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Human Identification Using Dental Biometrics

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***Abstract*— Dental radiographs are used for human identification in dental biometrics. The dental radiograph gives us various information such as teeth contours, relative positions of neighboring teeth and shape of the dental work (e.g., crowns, fillings, and bridges). The proposed system has 2 stages namely (1) Feature Extraction and (2) Matching. In feature extraction, active contour model is used to extract the contour. The matching stage has 2 steps viz. Computation of Image distances and Subject identification. In tooth level matching tooth contours are matched using "Shape registration Method" and depending upon the overlapping areas the dental works are matched. Then the values of the distance between the tooth contours and dental works are combined using posterior probabilities. Tooth correspondence between query radiograph and database radiograph are established. Distances between the teeth are used to calculate the similarity between the two radiographs. Finally the distance between the radiographs provide the details about the subject associated with these radiographs. The dataset contains 10 normal images and 55 OPG images which were collected from Madura Dental Hospital. The accuracy of the algorithm is measured by the ratio of Correct Detection images to Total No of images. The experimental results show that this proposed algorithm is accurate about 72%.**

Keywords*— *Dental Radiographs, Feature Extraction, Matching

I. INTRODUCTION

A. Biometrics

A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, dental features, Handwriting, the retina and the one presented in this paper is the dental features.

B. Forensic Dentistry

Forensic dentistry is the application of dental knowledge to those criminal and civil laws that are enforced by police agencies in a criminal justice system Forensic dentists are involved in assisting investigative agencies to identify recovered human remains in addition to the identification of whole or fragmented bodies; forensic dentists may also be asked to assist in determining age, race, occupation, previous dental history and socioeconomic status of unidentified human beings. Identification is done by the comparison of ante mortem and post mortem dental records and using the unique features such as shape, dental works that are visible on dental radiographs.

Forensic dentistry or forensic odontology is the proper handling, examination and evaluation of dental evidence, which will be then presented in the interest of justice. The evidence that may be derived from teeth, is the age (in children) and identification of the person to whom the teeth belong. This is done using dental records including radiographs, ante-mortem (AM) (prior to death) and post-mortem (PM) photographs and DNA.

Forensic dentistry is responsible for six main areas of practice

- Identification in mass fatalities
- Assessment of bite mark injuries
- Assessment of cases of abuse
- Civil cases involving malpractice
- Identification of found human remains
- Age Estimation

II. LITERATURE SURVEY

Said, E.H.et.al [10] proposed Mathematical Morphology Approach for teeth segmentation. This technique performed greyscale contrast stretching transformation to improve the performance of teeth segmentation. This technique had lowest failure rate among all approaches.

Hofer, M.et.al [3] proposed a method to perform human identification based on dental work information. The algorithm involves 3 steps namely Segmentation, Feature extraction, Creation of a dental code and matching.

Nassar, D.E.et.al [15] created a Dental chart based on the data structure that guided tooth-to-tooth matching. Two-stage approach was used for labeling. First stage utilized low computational cost, appearance-based features for assigning an initial class. Second stage applied a string matching technique to validate initial teeth-classes and, hence, to assign each tooth a number.

Jong-Bae Jeon.et.al [9] proposed - Difference Image Entropy (DIE) and Input Image Selection method. DIE coefficient reflecting histogram levels have peak positions from -255 to +255. Teeth image recognition was performed using K-NN with PCA. DIE threshold values from 6.9 to 7.3 for teeth image selection.

Nomir, O.et.al [1] proposed new matching technique for identifying missing, and wanted individuals from their dental X-ray records. It searched a database of ante mortem (AM) radiographs and retrieved the best matches from the database. The technique was based on matching teeth contours using hierarchical Chamfer distance.

Kondo, T.et.al [6] proposed automated method for tooth segmentation from the three-dimensional (3-D) digitized image. Dental arch was first obtained and using this arch as reference image of the dental model can be computed.

Nomir, O.et.al [4] proposed a technique for identifying people based upon shapes and appearances of their teeth from dental X-ray radiographs. This technique used appearance and shape-based features to overcome the drawback of using only the contour of the tooth, which can be strongly affected by the quality of the images.

Nikaido, A.et.al. [16] proposed a dental radiograph registration algorithm. Along with algorithm phase-based image matching was used for human identification. Using 2D discrete Fourier transforms of dental radiograph images achieved highly robust image registration and recognition.

III. System Analysis

A. *Existing System*

Forensic dentistry is a method of identifying people based on unique patterns in the dental radiography images. It makes use of a biological Characteristic dental recognition is considered as a form of biometric verification. The accuracy of the system is measured by Receiver Operating Characteristic (ROC) curve. The existing system used algorithms to align the contours and calculates the average distance between all points in the query shape and their closest points in the database shape and uses it to represent the distance between tooth contours.

B. *Proposed System*

The matching algorithm utilizes both the contours of teeth and the shapes of the dental work. The shape registration method presents a systematic approach for establishing similarity between AM and PM radiographs. In this paper three major procedures are involved in human recognition namely Feature Extraction, Computation of image distances, and Subject identification. . At the feature extraction stage, the contour and dental work is extracted. Based on tooth contours and dental work, a distance representing the dissimilarity between the PM image and the AM image is computed; the third stage utilizes the distances between images to infer the identity associated with the PM images.

IV. System Design and Methodology

A. *Human Identification System*

The Human identification system consists of feature extraction, Contour extraction, Dental work extraction, Computation of image distance and subject identification. The architecture of human identification system is given in figure 1. The function of each module is explained below.

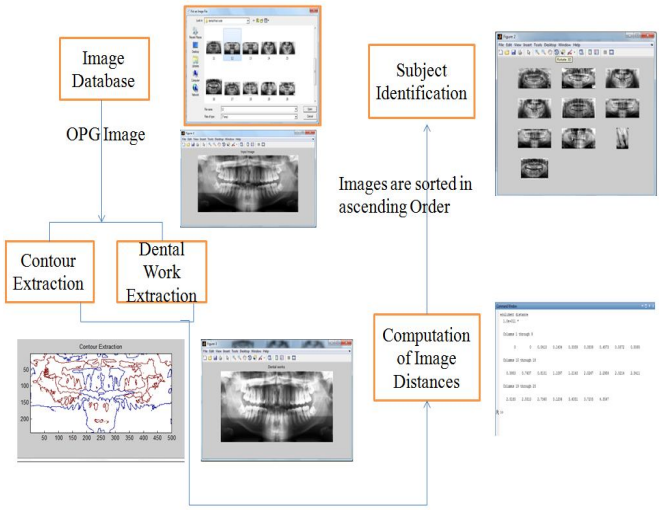


Fig.1. Process of Human identification System

1) Image Database

Image database contains 55 Ortho Pantomo Graph (OPG) and 10 Normal image that are collected from the Madura Dental Hospital, Madurai, Tamil Nadu, India.

2) Input Image

OPG image from database is given as the input image to the recognition system. The sample OPG image is shown in figure 2.

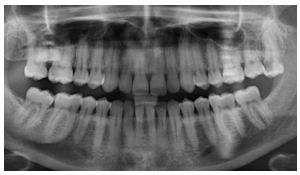


Fig.2.OPG Image

3) Feature Extraction

The feature extraction has two steps,

(i) Contour extraction

(ii) Dental work extraction.

Using the active contour model the tooth contours are extracted. The dental work, which appears as bright regions in the radiographs, is another salient feature for subject identification. To extract the contours of the dental work, the intensity histogram of the tooth image is approximated. The dental work is enhanced by histogram equalization which separates the dental work component from the noise components.

4) Contour Extraction

A contour matching algorithm aligns the contours and calculates the average distance between all points in the query shape and their closest points in the database shape and uses it to represent the distance between tooth contours. However, if one of the contours has some missing points due to occlusion or poor image quality, the algorithm fails to align the partial contour to the complete contour. The algorithm proposed in this paper solves this problem by establishing the point correspondence between the two curves and then computing the distances between the curves on the basis of the corresponding points. The contour extraction for Figure 3 is shown in Figure 4.

Fig.3.Input Image

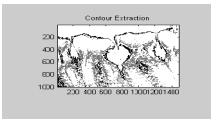


Fig.4.Contour Extraction

5) Dental Work Matching

The dental work is another feature for matching dental radiographs. The pre-processing stage sets the pixels inside the tooth contours to be 0 and then the pixels inside the contours of the dental work to be 1 . The dental work extraction can be done using intensity histogram to identify that the bright region in the image is a noise or an dental work. The grey level value of an image is . Consider histogram equalization for colour image. For The input colour image the grey level value will be = 8 values. Let's assume that each grey level has occurred randomly as n no of times. Probability Distribution Function (PDF) is calculated by Equation (1). The input and equalization image is provided in Table 1 and Table 2.

$$PDF = n / \sum n \qquad (1)$$

TABLE 1 GREY LEVEL VALUE OF INPUT IMAGE

Grey Level	No of Time occurred(*n*)	PDF	CDF
0	841	0.2546	0.2546
1	236	0.0714	0.326
2	744	0.2252	0.5512
3	821	0.2485	0.7997
4	210	0.0635	0.8632
5	110	0.0333	0.8965
6	200	0.0605	0.9570
7	141	0.0426	0.9946
Total	3303		

TABLE 2 GREY LEVEL VALUE OF EQUALIZATION IMAGE

Grey Level	No of Time occurred(*n*)	PDF	CDF
0	81	0.2242	0.0242
1	36	0.0107	0.0349
2	42	0.0125	0.0474
3	784	0.2350	0.2824
4	486	0.1457	0.4281
5	381	0.1142	0.5423
6	711	0.2132	0.7555
7	814	0.2440	0.9999
Total	3335		

TABLE 3 GREY LEVEL VALUE OF EQUALIZED IMAGE

Input Grey level	Equalization Grey Level
0	0
1	0
2	0
3	1
4	2
5	2
6	3
7	7

In Table 3 the Equalized image values are given. The equalized image values are calculated by comparing the each CDF value of Table 2 with the corresponding CDF value of Table 1 and give us the range in which the value lies. The dental work extraction for Figure 1 is given in Figure 5.

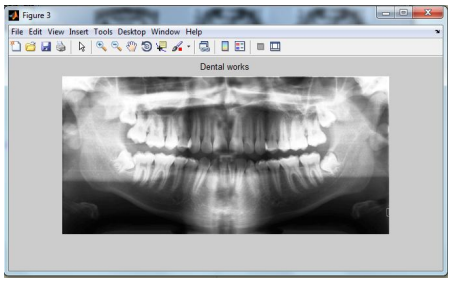


Fig.5.Dental Work Extraction

6) Computation of Image Distances

The matching distance between images should rely on the corresponding teeth only. Based on the assumption that no teeth are missing between the acquisitions of AM and PM images; so, for neighboring teeth in AM images, their corresponding teeth in PM images should be neighbors as well. Image distance is calculated based on the "Euclidian Distance". Euclidian Distance(ED) is calculated by

ED = Features of images in Database – Features of Query image

7) Subject Identification

Given the matching distances between two images, the similarities between subjects are computed. The algorithm for

subject identification has two steps. The first step is to compute the matching distances between one PM image up and all the AM images. If two images do not have any tooth in common, their matching distance will be large. Only if the images have some teeth in common and the correspondence is correct will the matching distance be small. So, the smallest matching distance is chosen to represent the matching distance between the images. Based on the values the images are ranked in ascending order. Figure 6 shows Subject Identification of input figure 2.

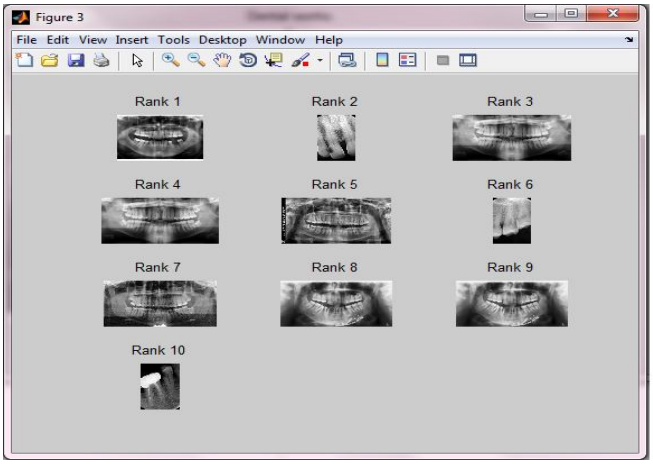


Fig.6.Subject Identification

8) Result Analysis

In this paper the performance was analyzed using Correct Detection (CD) and False Detection(FD). CD refers to the Correct detection by the algorithm and FD refers to the False detection by the algorithm. The false and failed detection may be due to

a. Noise in the images

b. Poor quality of the images

The accuracy is calculated using the formula in equation 2.

$$\text{Accuracy} = N_{CD} / N_{FD} \qquad (2)$$

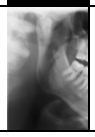
TABLE 4 ACCURACY OF IMAGES IN DATASET

Total images	Correct Detection	Wrong Detection	Failed to detect
55	40	8	7

The accuracy is calculated and obtained as

Accuracy = 40/55 = 72%

TABLE 5 SAMPLE ACCURACY CALCULATION FOR IMAGES IN DATASET

S.No	Image Name	Input Image	Output Image	Correctly Matched	Wrongly Matched
1	11.bmp			Yes	
2	19.bmp				Yes
3	20.bmp			Yes	
4.	15.bmp			Yes	

V. CONCLUSION

Dental biometrics is used to identify individuals in the forensic domain. This paper presents an automatic method for matching dental radiographs. The matching is performed in three steps. In the first step, a shape registration method aligns the tooth contours and computes the distance between them. If dental work is present, then the dental works are extracted using Intensity Histogram. The second step is to compute the similarity between the pair of images. In the third step, the distances between subjects are used to retrieve the identities from the database. Experimental results show that this approach is accurate about 72%.

VI. FUTURE WORK

There are still a number of challenges to overcome. The shape extraction is a difficult problem for dental radiographs, especially for poor quality images where some tooth contours are indiscernible. For subjects with missing teeth, we are exploring other features for identification, such as the shape of mandibular canals and maxillary sinus. We are also in the process of obtaining a larger database for evaluating the algorithm.

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