Feature Extraction Technique for AM Dental Radiographs

Naik Harsh P.[1] Mrs.Krupa S. Dave[2]
[1]M. Tech (Purs.) [2]Assistant Prof.
[1, 2]Electronics & Communication Dept.
[1, 2]CGPIT, Maliba Campus, UTU

Abstract---Dental image processing is most immerging field for human identification. Dental features remain more or less invariant over time compared to other identification clues like fingerprint, iris, etc. which are not available in some case of major accidents. 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 for human identification. Image enhancement is necessary because of poor quality and low contrast of dental image at primary stage. Thereafter segmentation algorithms are applied to the enhanced dental x-ray image which helps to find two major regions namely gap valley and tooth isolation. The main crucial part is tooth and feature extraction of dental image. In this paper, we propose a novel approach to extract individual tooth and thereafter we extract a geometrical features of dental x-ray radiograph for human identification purpose.

Keywords: region growing; median filter; erosion; major axis; minor axis

I. INTRODUCTION

Dental X-ray has played an important role in human identification. Human identification based on dental features has always played a very important role in forensics [5]. Due to poor quality of dental images, the first step is to enhance the radiograph; thereafter segmentation is performed and followed by feature extraction which produces a region of interest which is unique for each individual [8]. Thereafter the feature vector produces for individual images and store in database. It will help for matching with query image for human identification.

The dental radiograph is categorized in three region namely teeth area, bone area and background area which having variable intensity high, medium and low respectively. Sometimes bone area and teeth area are having same intensity so; it is very difficult for segmentation and feature extraction. Various techniques are used for segmentation of dental radiograph and extracting two main regions, gap valley and tooth isolation.

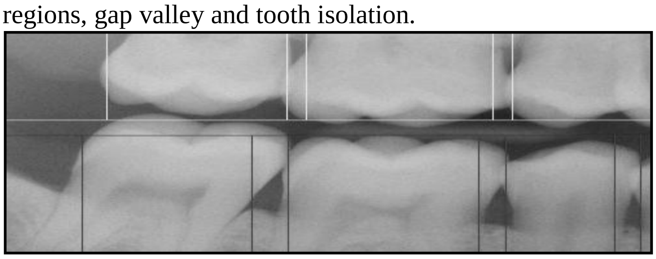


Fig. 1: Identifying tooth isolation and gap valley from binary integrated edge intensity curves [9]

In [2] Anil Jain et.al proposed a segmentation algorithm for the detection of ROI needed to automatically find the contours of the teeth. The segmentation algorithm proposed in [1,5] uses "gray level integrated intensity curves" to fit a curve called as *Sv* curve " between lower and upper jaw teeth (gap valley).

The segmentation algorithm proposed in [9] Nirav desai et al. used "binary integral edge intensity curves" to fit a curve called as *Sv* curve between lower and upper jaw teeth (gap valley) to detect ROI. It is as shown in Fig. 1.

In this paper we are extending this work to extract each and every individual tooth from dental radiograph. Thereafter we are extracting geometrical features of individual tooth namely area, major axis length and minor axis length of individual tooth. If we store these features of all teeth in vector form for a dental radiograph and we do it for all the dental radiographs available in a database.
In section II we discuss the problem of dental X-ray image segmentation and feature extraction. In section III we focus on various tools used in proposed algorithm. In section IV we discuss the proposed algorithm. Section V deal with the results and analysis. Section VI concludes the paper.

II. DENTAL RADIOGRAPH SEGMENTATION AND FEATURE EXTRACTION PROBLEMS

Thresholding based methods used for segmentation of teeth but they usually fail to discriminate between teeth and bone areas as their intensities are more or less similar. To overcome that problem, In [2], the authors suggested extraction of tooth contour as a feature because they remain more invariant over time compared to other features of teeth. The matching algorithm was divided into 3 main tasks namely: Radiograph Segmentation, Contour Extraction and Shape Matching. Radiograph Segmentation is done based on gray level integrated intensity of dental radiograph images. After that Crown Extraction is done to separate Crown part and root part. Finally, a matching distance between PM and AM images is found and ranking of database images is generated with respect to their minimum matching distance (Shape Matching). A smaller matching distance signifies better Match**.** In [4], the authors proposed iterative and adaptive thresholding and thereafter horizontal and vertical integral projection is used for separating the jaws as well as individual tooth. They match distance between signature vector of AM and PM and rank them for identification.

In [8], the authors proposed a novel approach to feature extraction of dental x-ray radiograph based on the shape and texture of extracted tooth from the radiograph. They extract 5 features namely: Fourier descriptors (feature1) and four properties of gray level co-occurrence matrix (GLCM) features such as Energy (feature2), Contrast (feature 3), Correlation (feature 4) and Homogeneity (feature 5). Thereafter matching is done by finding mean square error between the query and database images.

In [9], the authors proposed a simple and novel algorithm for automatic selection of ROI for dental radiograph segmentation. They use Canny edge detection technique to find out edges of tooth and use "binary integrated edge intensity curves" to find out ROI for gap valley and tooth isolation. It automatically finds the ROI both for gap valley and tooth isolation in 83% dental radiograph images without rotation [9].

III. BACKGROUND OF VARIOUS TOOLS

A. *Region growing approach*

We start with a single pixel *p* and wish to expand from that seed pixel to fill a coherent region. Let's define a similarity measure *S (I, j)* such that it produces a high result if pixels *i* and *j* are similar and a low one otherwise. First, consider a pixel *q* adjacent to pixel *p*. We can add pixel *q* to pixel *p'*s region if *S(p, q) > T* for some threshold *T*. We can then proceed to the other neighbors of *p* and do likewise. Suppose that *S (p q) > T* and we added pixel *q* to pixel *p*'s region. If we continue this recursively, we have an algorithm analogous to a, flood fill but which works not on binary data but on similar grayscale data.

B. *Median filter*

Median filter is a nonlinear filter mostly used to remove the impulsive noise from an image. It creates a 2-D mask that is applied to each pixel in the input image, by centering the mask in a pixel, evaluating which brightness value in the masked window is the median brightness value, and replacing the pixel value by it. Furthermore, it is a more robust method than the traditional linear filtering, because it preserves sharp edges. Filtered images have usually strong changes in their statistics, due to noise removal by smoothing. Salient points depend on edges, so measurements should not be affected by this transformation, and visual appearance of the image should be improved.

C. *Erosion*

In binary morphology, an image is viewed as a subset of a Euclidean space R^d or the integer grid Z^d, for some dimension *d*. To probe an image with a simple, pre-defined shape, drawing conclusions on how this shape fits or misses the shapes in the image in binary morphology. This simple "probe" is called structuring element which is a binary image (i.e., a subset of the space or grid). Let *E* be a Euclidean space or an integer grid, and *A* a binary image in *E*. The erosion of the binary image *A* by the structuring element *B* is defined by:

$$A \ominus B = \{z \in E | B_z \subseteq A\},$$

Where B_z is the translation of *B* by the vector z, i.e.

$$B_z = \{b + z | b \in B\}, \forall z \in E.$$

When the structuring element *B* has a center (e.g., a disk or a square), and this center is located on the origin of *E*, then the erosion of *A* by *B* can be understood as the locus of points reached by the center of *B* when *B* moves inside *A*. The erosion of *A* by *B* is also given by the expression:

$$A \ominus B = \bigcap_{b \in B} A_{-b}$$

IV. PROPOSED ALGORITHM

In this section we propose an algorithm of tooth extraction and feature extraction of dental radiograph. Table I contains the proposed algorithm.

In proposed algorithm [9], the authors Plot the *Sv* lines using upper and lower jaw binary integrated edge intensity curves for segmentation of dental radiograph. We are extracting the individual tooth from dental radiograph using pick and valley co-ordinate of binary integrated edge intensity curves.

No.	Steps
1	Apply the Region growing algorithm on dental image.
2	Invert image using logical NOT operation.
3	Apply median filter to remove paper & salt noise.
4	Apply erosion to remove unwanted region.
5	Extract individual tooth from upper and lower jaw.
6	Extract features of tooth like area, major axis and minor axis.

Table. 1: Proposed algorithm

In some cases the intensity of the bone areas is close to the intensity of the teeth. In the algorithm proposed in [4], the tooth areas are fused with equal intensity. We take an alternative approach of fusing the region in which the features are available. To achieve that first we apply region growing method on the original image shown in Fig. 2.

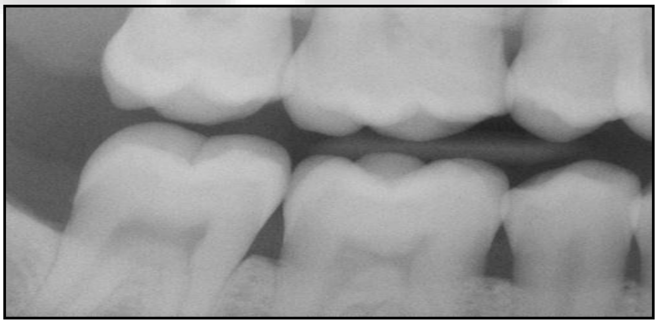


Fig. 2: Original image

We get the regions as shown in Fig.3 in which gap valley and tooth isolation areas a fused with equal intensity [9].

Fig. 3: Region grow image

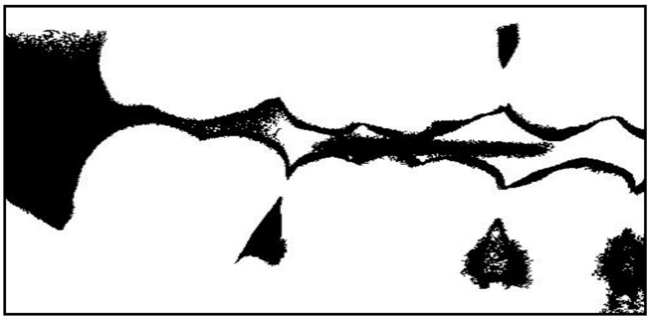


Fig. 4: Invert image of region growing image

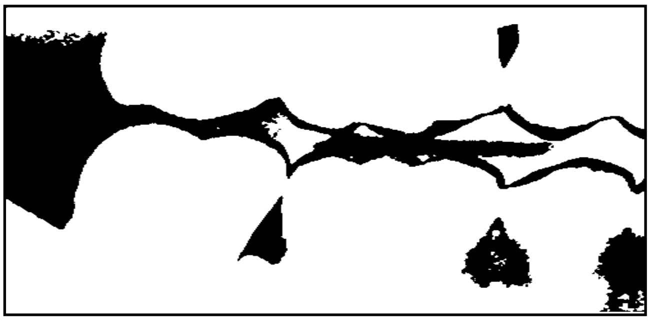
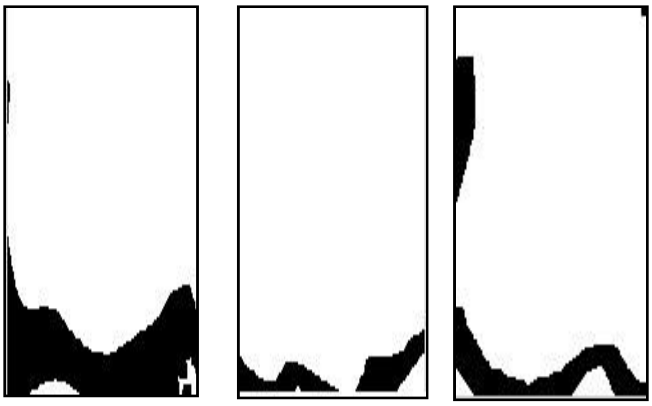


Fig. 5: Image after applying median filter

In next step we convert gray image into binary image and apply logical NOT operation and convert white region into dark region and dark region into white as shown in figure 4. To remove some small artifacts we apply median filter on inverted image. The resultant image is as shown in figure 5 but still there are unwanted regions present between teeth. To remove unwanted regions we use morphological erosion operation on resultant image. For erosion we use disk type structuring element which is size of somewhat smaller than the object. Resultant image is as shown in fig 6.

Fig.6:Image after Erosion

Upper jaw first teeth   Upper jaw second teeth   Upper jaw third teeth



Lower jaw first teeth   Lower jaw second teeth   Lower jaw third teeth

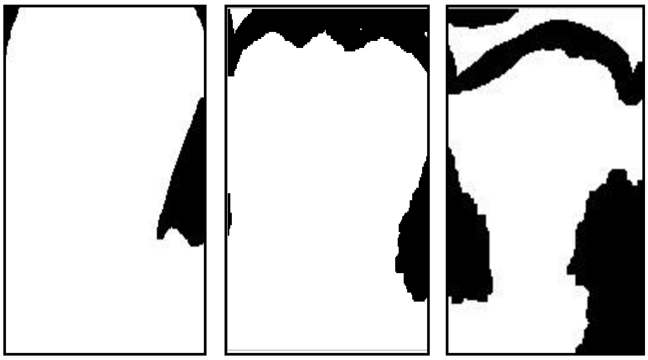


Fig. 7: Individual tooth Extraction.

To extract teeth, we are using gap valley and tooth isolated image using binary integral edge intensity curves (fig.1). From binary integral edge intensity curves we can obtain the peak and valley co-ordinates which are used to crop individual tooth from erosion image. Resultant image is as shown in fig 7. After tooth extraction we are finding geometric features of individual teeth. We are extracting tooth Area, Major axis length and Minor axis length of individual tooth.

V. RESULTS AND ANALYSIS

In proposed algorithm, for region growing we take the values of the structuring element *s* and *t* to be 100 and 30 respectively. For morphological operation erosion we use disk type structuring element with size 3.All these values are selected experimentally and found to be optimum for the results. We are extracting three features tooth area; major axis length and minor axis length of individual tooth of dental radiograph which is shown in table II.

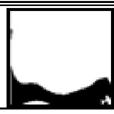
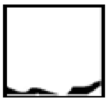
Tooth position	Tooth	Area	Major axis length	Minor axis length
Upper jaw first teeth		16415	158.2296	136.1810
Upper jaw second teeth		19439	166.0505	154.8641
Upper jaw third teeth		13668	153.2415	119.7299
Lower jaw first teeth		27502	222.8616	171.4354
Lower jaw second teeth		26202	201.7916	176.1321
Lower jaw third teeth		1633	153.2282	31.0126

Table. 2: Result of feature extraction

VI. CONCLUSION AND FUTURE WORK

In this paper we have proposed a simple and novel algorithm to extract individual tooth from dental radiograph and find geometrical features such as tooth area; major axis length and minor axis length. It remains inherently unique to each individual which describe the geometry of teeth. In future work we will find more features of teeth and used to match it with query image for identification purpose.

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