Dental Biometric in Human forensic Identification

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***Abstract*— Use of image processing for biometric systems goes on increasing from last decade. The biometric is a tool used for person identification system. Dental biometric is one of the effective methods used in the forensic science for person identification. This system utilized dental radiography and dental photograph as it provides unique teeth features like shape, contour, dental work like crown, bridges and fillings, the relative distance between neighboring teeth etc. The proposed method consists of three processing stages: image acquisition, preprocessing, feature extraction, dental code formation and matching. The proposed system gives an accuracy of 94% for dental photograph and 96% for dental radiograph.**

Keywords — Biometrics, Dental Radiograph, HMM, Matching, Missing teeth detection, Teeth contour, SVM.

I. Introduction

The application of digital image processing in the field of biometric and bioinformatics goes on increasing day by day. The biometric system, identifier specifies the unique physiological characters. There are different biometric feature which are unique for human top human such as fingerprint, iris, vein structures, face, teeth etc. In forensic identification, fingerprint, face, iris may vanish due to soft tissue decay and hence postmortem identification could not be possible. Unlike these identifiers, the tooth is only identifier which doesn't decay year after death so teeth may be a strong identifier for post mortem identification of the person.

Lots of studies have been highlighting the importance of dental records to identify the missing person [1]. In natural disaster tots of time required to identify the missing person because of numbers of the victims. To solve this problem, automatic dental biometric system plays important role.

Dental biometric is based on the ante mortal (AM) and post mortal (PM) records of the tooth. The dental radiograph encodes the morphological features of the tooth like tooth shape, dental pathology, missing teeth, restoration, relative distance of the neighbor tooth, contour, artificial prosthesis, number of cupids etc. According to these features feature code is formed and stored as an AM record. While testing, features code of the PM tooth is extracted. The matching of the PM and AM record identifies the person.

The main important part of the system is dental photograph and dental radiograph. Dental photograph is the pictorial representation of the teeth structure. It shows the relative distance between neighborhood teeth position and shape of the teeth. This can be capture by the any camera. Fig.1. shows the dental photograph. Dental radiograph is the X-ray image of the tooth. X-ray image of tooth consist of teeth, bones and soft tissue of the jaw. Dental radiograph are of three types: Panoramic, periapical and bitewing. Panoramic radiograph is large and show the whole bone structure of Jaw. It provides good information for forensic purpose. A periapical radiograph is taken from an angle so that the three elements of the tooth are not parallels align. The bitewing radiograph is taken of back, top and bottom view of teeth.

Fig. 1. Panoramic radiograph

Fig. 2. Periapical radiograph

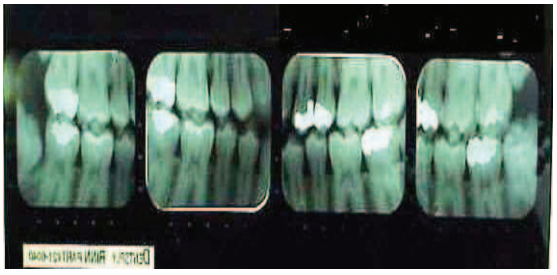

Fig. 3. Bitewing radiograph

This paper is organized is as follow- section II explains the review of different dental biometric algorithms. Section III explains the proposed technique for person identification.

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Section IV described the results in qualitative and quantitative way. In last Section paper has been concluded.

II. Literature Review

In last decade, many researchers have been proposed different method for feature extraction and matching of dental radiograph and dental photograph.

Akira Nikaido et al. [2] proposed an efficient algorithm for person identification which includes radiograph registration using Phase based image matching technique. Image registration and recognition achieved by 2D- DFT. The experiment is performed on 50 images. This system gives 80% recognition accuracy.

Michael Hofer et al. [3] present dental biometrics system for person identification. This system consists of feature extraction, dental code and matching process. In this work, dental work of panoramic dental radiograph is considered as the main feature. Dental boundaries were extracting using active contour segmentation method. Levenshtein distance was used to matching. 86% of accuracy is obtained by this method.

P. L. Lin et al. [4] proposed method to classify the molar teeth from premolars. Homomorphic filter enhance the dental images. Thresholding based approach is used to segment out the tooth and finally contour is applied over the tooth image. The length to width ration of each extracted tooth is a feature for this system. The feature set is classified into molar and premolar using support vector machine. This system gives classification accuracy of 93.9%, 95.7%, 98.6%, and 91.9% for classifying both molars and premolars in both maxilla and mandible.

Jincy Raju et al. [5] proposed feature extraction technique. In this method, Fourier description, GLCM (Contrast, Correlation, Energy and Entropy) are proposed. Two matching technique, mean square error and Euclidean distance method are implemented classify the testing image. Fourier description and approach gives 66.67% accuracy.

Dental biometrics is very useful in natural disaster like earthquake, plane crash, Tsunami where number of peoples died and person identification is difficult.

Takafumi Aoki et. al. [6] worked on disaster victim identification system which is used in Great east Japan earthquake and Tsunami in 2011.

Vijayakumari Pushparaj et al. [7] worked on the dental radiograph for person identification. In this system the dental radiograph is preprocessed using Butterworth band pass filter and homomorphic filter. The tooth was extracted by B-spline function. SVM classifier classify into molar and premolar. This system has accuracy of 93.3% for Molars and 92% for premolars.

Faisal Rehman et al. [8] proposed colored dental image for person identification system. This system is process through four steps: preprocessing, segmentation, feature extraction and matching. An Equal Error Rate (EER) of 85.7% dental radiographs and 88.8% for colored teeth images found on matching the performance of our dental biometric analysis.

III. Proposed System

The proposed system of person identification using dental biometrics consists of five main steps: Image segmentation, tooth localization, tooth shape extraction, shape and contour matching, and missing teeth detection

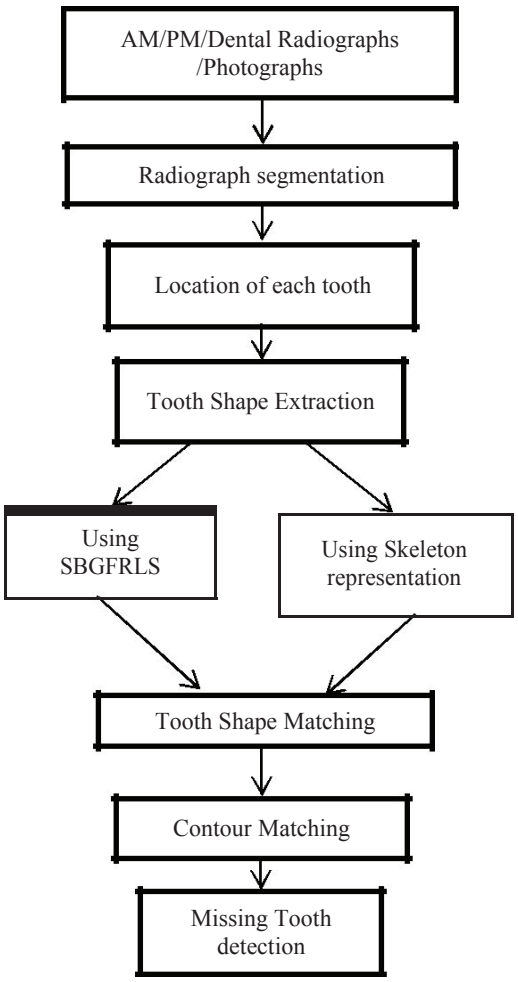

Fig. 4. Flow diagram of Proposed system

A. Input Image

The dental radiograph with or without tooth images are the input of the system. The image preprocessing is the step to improve the quality of the image.

B. Segmentation

Initially, the dental photograph/radiograph is converted into grayscale image. After this, gray image converted into binary image. Canny edge algorithm is used for segmentation of image. Boundary of each tooth is been extracted to detect location of each tooth

C. Tooth shape Extraction

To detect the person, the shape of the tooth provides the valuable information. This can be achieved by two methods: contour based and skeleton based.

1. SBGFRLS method

In this section, a region-based active contour model with a SBGFRLS method is introduced. It uses SPF function which is work on region based segmentation can efficiently stop blurred edges. The advantage of this technique is automatically detecting the interior and exterior boundaries with the initial contour being anywhere in the image. It is possible to segment not only the desired object but also the other objects.

2. Skeleton based method

It is a conventional method. It computes a set of node, connecting each node to form a graph and that graph indexing into a database and verification with one or more objects is followed. In this paper additional parameters are considered for skeleton matching are centroid, skeletal distance, length of skeleton and angle between skeleton end point and reference point.

D. Contour Matching

The ante-mortem dental records might have captured a long before than the post mortem images. Hence the viewing angle might be differing in both the dental records. So, there is a necessity of applying a rigid transformation to both ante mortem and post mortem images before finding the distance. The matching distance obtained can be improved by the rigid transformation. It is of the form

(1)

Where, x' is the transformation on x, R is the transformation matrix and t is the translation vector. The value of R is given as

(2)

Where, θ is the angle of orientation, S_x and S_y are the horizontal and vertical scaling parameters.

E. Missing tooth detection using classifier

To find the missing teeth, we propose a hidden Markov model (HMM) as an underlying representation of the dental atlas. In our model, the states representing the available teeth have discrete observations, namely the class of each tooth and the states representing the missing teeth have continuous observations: the distance between neighboring teeth. To classify the teeth as missing and available support vector machines (SVMs) is been used.

IV. Result

The result of the system is calculated in qualitative and quantitative way.

A. Qualitative analysis

Qualitative analysis is the pictorial representation of the stages of the research. Stepwise qualitative analysis of the proposed system is shown below.

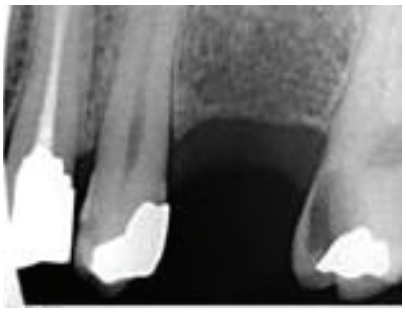

Fig. 5. Input image

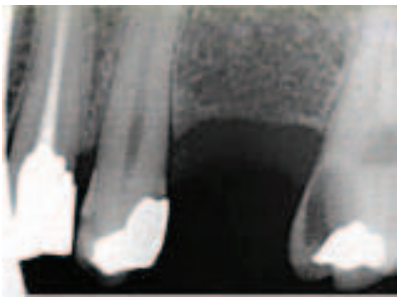

Fig. 6. Grayscale Image

Fig. 7. Binarized image

Fig. 8. Segmented Image

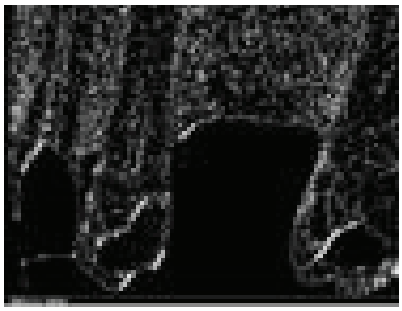

Fig. 9. Canny edge image

Fig. 10. SBGFRLS output

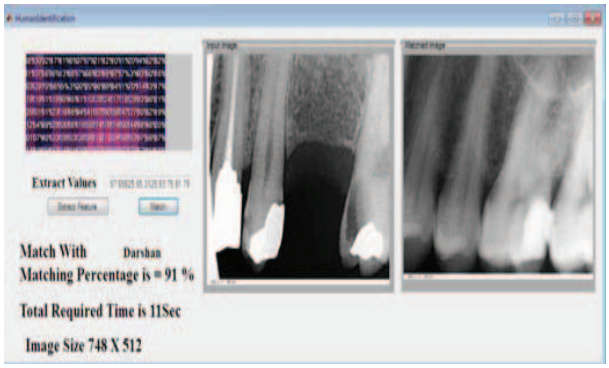

Fig. 11. Person Identification

B. *Quantitative analysis*

Qualitative analysis is the numerical representation of the research. It is representing in terms of sensitivity, specificity and accuracy. In this proposed approach 50 images of dental radiograph and 50 images of dental photograph are consider for testing. The results of this approach is tabulated in TABLE I.

TABLE I. Quantitative analysis

Method	Testing Images	Matched Images	Identity Rate (%)
Dental photograph	50	47	94
Dental Radiograph	50	46	92

Comparative analysis of proposed system with other system is tabulated below in TABLE II.

TABLE II. Comparative analysis

METHOD	Total Testing images	Identity Rate (%)
Proposed Method	100	93%
Radiographs [8]	84	85.7%
Colored Images [8]	90	88.8%

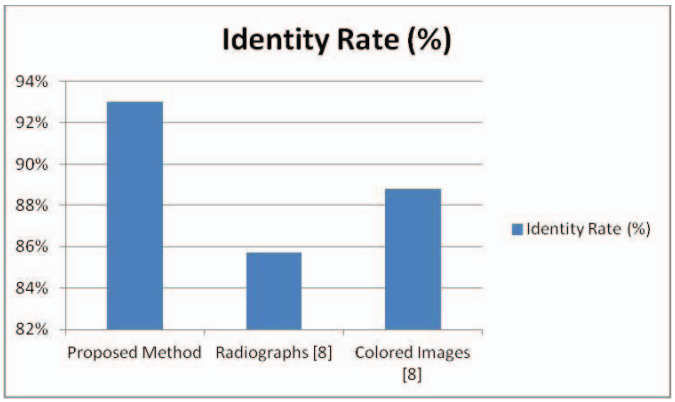

Fig. 12. Comparison of previous and proposed method

V. Conclusion

In this paper a novel shape matching algorithm using skeleton is proposed for dental images. Another novel focus of this paper is usage of dental photographs if there is unavailability of dental radiographs. It is an attempt to provide an aid for forensic law enforcement with the help of photographic images also. The contour tracing is implemented using a level set method named SBGFRLS method. Missing tooth is recognized by the HMM. And classification of person is done with SVM classifier.

The experimental results show that the proposed algorithm is applicable to both radiograph dental image and dental photograph. The precision and overall measures are higher for skeleton than contour, while considering the whole image, either maxilla or mandible separately for matching. The proposed system gives the identification rate of 94% for dental photographs and 92 % for dental radiograph.

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