International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:2682
Vol.2, No.10, October 2013 DOI:10.15693/ijaist/2012.v2i10.76-80

Detection of Dental Plaque using Image Processing

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Abstract -- Dental radiographic images still plays an important role in assisting dentists in doing their diagnosis. However uncertainty also may occur by the dentists due to the quality of the radiograph that leads to weak visual signal that may produce false negative recording. In treatment for dental diseases, it is a tedious process to find the axis of teeth,root canal length of the tooth,etc.Due to inaccurate measurement of these parameters of teeth ,the failure rate of orthodental surgeries made for the patient increases.Measuring of these parameters using an engineering tool plays a vital role.The objective of the paper is to diagnose the Dental Plaque, to eliminate the limitations in the conventional radiographic diagnostic methods. The need of an image processing based Digital Radiography for early detection methods to arrest the progression of the dental diseases and it is more comfortable in terms of technique and interpretation.

Keywords-*DentalPlaque,Diagnosis,Dentistry,Kmeans,spatial, spectral classification,Clustering,etc.*

INTRODUCTION

I. DENTISTRY

Dentistry is an art and science of diagnosis and treatment of diseases and disorders of the oral cavity and its associated structures. The components of dentistry includes, periodontics, oral pathology, orthodontics, oral and maxillofacial surgery, pedodontics, prosthodontics, forensic odontology, geriatric dentistry and dental implantology. Periodontics deals with diseased gums , Oral pathology concentrates in the diagnosis , Orthodontics aids in the correction of mal-aligned teeth, oral and maxillofacial surgery is concerned with major surgical procedures related to the dental and associated structures , pedodontics deals with children and prosthodontics accounts for the rehabilitation process . Forensic odontology consists of the gathering and the use of dental evidence in human identification that is primarily documenting and verification of identity . Geriatric dentistry is the delivery of dental care to senior adults involving the diagnosis and treatment of problems associated with age related diseases . Dental implantology is a recent milestone in dentistry and in this method the dental images play a vital role in the selection and correct placement of implants.

II. DENTAL DISEASES

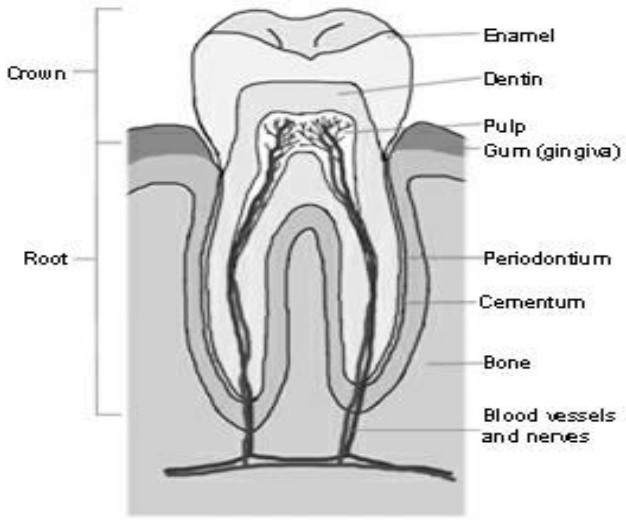
Common dental diseases are tooth decay and gum diseases. Other dental related disorders include , discolored front tooth, fractured teeth from trauma,over-retained primary teeth, abnormal eruption of wisdom teeth, tempero-mandibular joint disorders and pathological lesions like dental cyst, plague,cancer and tumor. In recentyears there is increasing awareness among people about the fact that the dental problems can cause other serious health implication. Prevention and early treatment of dental diseases may contribute to overall health. The conventional diagnostic procedures include tracing the history, measurement of pocket depth and clinical attachment level, and assessment of tooth mobility and displacement, and the increase in local temperature. Apex locator is the diagnostic aid to assess the length of the root canal . Testing with ethyl chloride (cold stimulus in thermal testing), application of heat (hot stimulus in thermal testing) and electronic pulp testing aid to assess the vitality of tooth.

III. IMAGING FOR DIAGNOSING DENTAL DISEASES

Medical imaging is a technology to visualize and analyze healthcare related complex data sets. Great advances have been made in medical imaging technologies over the last two decades . Medical Imaging is increasingly playing a vital role in areas like ophthalmology, cardiology, gynecology, orthopedics, dentistry and neurology. However, current visualization and analysis technologies are often proprietary and expensive, which can preclude or delay its use in acute care medicine. Further, diagnostic interpretation of the digital image is still largely qualitative, subjective, and prone to observer variability .

In the recent years, image processing techniques have been actively used for the diagnosis of oral diseases in dentistry. Dental diagnostic imaging methods include Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Ultrasonography (US), Scintigraphy, Panoramic Imaging, Intra Oral and Extra Oral Radiography. These imaging systems are helpful in confirming the presence and the extent of soft tissue infections. Axial and coronal CT slices play vital role in determining the optimal size, and orientation of the proposed dental implants. CT with contrast injection is useful in the differential diagnosis of any vascular lesion and other neoplasms of the jaw. MRI can help in establishing the intraosseous extent of the tumor . MR angiography is now being used to document the size, extent and vessels in vascular lesions by injectting radiopaque contrast agent in the vessels . MRI and CT can be used to differentiate soft tissue neoplasia from inflammatory lesions.

Radiography is a main diagnostic tool for detecting dental and maxillofacial lesions. Radiographic images have two dimension of three dimensional reality.The principal advantages of panoramic imaging are broad coverage of the facial bones and teeth, low patient radiation dose, ability to be used in patients who are unable to open their mouths, short time required to make the image. Panoramic images are most useful for clinical evaluation of trauma, location of third molars, tooth development, retained teeth or root tips and developmental anomalies. The main disadvantage of panoramic radiography is that the images do not display the fine anatomic detail available on intra oral periapical radiographs.The application of image processing techniques on digital dental radiograph image has proven to improve diagnostic accuracy as well as assisting dentists in doing their diagnosis accurately. There are different views for viewing the teeth structure. They are intraoral radiographic and Extraoral



radiographic views.The Tooth structure is shown in Fig.1

Fig.1 Tooth Structure

A.Intraoral radiographic views

Placing the radiographic film or sensor inside the mouth produces an intraoral radiographic view.

i.Periapical view

The periapical view is taken of both anterior and posterior teeth. The objective of this type of view is to capture the tip of the root on the film. This is often helpful in determining the cause of pain in a specific tooth, because it allows a dentist to visualize the tooth as well as the surrounding bone in their entirety

ii.Bitewing view

The bitewing view is taken to visualize the crowns of the posterior teeth and the height of the alveolar bone in relation to the cementoenamel junctions, which are the demarcation lines on the teeth which separate tooth crown from tooth root. Routine bitewing radiographs are commonly used to examine for interdental caries and recurrent caries under existing restorations.

ii.Occlusal view

The occlusal view is indicated when there is a desire to reveal the skeletal or pathologic anatomy of either the floor of the mouth.

B.Extraoral radiographic views

Placing the radiographic film or sensor outside the mouth, on the opposite side of the head from the X-ray source, produces an extra-oral radiographic view.

IV. DENTAL PLAGUE

Dental Plague, known colloquially as tooth decay, is a disease that occurs on any surface of a tooth that is exposed to the oral cavity. However certain sites are more common than others because they make retention of plaque bacteria easier . Tooth has several layers; the outermost layer is enamel, which is the hardest and the most mineralized substance in the body. Below the enamel is dentine followed by dental pulp. The normal color of enamel varies from light yellow to grayish white. Thickness of the enamel varies over the surface of the tooth and is often thicker at the cusp and thinner at its border. The grooves on the biting surfaces of molar and premolar teeth provide microscopic retention, as does the point of contact between teeth. Plaque may also collect more along the gingival margin. In addition, the edges of fillings or crowns can also provide protection for bacteria, as can intra-oral appliances such as orthodontic braces or removable partial dentures

V. IMAGE SEGMENTATION

The first step of dental plaque quantification is separating plaque from other parts on digital photograph of the anterior teeth. The purpose of this study is to propose a quantitative method to measure dental plaque accumulation via digital images segmentation based on some clustering algorithms . The dental plaque segmentation the scheme of the dental plaque quantification consists of following four consecutive stages:

Stage 1: Select the region of interest (ROI). We used human outlining, which was conducted very carefully by an experienced dentist. In practice,we found that a reasonable curve-shaped ROI could be specified efficiently by using the mouse on a friendly graphical user interface on the Photoshop.

Stage 2: Transform the color space from RGB to HSI. We obtained individual component hue, saturation and intensity image respectively

Stage 3: Apply the clustering Algorithm

Stage 4: Compute the area percentages of tooth surface covered by dental plaque (not include background).

The flow diagram of existing method is as follows

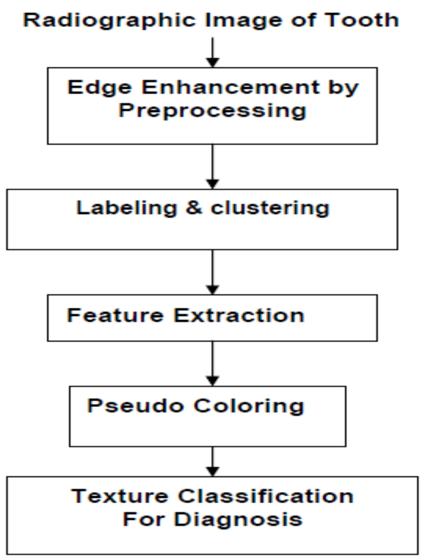


Fig 2.Representation of Existing Method

VI. CLUSTERING METHODS

There are numerous clustering algorithms that can be used to determine the natural spectral grouping present in a data set. One common form of clustering, called k-means approach, accepts from the analyst the number of clusters to be located in the data. The algorithm then arbitrarily "seeds" or locates, that number of cluster centers in the multidimensional measurement space . Each

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pixel in the image is then assigned to the cluster whose arbitrary mean vector is closest. After all pixels have been classified in this manner, revised mean vector for each of the clusters are computed. The revised means are then used as the basis to reclassify the image data. The procedure continues until there is no significant change in the location of class mean vectors between successive iterations of the algorithm.

VII. K-MEANS ALGORITHM

In K-means clustering, $X = \{x_1, x_2, \ldots\ldots, x_n\}$ represent a set of data, where n is the number of data points . $V = \{v_1, v_2, \ldots., v_c\}$ is the corresponding set of centers, where c is the number of clusters. The aim of K-means algorithm is to minimize the objective function $J(V)$,in this case a squared error function:

$$J(V) = \sum_{i=i}^{c} \sum_{j=1}^{c_i} \left\| x_{ij} - v_j \right\|^2 \text{, Where } \left\| x_{ij} - v_j \right\|$$

is the Euclidean distance between x_{ij} and v_j . c_i is the number of data points in the cluster i .The i^{th} cluster center can be calculated as:

$$v_i = \frac{1}{c_i} \sum_{j=1}^{c_i} x_{ij} \quad \text{and} \quad i = 1,2,\ldots\ldots c$$

The steps involved in the k-means clustering are,

Step 1: Initializing cluster centers randomly.

Step 2**:** a. Computation of Euclidean distance between the cluster centers.

b. Grouping the pixel to those clusters whose center yields the minimum distance from the feature vector.

Step 3: Updating the cluster centers by computing the mean of the feature vectors of the pixels belonging to that cluster.

Step 4*:* Assessing the changes, so as to decide on the continuance of iteration. This process is continued until convergence occurred otherwise it is repeated.

In fig 5, Using K-means clustering the plaque portion is highlighted using pseudo coloring to improve the visibility

VIII. PROPOSED METHOD OF SPECTRAL SPATIAL CLUSTERING

i.Feature selection/extraction**:**

Feature selection consists in identifying a subset of the original features. *Featureextraction* consists in applying one or moretransformationsof the input features to produce new salient features.Either or both of these techniques can be applied to obtain the most effective set of features to be used in clustering

ii.Similarity measure**:** Clustering aims at grouping pixels,so that pixels belonging to the same cluster are spectrallysimilar. To quantify this relationship, a similaritymeasure must be chosen. Proximity between pixels isusually measured by a distance function defined on pairsof spectral values. A simple distance measure like theEuclidean distance is often used to measure similaritybetween vectors.

iii.***Grouping*****:** In this step, pixels are grouped into clusters.Partitional clustering algorithms identify the partitionthat optimizes a clustering criterion (deducted from thesimilarity measure step).

A).ISODATA Algorithm*:* As described in , the simplest and most frequently used criterion in partitional clustering is the squared-error criterion, which is the most suitable in the case of isolated and compact clusters. The squared error for a clustering Y of a set **X** into *C* clusters is defined as where ***μc*** is the centroid of the cluster *c*. ISODATA clustering is a well-known algorithm introducedby Ball and Hall which uses the squared-error criterion. It starts with a random initial partition of the pixel vectors into candidate clusters and then reassigns these vectors to clusters in such a way that the squared error is reduced at each iteration, until a convergence criterion is achieved . The algorithm permits splitting, merging, and deleting of clusters at each iteration in order to produce more accurate results and to mitigate dependence of results on the initialization

B)EM Algorithm: While ISODATA is a deterministic clustering approach, the EM algorithm belongs to the group of statistical algorithms that assume a statistical model that characterizes.The Cluster assignment stepof EM algorithm is as follows

Step 1. Assign each pattern in **X** to one of the clusters accordingto the maximum probability criteria

Step 2. Eliminate cluster , if *c* is less than the dimensionalityof patterns, *c* = 1, 2, . . . , *C*. The patterns that belonged to thedeleted clusters will be reassigned to the other clusters in thenext iteration.

Step 3. If the convergence criterion is not achieved, return to theparameter estimation step.The total number of parameters to be estimated is

$P = (B(B + 1)/2 + B + 1)C + 1$,

where *B* is a dimensionality of feature vectors. If the value of *B* is large, *P* may be quite alarge number.

IX. PROPOSED TOOTH ISOLATION ALGORITHM

Step 1: Calculate the projected histogram of the image to be analysed.

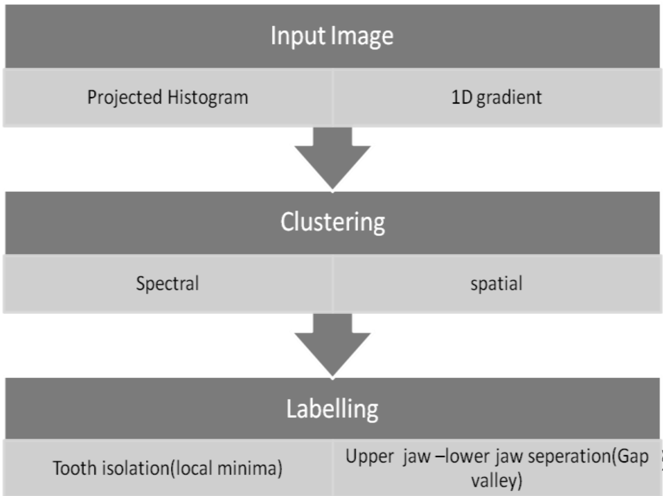
Step 2: Apply a smoothing filter to the image for removal of spikes.

Step 3:local minima is found,to locate the gap valley between the upper jaw and lower jaw in the tooth.

Step 4:calculate the one dimensional gradient for upper jaw and the lower jaw separately.

Step 5:finally ,sorting is done and the tooth isolated image is obtained as a result.

Fig 3.Flow diagram of proposed tooth isolation method



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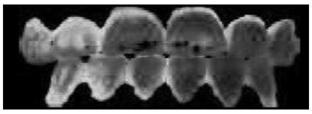
Vol.2, No.10, October 2013 DOI:10.15693/ijaist/2012.v2i10.76-80

X.EXPERIMENTAL RESULTS

The results of the image segmentation based on k means clustering algorithm and histogram aided classification,based on finding the local minima in both spectral and spatial methods were discussed. The experimental results of existing algorithm is as follows

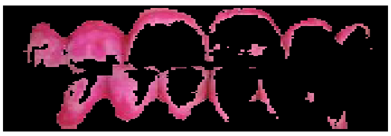
Input Image

S-Plane



Plaque Region

Preprocessed Image

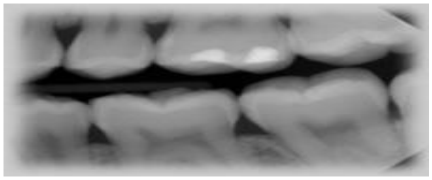


Kmeans output image

Fig 4.Results of existing work

The proposed tooth isolation algorithm is executed ,the tooth isolation is achieved in upper jaw and lower jaw.The experimental results of the proposed algorithm are as follows

Input Image

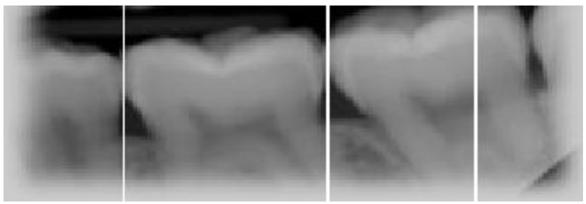


Upper Jaw

Lower Jaw

Teeth Isolated Upper Jaw

Teeth Isolated Lower Jaw



Methods & parameters	**Existing work**	**Proposed work**
Clustering algorithm	K-means	Spectral spatial classification
Clustering parameter	Euclidean distance	Average value in histogram,1D gradient,local minimal value.
Pixel processing	Entire image	Entire image and also in segmented image.

XII.COMPARISON OF K MEANS AND SPECTRAL SPATIAL METHOD:

XIII.CONCLUSION

This paper presented the various views present for detection of dental diseases using image processing. The various enhancement techniques used to improve the visibility are presented and limitations of each method are discussed and the difficulties in the detection of dental plague is discussed.The algorithms developed for Dental Plaque segmentation and quantification is also presented.The visibility of the dental plaque is improved by K- means clustering based pseudo coloring is done.a new method for separating the upper jaw and lower jaw is proposed.Toothisolation is done based on histogram aided,spectral spatial classification.

XIV. FUTURE ENCHANCEMENT

The proposed work can implemented as a product for medical applications.The latest Spartan 3 kit and XILINX DSP SYSTEM generator tool supports the image data can be directly processed by the integrated circuit present in the FPGA board.some Xilinx FPGA KIT is supported with inbuilt video camera within the kit,for image processing applications.

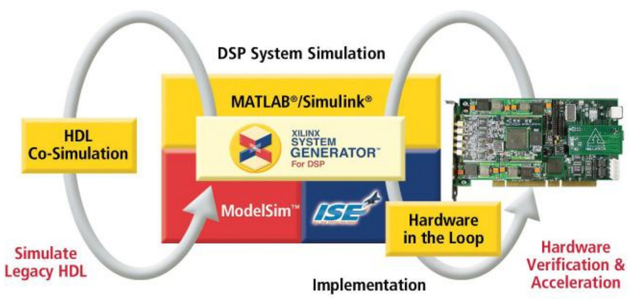


Fig 6.Representation of hardware implementation

REFERENCES
[1] A Semi Automatic Algorithm Based on Morphology Features for Measuring of Root Canal Length, 2011 IEEE,Azam Amini Harandi, Hossein Pourghassem
[2]. Upper and Lower Jaw Segmentation in Dental X-ray Image Using Modified Active Contour 2011 International transaction on Intelligent Computation and Bio-Medical Instrumentation, Azam Amini Harandi, Hossein Pourghassem, Hamid Mahmoodian
[3] A simple and Novel CBIR technique for features extraction using am dental radiographs. 2012 IEEE journal on Communication Systems and Network Technologies, Dharmesh B. Prajapati, Nirav P. Desai, Chintan K Modi
[4] A simple and novel algorithm for automatic selection of ROI for dental radiograph segmentation, Chintan K. Modi and Nirav P. Desai. IEEE journal on ECE 2011.
[5]The Qualitative and Quantitative Evaluation of Enhanced Dental Radiographs,Siti Arpah Bt Ahmad, Mohd Nasir Taib, Noor Elaiza A.Khalid, Haslina Taib nternational journal on Electrical, Control and Computer Engineering June 21-22, 2011
[6].Siti Arpah Bt Ahmad, Mohd Nasir Taib, Noor Elaiza A.Khalid, Haslina Taib4The Qualitative and Quantitative Evaluation of Enhanced Dental Radiographs, 2011 International Conference on Electrical, Control and Computer Engineering Pahang, Malaysia.
[7] M. Abdullah-Al-Wadud, et al, “A Dynamic Histogram Equalization for Image Contrast Enhancement”, IEEE Trans., Consumer Electronics, vol. 53, no. 2, pp. 593–600, May 2007.

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