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A Review of Dental Biometrics from Teeth Feature Extraction and Matching Techniques

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Abstract: ***Biometric is a tool of identification that has been broadly used in many applications. A biometric identification system is based on physical characteristic. Dental biometrics has emerged as vital biometric information of human being on account of its stability, invariant nature and uniqueness. It utilizes dental photograph and dental radiograph for human identification because it provides information about teeth including tooth contour, relative position of neighboring teeth and shapes of dental work like crown, fillings and bridges. A biometric identification system is based on physical characteristics such as face, fingerprint, palmprint, fingerprint, eyes (iris, retina) and DNA. However, many of those characteristics are only suitable for ante mortem identification when a person to be identified is still alive. They cannot be used for post mortem identification especially in such cases of decay or severe body damage caused by fire or collision, due to this dental biometrics plays an important role in human identification and post mortem identification. These papers address review of such different techniques used in dental biometrics.***

Keywords: Dental radiograph, Dental photograph, Dental Biometrics etc

1. Introduction

Most of the applications of digital image processing that we have witnessed in the last two decades are in the areas of biometric and biomedical image processing. The human vision system comes across a large set of biometric features and biomedical images and recognizes them without any conscious effort. To impart this capability to a machine is, however, difficult. The biometric identification systems are useful in several applications such as commercial and law enforcement applications, especially in criminal identification, security system, videophone, credit card verification, photo IDs for personal identification, etc. Recognition of human faces, fingerprints, signatures, and many other such biometric images constitute an important area of research in the field of computer vision. Similarly there are different types of biomedical non-evasive imaging modalities such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound images, and many others, which are used in the medical field for disease diagnosis and treatment planning. These imaging modalities reflect the state of the internal anatomy and dynamic body functions. It is important to understand the principal imaging modalities and the processing techniques to enhance, filter, segment, and interpret such images.

Teeth are parts of human organ that are not easily decayed, located inside mouth and thus they are more protected from decaying after human's death or major accident. Therefore, teeth based identification is one of reliable tools for human identification. On average, human has 32 teeth; each tooth has five surfaces, meaning that inside a mouth there are 160 tooth surfaces with various conditions. If we use dental features as a tool of identification, manual matching of based on teeth appearance needs a large amount of time and some expertise, therefore computer aided for an identification system is needed. Teeth of a human being have its own characteristics based on a number of distinctive features for each individual tooth. These features include properties of the teeth e.g. tooth present or not present, crown and root morphology, pathology, and dental restorations, periodontal tissue features and anatomical features. During the feature extraction certain salient information of teeth such as contour, artificial prosthesis, number of cupids etc is extracted from radiograph and photograph. In this work the feature extracted is tooth contour because they remains more invariant over time compared to some other features of teeth and this thing plays important role in PM identification and Dental biometric also.

1.1 Dental Photograph

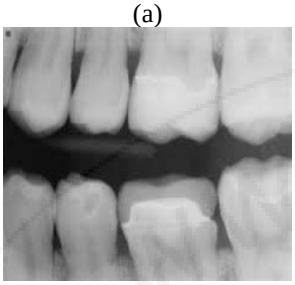
Dental photograph is a pictorial view of teeth structure and its appearance; it gives relative position of neighboring teeth and shapes of dental work. It can be taken by any digital camera by stretching upper and lower lips as shown in fig

Figure 1.1: Dental photograph

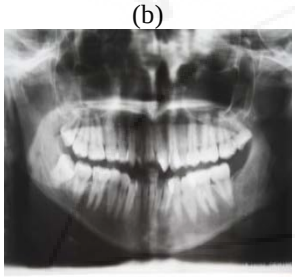
1.2 Dental radiograph

Dental radiograph is an intra or oral image that is taken using X-ray radiation. Dental radiograph consists of teeth using X-ray radiation. Dental radiograph consists of teeth, bones and surrounding soft tissues. There are three types of dental radiograph that is commonly used in dentistry that are periapical, bitewing and panoramic as shown in fig 1.2 (a) (b) (c).

(a)



(b)



(c)

Figure 1.2: (a) Periapical radiograph (b) Bitewing radiograph (c) Panoramic radiograph

2. Literature Review

Many authors explored the feature extraction and matching techniques based on dental radiograph and photograph in dental biometric. Hong Chen and Anil K. Jain proposed feature extraction and matching in which the feature extraction stage uses anisotropic diffusion to enhance the images and a Mixture of Gaussians model to segment the dental work. The matching stage has three sequential steps: tooth-level matching, computation of image distances, and subject identification [1]. Vijaykumari Pushparaj, Ulagnathan Gurunathan, Banumathi Arumugam uses contour and skeleton-based shape extraction as well as matching algorithm for dental images.An active contour model with selective binary and Gaussian filtering regularised level set method is used for contour extraction. Shape matching is done by both contour and skeleton-based approaches [2].

Eyad Haj Said, Diaa Eldin M. Nassar and Gamal Fahmy propoed segmentation in digitized dental X-Ray films using mathematical morphologyin whitch they uses a grayscale contrast stretching transformation to improve the performance of teeth segmentation[3]. Anny Yuniarti, Anindhita Sigit Nugroho, Bilqis Amaliah, Agus Zainal Arifin perform a work on Classification and Numbering of Dental Radiographs for an Automated Human Identification System in this they uses classification process which aims to classify the extracted tooth into molar or premolar using the binary support vector machine method. After that, a numbering process is executed in accordance with molar and premolar pattern obtained in the previous process [4].

Dental classification is introduce byMartin L. Tangel, Chastine Fatichah, Fei Yan and Kaoru Hirota for periapical radiograph based on multiple fuzzy attribute, where each tooth is analyzed based on multiple criteria such as area/perimeter ratio and width/height ratio. A classification method on special type of dental image called periapical radiograph is studied and classification is done without speculative classification (in case of ambiguous object), therefore an accurate and assistive result can be obtained due to its capability to handle ambiguous tooth[5].

Dental biometrics as human personal identifier using pixel neighborhood segmentation techniques is introduce by Sunita Sood, Rnaju Kanwar and Malika Singh it shows the dental unique feature set that may be used for claiming of the human personal identity using dental radiograph (x-ray graph)[7].

Elizabeth Bonsaglia Barboza, Aparecido Nilceu Marana and Denise Tostes Oliveira proposed graph-based segmentation algorithm and teeth shapes features in this work they propose the use of a graph-based algorithm to extract the teeth contours from panoramic dental radiographs that are used as dental features [10]. Maja Omanovic and Jeff J. proposed exhaustive matching of dental X-rays for human forensic identification in this they utilize an automated scoring and ranking method that can be used to augment other text-based method [12].In this overall review study of dental biometrics, mostly radiographs are used as biometric tool as compare to photograph as it retrieve more information of teeth.

3. Comparative Analysis

In this section, we are analyzed different techniques with their methods, algorithm, parameter and advantages which are listed in below table

Table 1: Comparative analysis of different techniques

S.No	*Method used*	*Algorithm*	*Parameter*	*Advantages*
1	Aligment and matching	Shape registration	Tooth contour	It gives totally automatic method for matching of dental radiograph
2	Shape extraction and matching	SBGFRLS algorithm	Tooth shape	It is helpfull in missing tooth identification cases in forensic.
3	Semiaomatic contour extraction	Integral projection	Crown and root contour	It is feasible approach for large database.
4	Automated dental image recognition	Hierarchical chamfer distance	Shape and contour	It speed up computational time and reducing search space
5	Feature extraction and matching	Scale invarient feature transform	Contour, shape and edgedistance	It gives better matching and applicable for large database

4. Conclusion

In this paper, we review a role of dental images in human identification and different techniques used in dental biometrics. We make comparative analysis of various methods from this we conclude that most of the system used dental radiograph only, while some uses both dental photograph and radiograph in which dental radiograph utilize crown and root contour while dental photograph utilize shape and appearance of teeth structure. From this study we found that radiograph is more feasible and retrieved more information for feature extraction as compare to photograph. Dental biometric is applicable in some critical situation like mass disaster, bomb blast, air crash, major fire accident or flood where there is inaccessibility of other biometric like face, fingerprint, palmprint, fingerprint, eyes (iris, retina) and DNA. It is also used in postmortem identification used in forensic lab. There are different new techniques still problem for poor quality and blur images; this will be improve in future work.

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