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A STATE OF ART AUTOMATED DENTAL IDENTIFICATION SYSTEM (ADIS)

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Abstract- This paper address review of new methodologies for postmortem Identification Using dental records that means the Automated Dental Identification System (ADIS) can be used by Law enforcement agencies to locate missing persons also to identify Victims in Mass disasters (e.g. earthquakes, Tsunami, airplane Crash etc.) Using databases of dental X-rays. In PM identification, forensic odontologists rely mainly on dental radiographs, among other types of records (e.g., oral photographs, denture models, and CAT scans) to compare the morphology of dental restorations of unidentified individuals to choose those of candidates in the missing persons file. This paper reviews the new methods & techniques in which Identification is carried out by Comparing post Mortem (PM) images with Ante mortem (AM) dental records of missing people to find similar records.
Key words- forensic odontology, radiographs, Post Mortem Identification (PM), Ante mortem (AM) Identification, Multi-slice computed Tomography (MSCT), Chamfer Distance matching.

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Introduction

Recent disasters have highlighted the Significance of automated dental identification System. For example many of the Victims of 9/11 were identified based on information contained in pieces of their jaw bones. Forensic experts using dental records identified around 20 % of the 973 victims whose identification was determined in the First year the attack. Identifying all 2,749 victims of 9/11 disaster [1] took around 40 months. The number of Asian tsunami victims identified during First 9 months was 2200 and most of these 2200 victims were identified based on dental information using dental records, compared to just 0.5% using DNA) [2].

Law enforcement agencies have exploited biometric identifiers for decades as a means of Forensic identification. With the huge volume of cases that need to be investigated by Forensic specialists and the evolution in information technology, it has become important to automate forensic identification System. In 1997, the Criminal Justice Information Services Division (CJIS) of the FBI created a dental task force (DTF) whose goal is to improve the utilization and effectiveness of the National Crime Information Center (NCIC) missing unidentified persons files. The DTF recommended the creation of a Digital Image Repository (DIR) and automated dental identification system (ADIS) with goals and objective similar to automated fingerprint identification system (AFIS) but using dental characteristics instead of fingerprints [3].

As Post mortem (PM) Identification methods includes 1) Dental Comparisons 2) Comparisons of Finger Prints, palm prints, or foot prints; 3) DNA identification 4) Radiographic Superimpositions. Under severe circumstances, Such as those encountered in high energy mass disasters (e.g. airplane crashers, Tsunami, hurricanes etc.) or if identification being attempted more than a couple of weeks after death most physiological biometrics (e.g. Fingerprints) do not qualify as basis for identification; as soft tissues of the human body would have decayed to Unidentifiable status

therefore, a PM biometric identifier must outlive the early at death has been shown to last, in Some cases for centuries that is why dental features are the best candidates (records) for biometric PM Identification.

ADIS is a process automation tool, For PM Identification that is being designed to achieve accurate and timely identification results with minimum amount of human intervention. Next in this paper we see some new techniques using different methodology for ADIS and their comparative Analysis.

Different methodologies used in ADIS

Retrieving Dental Radiographs for post mortem Identification.

In this methodology [4] ADIS is composed of three main components.

- Dental Records Processing Component, which involves several segmentation & Classification, steps in order to isolate each tooth & determine their class.
- The search & Retrieval component managers the archiving, searching & retrieval of dental matches in order to produce a candidate list of matches. The desirable features of this stage are speed and accuracy.
- The Image comparison Component registers of compares two sets of dental records and is used during the search process.

Potential Search Matching Component:

This component extract the high level dental features and stores it in the DIR, and then it retrieves a list of candidate images for every subject image. In extracting high level features there are two methodologies adopted in ADIS. The first one focuses more on contour of roots and crowns. (i.e. shape), that are usually important periapical images. The Second methodology focuses on extracting the contour of each individual tooth in bite-using images (i.e. enhancement and bite using segmentation).

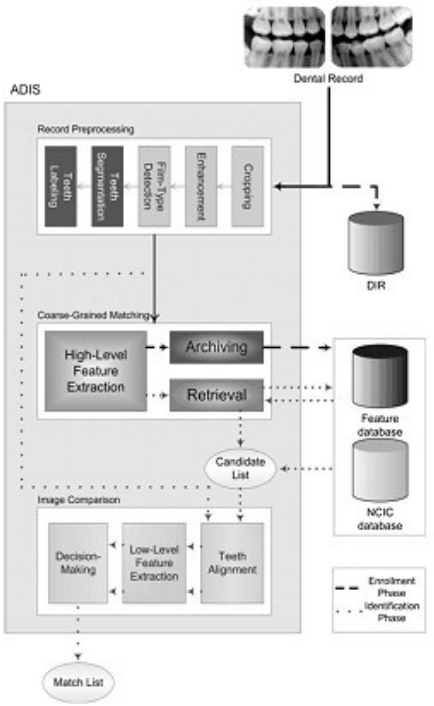

Fig.1- ADIS Block Diagram.

Image Comparison Matching Component:

In this component the radiograph images is processed through four main stages, enhancement, Segmentation, alignment and matching. While enhancement stage removes noise and enhance the quality of the radiograph images, the Segmentation stage automatically segments the dental image into rectangular regions where each region independent of orientation, scale and translation. These regions are then matched through a neural network based matcher.

Computer Aided PM Identification System CAPMI and Win ID:

These are most well known systems. However the dental codes used in this system are entirely based on characteristics of the dental work and not the inherent dental features.

The Computer assisted postmortem Identification (CAPMI) [5]. System was developed by the bioengineering branch of the US Army Institute of Dental Research CAPMI is the Computer Software program that compare between dental codes extracted from AM & PM dental records. The program generates a prioritized list of candidates based on the number of matching dental characteristics. This list guides forensic odontologist to reference records that have potential. Similarity with subject records. The odontologist then completes the identification procedure by Visual comparison of radiographs.

WinID [9, 10] is a Computer System that matches missing persons to unidentified persons using dental & Anthropometric characteristics to rank possible matches. Other Information on physical appearances, pathological findings and anthropologic finding can also be added to the database of WinID. The Dental codes used in WinID are extension of these used in the CAPMI. Matching using Dental Codes is shown in fig.2.

However none of these Systems provide the desired level of automation, as they require a significant amount of human Intervention. For example in both CAPMI and WinID feature extraction. Coding & Image comparison are carried out manually. Moreover dental codes used in these systems are entirely based on dental work. Hence CAPMI and WinID are more like sorting tools that help to cut down the time Forensic experts

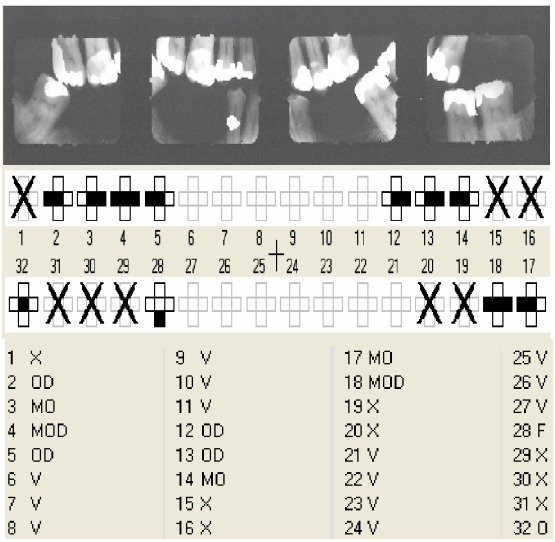

Fig. 2- Matching using Dental Codes

Automatic Construction of Dental Charts:
This methodology presented a dual-stage approach. For the automatic construction of dental charts using appearance based features and string matching. In which each segmented tooth (of a bitewing / periapical film) is independently classified based on teeth reconstruction in two / four image subspaces established using PCA [6].
The literature in this area has shown only shape-based techniques. Shape-based techniques need accurate feature (contours) extraction; also tooth Contour extraction is a very computational time-Consuming step. So having an appearance based technique that can solve the problem with the same performance in less than 7 % of the required processing time is a plus.
This technique is the first to classify teeth into four classes MPCI (i.e. Molar, premolar, Canine, Incisors). This enhances the subsequent labeling stage. They made use of film-type classification step. In bitewing Films, they reduced the four class problem to two. This enhances the initial classification performance for these films. Structure, class and Numbering system of teeth is shown in fig.3 and fig.4. Respectively.

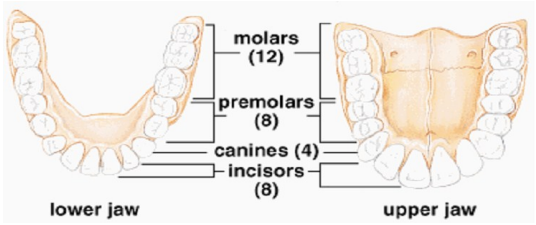

Fig. 3- structure and class of teeth

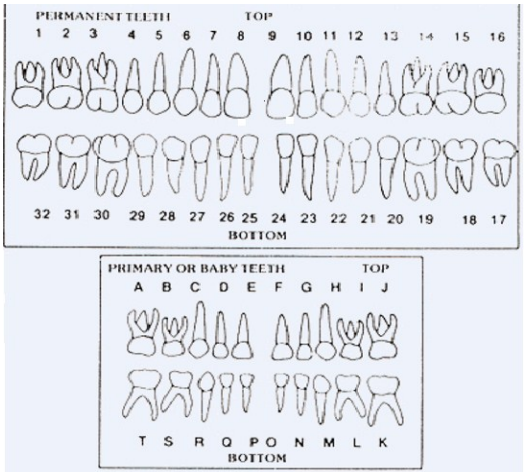

Fig. 4- Universal Numbering System of teeth

Hierarchical Dental X-Ray Radiograph Matching:
This methodology present new technique for dental X-Ray radiograph matching. The technique uses a hierarchical edge matching algorithm at different resolution. During Searching, Matching scores are features extracted from the AM and PM teeth [7].
This technique has two main stages: feature extraction & teeth matching. At feature extraction stage, the tooth's Contour is extracted and a distance map is built for each AM tooth in the database. At teeth matching stage given a PM query image, the distance calculated between the AM tooth distance map and PM tooth) contour at different resolution levels, so by using this hierarchical structure; the search space is reduced significantly as well as the computational load. This technique. Used the Chamfer matching Algorithm.

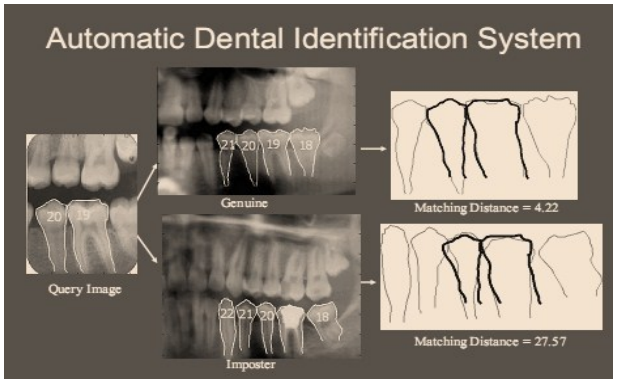

Fig. 5- Genuine image has smaller matching distance than imposter image. Image with smaller distance are included in candidate list.

Automated Dental Recognition in MSCT Images:
This methodology describes a multi-stage technique to classify teeth in Multi-slice computed Tomography (MSCT) images. The algorithm consists of three stages i.e. Segmentation, Feature extraction, and Classification [8].
The Segmentation of teeth based on previous experiences in feature extraction they introduced a multi-resolution method using wavelet - Fourier descriptor (WFD), they combined the benefits of multi-resolution representation and Fourier shape representation using wavelet Fourier Descriptors (WFDs). The Centroid distance based shape signature has been used for the derivation of descriptors.
WFD coefficients as feature vectors also used for classification. Teeth Classification is performed by a Conventional Supervised Classifier. For teeth identification they employ a feed forward neural network classifier with one hidden layer was trained by employing 50 % of teeth in the data set to discriminate different teeth from each other.

Comparative Analysis

Methodology type	Technique based on	Algorithm used	Test Data Set	Advantage
1.Retriving Dental Radiograph	Appearance Based	PCA	Teeth Contours	Reduced Dental Record Retrieval time
2.CAPMI & WinID	Dental Charactri--Stics	Comparing Dental Codes and Images	Dental Codes	Not fully automated but cut-down the time of Forensic Expert.
3.Automatic Construction of Dental Charts	Appearance Based & String Matching	Normaliza--tion , Eigen Values & LSE Classifier	Bitewing & Perapical Films	Work Fast & High Perform--ance.
4.Hierarchical dental x-ray radiograph	Feature & teeth matching	Hierarchical Chamfer distance	Bitewing Dental Image	Speed up computati--on by Reducing Search Space
5.Automated Dental Recognition in MSCT Images.	Classifi--cation of Teeth By Multistage Technique	Wavelet Fourier Descriptor (WFD)	MSCT Scan Images	Very High Classification Performance

Conclusion and Future Work

In this paper, we review different techniques of automated dental (ADIS). ADIS will be used by Law enforcement agencies for re-solving cases of missing and unidentified persons. We make a comparative study of some new techniques can be use for ADIS from which we can conclude that most of techniques improve computational speed as well as reduced the search space and increase classification performance rate. There is need to enlarg-ing the database of dental radiographs, combination of feature based approach and the appearance based approach.

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