Matching Of Dental Panoramic Radiographs Based On The Dental Work Information

Aqsa Ajaz[1], Kathirvelu.D[2]
Department of Biomedical Engineering
SRM UNIVERSITY, Kattankulathur-603203

Abstract

"Biometrics" means "life measurement" and the term is usually associated with the use of unique physiological characteristics to identify or verify an individual. Dental biometrics is the technology used in forensic dentistry to identify persons based on their dental radiographs. Dental features have been widely used for identification purpose. The paper presents a method for human identification based on the dental work information (crowns, fillings, bridges). The proposed method works with three main processing stages: feature extraction (segmentation) of dental work. The segmentation is carried out using mathematical morphological operations. Creation of dental code based on the features extracted in the segmentation process. Matching stage is performed by comparing a dental code with other dental code stored in the database i.e., the distance between the neighbouring dental work and the angle at which they are aligned. The method was tested on a database having 50 dental radiographs. In 90% of the identification trails our method gave the accurate results. These experiments validate matching of dental panoramic radiographs using the dental codes as a viable method for human identification.

1. Introduction

Biometrics is a science that deals with identification and verification of individual based on their physical and behaviour characteristics. It is derived from the Greek words "bios" for life and "metron" for to measure [1]. Biometrics is an automated method for recognition of a person. The commonly measured features are: face, fingerprint,hand geometry, handwriting, retina, iris, vein and voice [2]. Biometrics based solution finds a wide variety of applications in network security, military, law enforcement and health care. Dental biometrics is the technology used in forensic medicine (forensic dentistry) for identification of individual by matching their post-mortem radiographs (acquired after the person is deceased), with the ante-mortem radiographs (acquired before the person is deceased) in a database, but can be also used to match between two ante-mortem and post-mortem radiographs. In some situations like (plane crashes, fire accidents and natural calamities) it is not possible to identify an individual using the common methods like face, fingerprint recognition. In such cases dental biometrics prove an important method for human identification as the dental works (bridges, fillings and implant) can withstand the high temperature and force and also posses good biometric properties.

Jain and Chen proposed a biometric system for semiautomatic processing and matching of dental images for human identification. The method was used to extract shapes of teeth from the AM (ante-mortem) and (post-mortem) radiographs, and find the affine transform that best fits the shapes in PM images to those in AM images[3]. In Chen and Jain proposed a method for alignment and matching of dental radiographs. The method utilizes the information about the teeth contours and dental work for identification. The extraction of teeth contours was done using active contour models [4].Koichi and Nikaido developed an efficient dental radiograph registration algorithm using phase based image matching for human identification [5]. Omanovic and Jeff proposed an automated scoring and ranking method for human identification using the sum of squared differences (SSD) cost function [6]. Marana and Hofer proposed a method for human identification using the dental work information. The distance between the DWs is used for matching [7].

In this paper, our aim is to automate the process of human identification by matching of the dental panoramic radiographs (DPRs) based on the dental work (DWs) information. The algorithm performs the matching of the radiographs (DPRs) using a dental code, which includes the information about the distance between the neighbouring DWs and the angle at which these DWs are aligned.

2. Materials and Methods

The radiographs used for the proposed method were panoramic in nature, and were collected from a dental hospital during a free dental check-up camp, which was held twice a year. The method was implemented in MATLAB and tested on a database having 50 radiographs. Each subject dental record consists of 2 or more radiographs. The radiographs taken were from the Kodak 800C machine and saved in JPEG format for further processing.

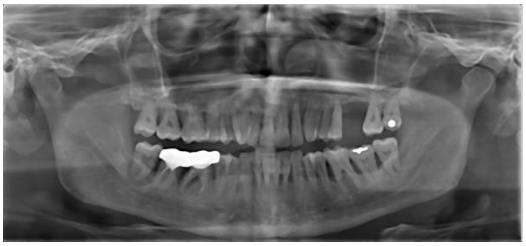
The proposed method for human identification based on the dental work information involves image enhancement followed by three main processing steps:

1) Feature Extraction (Segmentation) of the DWs.
2) Creation of a "dental code" (DC) out of the information of the detected DWs.
3) Matching of the dental panoramic radiographs based on the DC.

2.1. Image Enhancement

The DPR (RGB image) is first converted into a gray scale image. The digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that block the true intensities of an image. To reduce the noise variations in the image a median filter of size [15 15] is applied. Median filtering therefore removes the noise while maintaining the sharpness of the image (see Figure 1).

(a)



(b)

Figure 1. DPRs of the same person (a) Input image, (b) Median filtered image.

2.2. Feature Extraction

The dental work, which appears as bright regions (having high intensity) in the dental panoramic radiograph, is a salient feature for human identification. The dental work includes crowns, fillings and bridges. The segmentation of the dental work is done using mathematical morphological operations followed by thresholding.

After reducing the noise using median filter various morphological operations are performed on the image, the threshold value is set to a definite level which indicates the DWs. The threshold is used to binarized the gray value image. The conversion outputs an image having all the detected DWs (see Figure 2).

Figure 2. Segmented image showing the DWs

2.3. Creation of a dental code (DC)

Based on the above dental work, a dental code is created. This DC incorporates all the information about the center of mass of DWs, the distance between the neighbouring DWs and the angle at which they are aligned.

2.3.1. Center of mass of DWs.

As the intensity within the DWs vary it is very important to locate the center of mass of these DWs. This center of mass will act as a reference point for the calculation of distance and angle. An algorithm was implemented to sort all the DWs in the DPR from left to right and then locate the center of mass within each DW (see Figure 2.3.1).

Figure 2.3.1. Center of mass of the DWs.

2.3.2. Distance between the neighbouring DWs.

For matching of the DPR, the distance between the neighbouring DWs is taken into account. After determining the center of mass of DWs, it is used for the distance measurement. Distance is defined as the amount of pixels between the center of mass points of two DWs. An algorithm was implemented in MATLAB for distance calculation based on the Euclidean distance (Pythagoras theorem) (see Figure 2.3.2.).

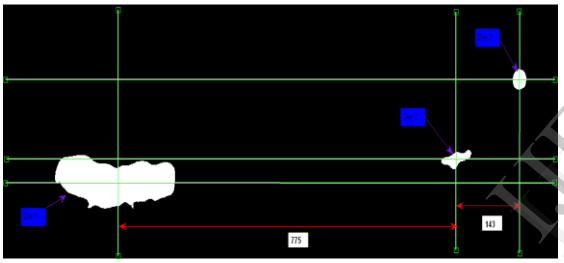


Figure 2.3.2. Distance between the neighbouring DWs.

2.3.3. Angle between the neighbouring DWs.

In order to make the matching process more sensitive, also the angle at which the DWs are aligned is included in the DC. The center of mass between the two neighbouring DWs is used for angle calculation. An algorithm was implemented in MATLAB for the angle calculation; the angle calculated is measured in degrees (see Figure 2.3.3.).

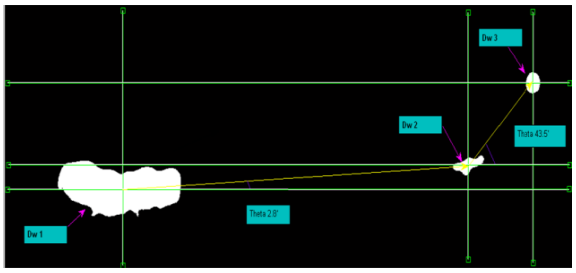


Figure 2.3.3. Angle between the neighbouring DWs.

2.3. Matching

After the DC is created, it is compared to the DCs in the database. The DC includes the information about the distance between the neighbouring DWs and the angle at which they are aligned. An algorithm was implemented in MATLAB that uses the DCs for matching. First the distance between the various DWs is matched with the database image .If the compared distances exceed the tolerance limit (±5), the output is set to not matched. In the other case if the distance lies within the tolerance limit, the matching of DCs based on the angle is performed. If the angle at which DWs are aligned in the query image resembles the database image, the output is said to perfectly match.

3. Results

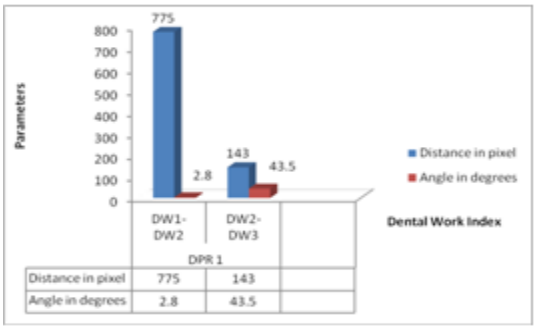
A database including 50 DPRs was used to evaluate the proposed identification system. It includes a pair of DPRs for 10 subjects (20 DPRs) and single DPRs for the other 15 subjects were used. For the 10 subjects with two radiographs, their oldest DPRs were considered as AM (ante-mortem) radiographs and their newest DPRs were considered as PM (post-mortem) radiographs. For the remaining subjects having one radiograph, the DPRs were considered as AM radiographs. Image enhancement operators were applied on the DPRs to improve their quality and to reduce the noise variations. The mathematical morphological operations followed by thresholding were used for the segmentation of DWs. In case of over-segmentation or under-segmentation, the algorithm needs to be altered for the threshold value. Matching of the DPRs for human identification purpose was done comparing the DCs, which includes the information about the distance between the neighbouring DWs and the angle at which the DWs are aligned.

Experiments were carried out, in which the query image was compared to the database images based on their DCs. The results showed those DPRs in the databases that have: no of DWs, the distance between neighbouring DWs and the angle at which they are aligned similar to the query image gave a true output; else a false output was given.

The figure shows the histogram chart obtained when the DPRs of imposter class (radiographs

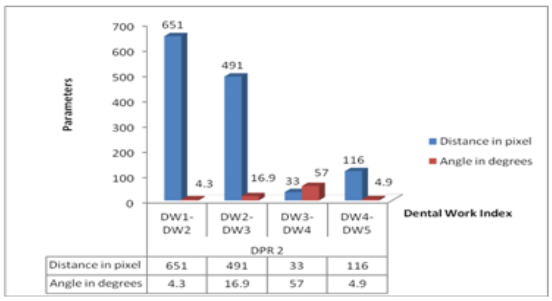
belonging to different persons) were matched based on their DC (see Figure 3.).

(a)



(a1)

(b)



(b1)

Figure 3. DPRs of the different person (a) DPR of subject 1. (a1) Histogram based on the DC of subject 1.(b)DPR of subject 2. (b1)Histogram based on the DC of subject 2.

It is clear from the above histograms that the DPRs are not belonging to the same person as there are variations in the DWs, the distance between the neighbouring DWs and the angle at which the DWs are aligned .

4. Conclusion

This work presents a computer aided, dental biometric identification method based on the dental work information extracted from the dental panoramic radiographs. The calculation of the distance between the neighbouring dental works followed by the angle at which the dental works are aligned to make the matching algorithm more robust. For the database used in the experiments, the results were good, though only the dental work information is considered by the method.

References

[1] National Science and Technology Council (NSTC) Subcommittee on Biometrics. "Introduction to Biometrics."Internet: http://www.biometrics.gov/,{May 14, [2007].

[2] Biometric Consortium "An Introduction to Biometrics" Internet: http://www.biometrics.org/,[2003].

[3] Hong Chen, Jain Dental Biometrics: "Human Identification Using Dental Radiograph" AVBPA Guildford, UK, [June 9-11, 2003] .

[4] Anil K. Jain and Hong Chen "Matching of Dental X-ray images for Human Identification". Pattern Recognition - The Journal of the pattern recognition society, 37:1519 – 1532. [2003].

[5] Nikaido, Koichi "A Phase-Based Image Registration Algorithm for Dental Radiograph Identification": Image Processing, IEEE International Conference - ICIP, vol. 6, pp. 229-232, [2007].

[6] Omanovic and Jeff "Exhaustive Matching of Dental X-rays for Human Forensic Identification" Journal of the Canadian Society of Forensic Science, 41 (3), [2008]

[7] Marana, Hofer Dental Biometrics "Human Identification based on Dental work Information" eHealth Wien, 29. -30. [May 2008].