Dental Biometrics for Human Identification based on Dental Records

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Abstract

Identification of Human based on Dental photograph or Dental radio graph is one of the popular and emerging trends in Biometrics. The Dental biometric system utilize dental photograph and dental radiograph for identification of person as it provide unique teeth feature such as crown, bridges, fillings, and relative distance between neighboring teeth. For implementation of a dental biometric system we have to implement various Techniques such as Image enhancement, Segmentation, Feature extraction and Matching. In this paper we try to make an effective system that identify person based on their dental records.

Keywords: *Ante mortem (AM), Dental Biometrics, Dental Anatomy, Post mortem (PM)*

1. Introduction

Image processing is a method to convert image into digital form by performing some operation on it, in order to get some useful information or some enhanced features from it [16]. It is a type of Signal processing where input is image and output is image or some characteristics features associated from it. Now a days image processing is Rapidly Growing technology where lots of research work is done in current trend. Image processing basically include three basic steps: First is to importing Images with the help of Optical scanner or digital photography. Second, is to manipulate or analyse image by image enhancement or image compression. Third, is output of image . [1]

Image processing is used for many purpose like visualization, image sharpening and restoration, Image retrieval, Measurement of pattern , Image recognition. There are two types of image processing methods Digital image processing and Analog image Processing. We focused on Digital Image processing Methods and Techniques.Digital image processing refers to use of computer algorithms and techniques to perform image processing on Digital Images. An image may be defined as two dimensional function $f(x,y)$ where x and y are Spatial coordinates and amplitude f at any pair of coordinates (x ,y) is called intensity of the image. When x , y and the amplitude values of f are all finite, discrete quantities, we call the image as digital image. [2]

Biometric derived from the Greek word “bios” for life and “metron” for to measure. A biometric system is used to identify person based on their physical characteristics such as finger prints , teeth pattern etc.A biometrics is a convenient and reliable method to identify human identity. Biometrics system is divided in to two categories: Behavioural biometric system and physiological or physical biometric system. Behavioural biometrics is the field of study related to measure of uniquely identifying and measurable patterns in human beings such as signature password. physiological or physical biometrics is the field of study related to specific characteristics of humans such as finger prints, iris patterns, face and palm print patterns. [3]

Dental biometrics is also used in forensic identification of human. Human Identification based on dental information was first observed in Roman Empire when Nero's mother Agripina ordered to kill loilla paulina who was later identified by her dental caries and bad dental condition.

The first treatise of human identification based on dental records was done in 1857, by Dr Oscar Amoedo Valdes who applied a dental based identification technique to identify disaster victim in Paris. After his work human identification based on teeth is accepted worldwide. [4]During last decades human identification based on dental records was extremely used to identify victims in massive disasters such as 9/11 terrorist attack in New york and tsunami in Asia.

Dental Biometrics in Forensic identification of human uses AM (anti mortem) and PM (post mortem) records in database for matching Teeth patterns to identify human beings.Biometric features such as finger print , face is destructed in accident such as plane crash, burning accidents, floods ,so it is not possible to work with conventional methods so in such case to identifying persons because bones and teeth does not easily decay and it takes high temperature up to 1100 degree temperature for melting. [5]

2. Dental Anatomy

Dental Anatomy is a field of Anatomy which deals with study of human tooth structure .It is also a taxonomical science that deals with naming teeth & structures of teeth [fig a].A Tooth (Teeth) is a small calcified whitish structure found in the jaws (mouth) for breaking food. Tooth formation begins before birth. Teeth are not made of bones but it is made of various types of tissues, enamel etc. Teeth are hardest substance in human body. Different parts of teeth are [fig b]:

1) CROWN: It is top part of tooth that we normally see. Shape of crown determines tooth structure.

2) GUMLINE: In this Gum-line tooth and gums are met.

3) ROOT: It is a part of tooth which is embedded in bone.

4) ENAMEL: It is outermost layer of teeth which is hardest substance found in human body.

5) DENTIN: It is next layer of tooth found after enamel.

6) PULP: It is the soft tissue found in the centre of teeth.

Usually there are 20 primary (Baby) teeth and 28 to 32 permanent teeth, last 4are third molars or wisdom teeth each of which may or may not grow in. Fig a shows that there are 16 teeth found in maxilla (upper jaw) and 16 found in mandible (lower jaw). There are four types of teeth they are:

1) INCISORS: sharp chisel shaped front teeth (4 upper and 4 lower) used for cutting.

2) CANINES: they are called cuspids because of their shapes like cusps, used for tearing food.

3) PREMOLAR: these teeth have two cusps shape for tearing and grinding.

4) MOLARS: These teeth have many cusps on their biting surface and use for grinding food

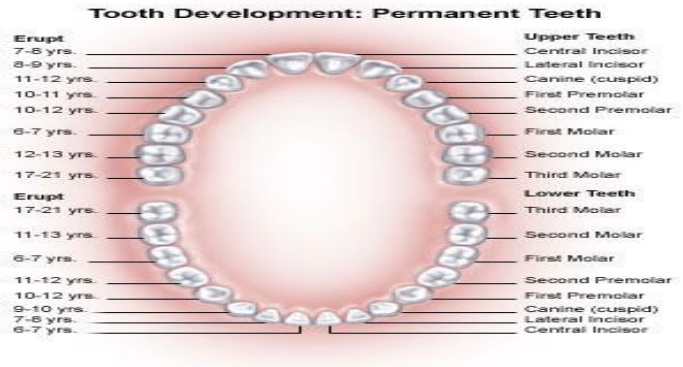

Figure a. Tooth Anatomy

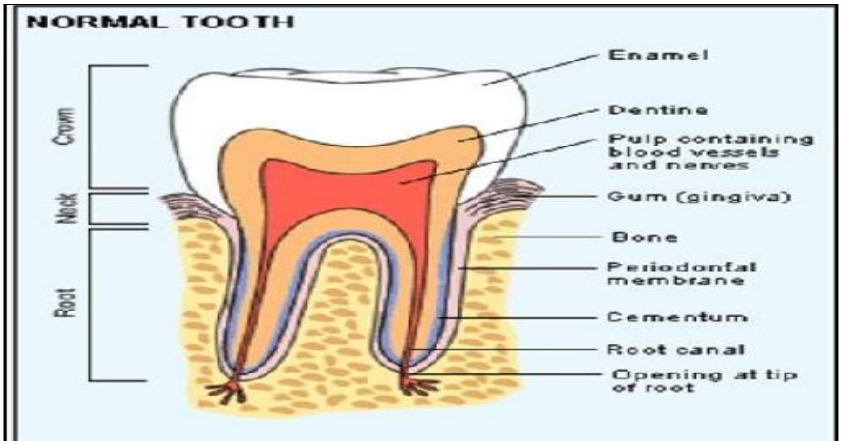

Figure b. Structure of tooth

3. Types of Dental Radiograph

Dental radiographs are commonly called as X rays. A Dental radiographic image is formed by a controlled burst of X ray radiation which penetrates oral structures at different levels, depending on varying Anatomical densities, before striking the film or sensor. Teeth appear lighter because less radiation penetrates them to reach the film. Dental caries, infections and other changes in the bone density appear darker because X ray readily penetrate these less dense structures. Dental restorations (fillings, crowns) may appear lighter or darker depending on the density of material. There are various types of dental radio graph few of them are as follows [3]:

1) BITEWING: This technique involves biting down a special piece of paper so that we can see the crowns of teeth. See (fig 1)

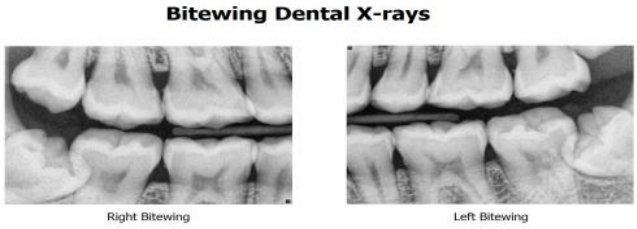

Figure 1.Structure of tooth

2) OCCLUSAL: This X ray is done when your jaw is closed to see how your upper and bottom teeth line up.See (fig 2)

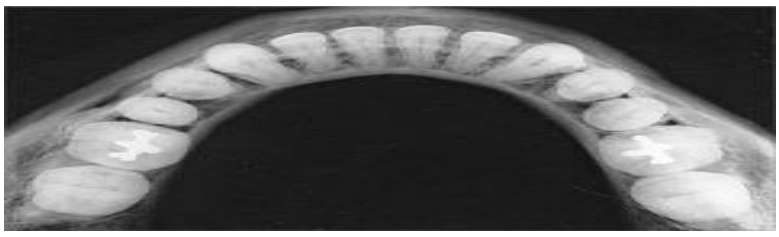

Figure 2.Structure of tooth

3) PANORAMIC: In this type of radiograph the machine rotates around the head.See (fig 3)

Figure 3.Structure of tooth

4)PERIPICAL: This technique focus on two complete teeth from root to crown. See (fig 4)

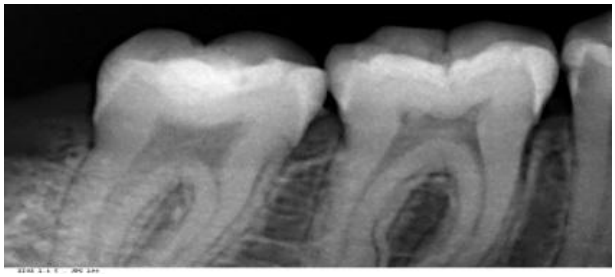

Figure 4.Structure of tooth

4. Dental Photograph

Dental Photograph See (fig 5) is an image which is taken with the help of camera. In some case where dental radiograph is not obtained easily on that case we use Dental Photograph. It is easy way to collect Dental Photograph where we can collect Dental photograph of various persons. For identification of human Dental photograph also play an important role. Use of dental Radiograph in identification of human takes less cost and it is easily Available. We can use any camera but its resolution is good enough so that it can take good quality of image.Use of good quality of dental photograph gives better output and make our Dental based identification system more effective. In below figure we see the Dental image of various persons.

Figure 5. Structure of tooth

5. Literature Review

In this review we present all the previous review of some selected paper in the form of table. Below table illustrates the literature review of various techniques which is used by different authors in Previous Years.

Table 1.review of various techniques

Year	Reference	Enhancement Technique	Segmentation Technique	Feature Extractor	Matching Techniqe	Results
2017	G. Jaffino, A.Banumati, UlaganathenGurunathan, J.Prabin Jose [6]	Butterworth High pass filter	Biteviewing radiograph using Spline Isolation, Missing tooth detection	Moments Feature Extraction	K-NN classification & Texture based, Fuzzy classification based matching	Efficient Algorithm with 93% accuracy
2015	Soma Datta&NabenduChaki [7]	De noising winner filter	Watershed & snake Algorithm used	ROI Extraction such as volume, size, area	NA	Efficient but not 100% accurate
2015	DipaliRindhe& Ganesh Sable [9]	Assumed good quality images were used in JPEG format	Thresholding	SIFT ALGORITHM	Matching feature based on Euclidean distance	It give better matching rate for identification
2014	Vijaya [8]Kumaripushparaj, UlaganathenGurunathan, BanumatiArumugan	Use good quality of radiograph & photograph	Missing tooth Identification & Spline isolation	Contour Extraction	Binary (SVM) Contour Based Matching	This Method Outperforms other methods in terms of Computation time & hit rate
2012	ShubhangiC.Dighe&RevtiShriram[3]	Histogram equalization	Extraction of ROI	Thresholding	Difference between radiograph based on dental work , mode, median, skewness &kurtosia Control Point	Method give direct visualization of matching or not matching & unsatisfactory for two blurred image

					Selection of tooth contour	

Table 1.review of various techniques [cont]

Year	Reference	Enhancement Technique	Segmentation Technique	Feature Extractor	Matching Technique	Results
2011	C.K Modi [10][17]	Assumed good quality of images were used	Radiograph Segmentation	Fourier Descriptors	Absolute and Euclidean distance	66.667 % Precision
2009	P.L.Lin&Y.H.Lai [11][17]	Hommorphic Filtering ; Adaptive contrast stretching &Adaptive morphological transformations	Thresholding ; Horizontal & Vertical integral projection	Relative length/width radio of a teeth, Relative crown size	Only classification is performed	94.9% for molars &95.6% for premolars.
2008	S.Kiattisin [12][17]	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).
2006	O. Nomir and M. Mottaleb [13][17]	Binary image masking	Radiograph Segmentation: Iterative & Adaptive thresholding ; Horizontal & Vertical integral projection	Tooth Contour	Hierarchical Chamfer Matching Algorithm	Out of 50PM quer images, Rank I-40, Rank II-3, Rank III-2, Rank V-4, Rank VII-1 images.
2004	O. Nomir and M. Mottaleb [15][17]	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 %PM images correctly retrieved.

2004	Anil K. Jain [14][17]	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%

6. Proposed Methodology

The methods we have proposed here comprises five main processing steps. All the image will pass these process. First dental radiograph is sent in to image enhancement technique where we improve the quality of image then image is sent to pre-processing stage where we process image then image is segmented in segmentation process then we extract some special feature by use of Feature Extractor then we match the image to get desired output.
The proposed system is implemented with five modules:
1. Pre-processing
2. Image Enhancement
3. Segmentation
4. Feature Extraction
5. Dental image Matching

Block diagram of proposed system
The block diagram of dental biometrics is shown in Figure 4.1.

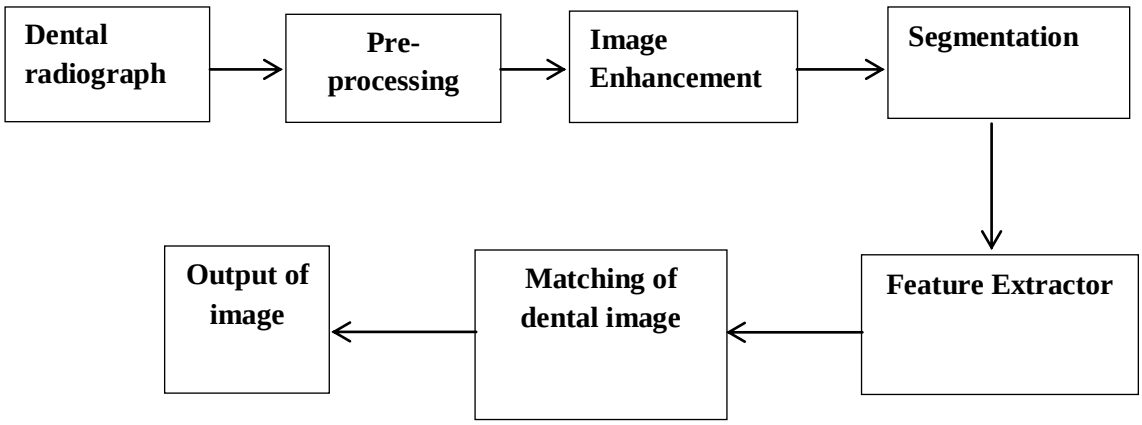

Figure 4.1: Block diagram of Dental biometric system

6.1. Pre-processing

It is the first step or fundamental step of Digital image processing. Image pre-processing or Image Acquisition basically deals with improving the quality of image.If our image quality is poor then we

have to remove noise from that image and make our input image more accurate. For removing Noise various types of Filters is used.

Removal of Noise in done in 3 ways:

1.Remove Noise by Linear Filtering.

2. Remove Noise Using an Averaging Filter and a Median Filter.

3.Remove Noise By Adaptive Filtering.

6.2.Pre processing

It is Simplest and mostly applied in various areas of digital image processing. It is used in those areas where the subjective quality of images is important for human perception. The idea behind this is to highlight certain features of interest in an image.

6.3. Segmentation

In Segmentation process we partition an image into constituent parts or object. In this we segment ourdental photograph or radiograph such that each region contains only a single toot. There are many different ways to perform image segmentation, including:

1. Thresholding Methods such as Ostu's method.

2. Transform Methods such as watershed segmentation.

3. Texture Methods such as Texture Filters.

6.4. Feature Extraction

Feature Extraction is a type of Dimensionally reduction that efficiently represents interesting parts of an image as a feature vector. This is technique is used when image size are large and reduced feature representation is required to complete tasks such as image matching. In this step we extract useful features of teeth so that it helps in matching and classification.

6.5. Matching

After doing all the previous process such as pre-processing, image enhancement, segmentation, feature extraction the last step is to complete our target is matching of image. For matching we have to develop an algorithm based on properties applied and image features and developed distance matching. Accurate matching leads good identification which is our desired goal.

7. Expected Results

We expect that our Dental Biometric system is able to Identify Person Based on their Dental records. We use various Techniques and Methodology in our system so that it can identify person more precisely and accurately. In previous system of Dental Biometrics for Human identification Various

Technique is used so our task is to use previous methods and Techniques and adding new Techniques to make our system more Effective.

8. Conclusion and Future work

Dental biometrics is not only used for identification of person but it is act as a confirmatory tool. It is used in forensic identification of human as well as disaster victim classification. Among other Biometric Methods for Identifying Human, Dental based Identification (DENTAL BIOMETRIC) gives better results in various conditions where person body parts were Damage. With the help of above research in this area, we can make an effective Dental Biometric System with efficient and time saving methods with accurate Results. Our main Challenge and Future work in Dental Biometric system for human Identification is to deal with poor quality of images, Teeth overlap, teeth shape change consideration due to ageing.

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