance matching	66.667% precision using Euclidean distance & Mean square error.

Table 1.Dental Matching Technique Based On Human Identification