An Automated Tool of Human Identification System using Dental Biometrics

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Abstract—**This paper presents a Dental Based Security System (DBSS), proves to be an equivalent alternative to the Thumb Impression Based Security System (TIBSS) for identifying the persons. The Human Identification System using Dental Biometrics (ATHISDB) enable content-based retrieval of antemortem (AM) images from the database by comparing the similarity of teeth to postmortem (PM) images. During storage, the system classifies the dental image to upper periapical and lower periapical views using horizontal and vertical edges. It then segments the teeth and the bones in the periapical view images, using statistical and geometrical calculations, given as an input to the neural networks stored in the database for comparison with postmortem images. Experiments on a small database show that our method is effective for dental image classification and teeth segmentation, provides good results for feature extraction, and acts as a good tool for human identification.**

Keywords - Smoothing, Classification, Segmentation, Feature Extraction and Neural Networks.

I. INTRODUCTION

Forensic dentistry is one of the most rapidly developing branches of forensic medicine and forensic science. This is mainly due to the immense importance of dental evidence in the identification of victims of mass disaster, abuse or organized crimes. A comprehensive understanding of this science is absolutely necessary for the pedodontists as they are often the first one to deal with children. They can play a valuable role by helping the forensic experts in identifying the affected victim or criminal and thereby contribute significantly in supporting and strengthening families to enable them to care for children more adequately and the society to develop sensitivity and skills for respectful and healthy personal relationship. Thus, a Pedodontist can play a vital role in protecting the human rights of children. [11]

A. Forensic Odontology

The branch of the dentistry which, in the interest of the law, deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of such evidence in the case Dental Fraud, Bite Marks Evidence, Dental Records, Age Determination, Mass Disaster. [2]

From the radiography of a dental image has to be smoothened using the nine methods reduce the amount of intensity variation between one pixel and the next. It is often used to reduce noise in the images. The Laplacian is often applied to an image that has first been smoothed with Gaussian smoothing filter in order to reduce its sensitivity to noise. The operator normally takes a single gray level image as input and produces another gray level image as output. The enhanced image will be classified based on the edge detection into two views as Upper Periapical and Lower Periapical using horizontal and vertical edges.

The classified is segmented using threshold technique and feature extracted for moment calculation, given as an weighted input to the neural networks for training and testing the images and stored the trained and tested values in the database with the help of index and label.

From the dental chart with different views of teeth, match the several teeth simultaneously, in the Antemortem (AM) and Postmortem (PM) images. The relative pixel values of training and testing of the teeth with respect to each other should rule out the inherent ambiguities that arise when one tooth at a time is matched, irrespective of the other teeth. [10]

II. THE METHODOLOGIES

First, classification is dealt in section 3 to identify the view, section 4 deals with segmented image using statistical and geometrical calculations, section 5 deals with Feature Extraction, section 6 deals with Construction of Neural Model, section 7 deals with Shape Registration, section 8 deals with Results and Conclusion, section 9 deals with the Evaluation, section 10 explains about the Results of Comparative Analysis. Section 11 described with future enhancements, and section 12 deals with the references.

III. IMAGE CLASSIFICATION

Image Classification deals with classifying the image into upper periapical and lower periapical views using horizontal and vertical edges.Where w=the transpose of a matrix to have vertical edges and vice versa. As specified in the system architecture of Dental Biometrics System (DBS), the horizontal and vertical edges will be given as an input to the Section 4 from the Image Classification.

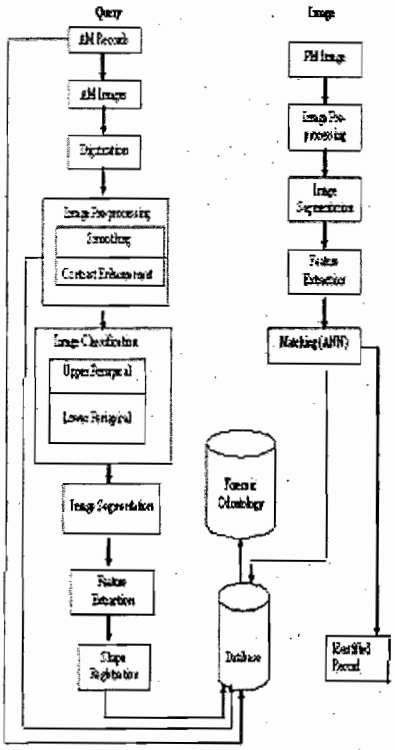

Figure 1: System Architecture.

IV. IMAGE SEGMENTATION

The Section 4 deals with the Image Segmentation where isolated objects in the image from the background will partition the images into disjoint regions.

Input Given to the Module
The input of the module is "Gray Scale Image".

Process
The image segmentation is the process of isolating objects in the image from the background that is partitioning the images into disjoint regions, such that each region is homogeneous.

Output
The result of the module is "Contrast Enabled Image".

Description
This module occupies the fourth level among various modules dealing with the project. A threshold concept is used to make 1's and 0's to represent the pixels of an image. The pixel values of the radiographic image are obtained. The total number of pixel in the Image is calculated.

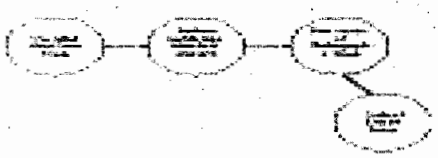

Figure 2: DFD for Image Segmentation

V. FEATURE EXTRACTION

The Section 5 deals with the Feature Extraction discussing about the Geometrical and Statistical Calculations as Mean, STD, etc.,

Input Given to the Module
The input of the module is "Contrast Enabled Image".

Process
The function of the module is to calculate the invariant moments, mean, standard deviation and variance of contrast enabled image.

Output
The result of the module is "Feature Vector".

Description

This module occupies the fifth level among various modules dealing with the project. In the feature extraction level, the system will separate the final teeth contours from the active contours, into defective area. Basically, moments for finding the accuracy, sharpness, etc..,

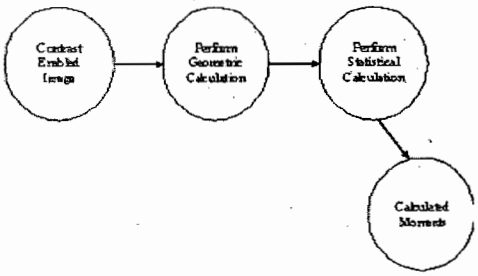

Figure 3: DFD for Feature Extraction.

VI .CONSTRUCTION OF NEURAL MODEL

The Section 6 discusses about the Construction of Neural Model (Back Propagation and Self Organizing Fuzzy Means Algorithms) Neural Network Model deals with the Back Propagation and Self Organizing Fuzzy Means Algorithms.

Input Given to the Module
The input of the module is Moments, Values / Weighting Factor for the radiographic image".

Process
The function of the module is to train and test the Moment Values for Index Calculation.

Output
The result of the module is "Trained and Tested Value / Segmented Image".

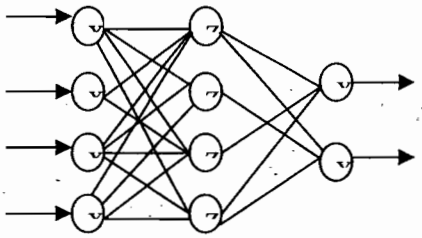

Figure 4. Sample Neural Network

Description

This module occupies the sixth level among various modules dealing with the project. This neural model, which consists of, an input layer of nodes with one node for each feature vector, a hidden layer, and an output layer with one node. Each computational node uses the sigmoid function. The network weights were found by the back propagation and self organizing fuzzy means algorithms.

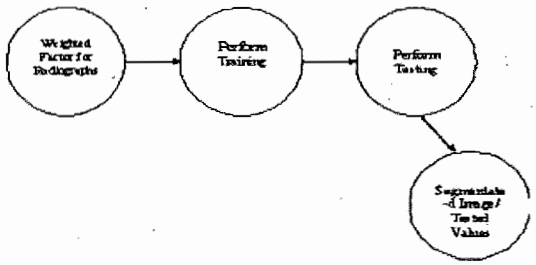

Figure 5: DFD for Neural Model Construction.

VII. SHAPE REGISTRATION

The Section 7 discuss about the Shape Registration (Index Storage) which deals with the storage of Index for the Images.

Input Given to the Module
The input of the module is "Feature Vector".

Process
The function of the module is to give moments as an input for the neural networks in the form of weighted Network following supervised approach which are stored in database for further comparison.

Output
The result of the module is "Indexed Images".

Description

This module occupies the seventh level among various among various modules dealing with the project. It deals with storing the different index values for a single image in the Database.

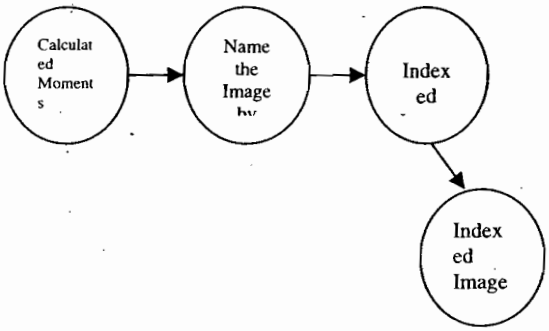

Figure 6: DFD for Shape Registration

VIII. RESULTS AND CONCLUSION

A. Unit Testing

Unit Testing is the process of testing the smallest components in the total system before they are put together to form a software whole. In this project, invariant moments has been calculated which will be given for training and testing in Neural Networks.

TABLE NO.1 UNIT TESTING

Method	M1	M2	M5	M6	M7	MEAN	STD.	VAR.
Training	0.086	0.099	0.009	0.009	0.009	0.007	0.006	0.100
Testing	0.099	0.007	0.009	0.007	0.086	0.007	0.099	0.009

The Table No. 1 gives the trained and tested values of similar type of images where the threshold value lies between (>0 & < 1).

B. Sample Pseudo code

Pseudo code for Neural Networks (Back propagation): Back Propagation Neural Network

STEP 1: Initialize weights to small random values.
STEP 2: For Loop
Set activation of input, Xi
STEP 3: For Loop
Calculate the hidden unit. Zj
STEP 4: For Loop
Activation function to
calculate the output signal. Yk

IX .EVALUATION

In evaluation process, using the following modules, Image Pre-Processing, Image Classification, Image Segmentation, Feature Extraction and shape Registration. The image index is approximate to the pool of image indexes existing in the database, **s = (1/n sum i=1 to n (xi-x bar) ^{2}) ^{½}** The standard deviation's' of a data vector X where x bar=1/n sum i=1 to n * x^i and n is the number of elements in the sample. The two forms of the equation differ only in n-1 versus n in the divisor.

Description: s = std(X), where X is a vector, returns the standard deviation using (1) above. If X is a random sample of data from a normal distribution, s^2 is the best unbiased estimate of its variance. If X is a matrix, std(X) returns a row vector 1, std(X, 1) returns the standard deviation using above, producing the second moment of the sample about its mean.

s = STD(X, flag, dim) computes the standard deviations along the dimension of X specified by scalar dim.

X. COMPARATIVE ANALYSIS OF NEURAL NETWORKS WITH OTHER MATCHING ALGORITHM

TABLE NO. 2 COMPARATIVE ANALYSES

Numberof Comparisons	Back Propagation and Self Organizing Fuzzy Means Algorithms	Hausdroff Distance Measure Algorithm
01	Values are trained and tested	Not possible
02	Slight change in the pixel value won't affect for Comparison	Slight change in the pixel value will affect for Comparison

The table no. 2 refers to the change in the pixel value will affect for the further future comparison, using Hausdorff Distance Measure Algorithm [12] but not happens in the case of Back Propagation and Self Organizing Fuzzy Means Algorithms. Neural networks [13] and conventional algorithmic computers are not in competition but complement each other. There are tasks are more suited to an algorithmic approach like arithmetic operations and tasks

that are more suited to neural networks. Even more, a large number of tasks, require systems that use a combination of the two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.[9]

"Neural networks do not perform miracles. But if used sensibly they can produce some amazing results".

XI. FUTURE ENHANCEMENT

In the future enhancement, the Human Identification System for Dental Biometrics (ATHISDB) system can be embedded in a chip. So that, when the child gets the teeth, then this chip can be fixed along with the tooth which contains the full details of that child. This type of system can help the forensic odontology to carry out the deceased person's case easily. In the future days, User will be able to reposition any tooth to match the patient's true condition. Includes impactions, tipping, and drifting. If a primary tooth is present, the permanent tooth will show underneath it, just like it is in real life. All dimensions will be in precise millimeters. This will facilitate period probing and recession features to be added.

The future work will focus on increasing the feature vectors parameters to be able to sustain the high accuracy of the proposed systems with larger dental database. And an e-based automated tool of human identification system using dental biometrics feature extraction using neural networks can be carried out. Also, using a real postmortem (PM) radiographs will be important to complete testing the system.

XII.CONCLUSION

Human Identification System for Dental Biometrics (ATHISDB) system is used to identify individuals in the forensic domain. In this project, an approach that enhances the poor contrast of dental radiology was implemented based on neural network training and testing methods. Extracting one tooth from a set of teeth becomes easier to be used in the matching between dental images. A useful image moment calculation neural networks (NN) overcomes the problem of different viewing angle of the dental radiology. A systematic tooth feature extraction method (Back Propagation) is proposed in this project to reduce the number of errors by epochs, if seven moments, mean and standard deviation is considered. Still, more moments are to be trained and tested to minimize the errors for large databases which will be helpful for the department of forensic odontology.

XIII.REFERENCES

[1]A.K. Jain, H. Chen, Matching of Dental X-ray Images for Human Identification, Pattern Recognition, pp. 1519-1532, July 2004.

[2]A. K. Jain, H. Chen and S. Minut, "Dental Biometrics: Human Identification Using Dental Radiographs", Pattern Recognition, pp. 429-437, Guildford, UK, June 9-11, 2003.

[3]Diaa Eldin M. Nassar, Hany H. Ammar, "A Prototype Automatic Dental Identification System ", March 2003 .

[4] Diaa Eldin Nassar, Eyad Haj-SAid, Gamal Fahmy, Robert Howel, and Dr. Hany H Ammar, Challenges of developing an Automated Dental Identification Systems ", January 2003.

[5]EyadHaj Said, Gamal Fahmy, Diaa Nassar, and Hany Ammar, Dental X-ray ImageSegmentation, December 2002.

[6].Gamal Fahmy, Diaa Eldin M. Nassar, Eyad Haj-Said, Hong Chen, Omima Nomir, Jindan Zhou, Robert Howell, Hany H. Ammar, Mohamed Abdel-Mottaleb and Anil K. Jain, Automated Dental Identification System (ADIS), December 2003.

[7].Hong Chen and Anil K. Jain, Dental Biometrics: Alignment and Matching of Dental Radiographs, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 27, No. 8, August 2005.

[8].Hong Chen and Anil K. Jain, Tooth Contour Extraction for Matching Dental Radiographs, January 2003.

[9].Hany H. Ammar, Diaa Eldin M. Nassar, "A Neural Network System for Dental Radiograph Comparison". In the proceedings of the 2nd. IEEE International Symposium on Signal Processing and Information Technology (ISSPIT), Marrakesh - Morocco, December 2002.

[10].Jindan Zhou, Mohamed Abdel-Mottaleb, A content-based system for human identification based on bitewing dental X-ray images,Pattern Recognition 38 (2005) 2132 – 2142, 4 January 2005.

[11].Mohammad Hossein Mahoor and Mohamed Abdel-Mottaleb, Automatic Classification of Teeth in Bitewing Dental Images, International Conference on Image Processing (ICIP), 2004.
[12].Sang-Cheol Parka, Sung-Hoon Lima, Bong-Kee Sinb, Seong-Whan Lee, Tracking non-rigid objects using probabilistic Hausdorff distance matching,Pattern Recognition 38 (2005) 2373 – 2384, Januray 2005.
[13].T. M. Nazmy, F. M. Nabil, D. A. Salam, H. M. Samy., Dental Radiographs Matching Using Morphological and PCNN Approach, Ain shams university, Cairo, Abbasia, Cairo Egypt, 19-21 December 2005.