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Dental Plaque Identification and Classification Using Artificial Neural Networks

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ABSTRACT: This paper focuses on detection of plaque at its initial stage to avoid the formation of Calculus. Here Plaque identification is done using artificial neural networks. The upcoming process deals with four stages Edge Detection, Segmentation, Feature extraction and Classification. Radiographic dental images are taken as input, the noise in these images are removed using Median filter and edge detection is carried out using Canny Edge Detection which is the initial step of the process. The method has been implemented by using clustering (Enhanced k-mean) method for segmentation. This method exhibits the lowest failure rate when compared to other methods.

KEYWORDS: Calculus, Plaque, Radiographic images, Clustering

I.INTRODUCTION

Dental plaque is a soft, colourless, microbial bio film that forms, over and sticks to teeth which leads to oral diseases.The primary concept of plaque formation is due to amino acids, proteins, glycoproteins which is obtained from saliva and gingival cervicular fluid which helps to maintain the PH of the mouth between 6 and 7.The plaque is found front and behind the teeth, along and below the gum. It can be found that 80-90% of plaque is water and 70% of dry weight is bacteria, the remaining consists of polysaccharides and glycoproteins. The dental disease is caused by the failure to remove plaque by regular brushing and bacteria is allowed to escalate thereby building a thick layer in the teeth. Calculus cannot be removed through tooth brushing or inter dental aids, but only through professional cleaning. The presence of patch is identified by Radiographic images.

Radiography uses electromagnetic rays most importantly X-rays to view the internal structure. Depending upon the composition and density the object absorbs certain amount of X-rays. X-rays with high photon energies are called hard x-rays and with lower energy are called soft X-ray. Hard X-rays are widely used to image the inside of objects. Wavelengths of hard X-rays are similar to the size of atoms they are also useful for determining crystal structure by X-ray crystallography. The radiography include medical and industrial radiography.

II. RELATED WORK

In this paper1, the biometrics human identification using dental radiographs is important. For individual and mass disaster identification Dental radiographs are mainly helpful. With shape extraction and matching techniques this work aims to produce an automatic person identification system. It can provide better matching because tooth contour information is a suitable choice here. Labelling is used to improve the output for misaligned images. When it is compared with the semi-automatic contour extraction method the matching distance observed for this method is comparatively better. Similarly, in paper2, segmentation of dental X-ray image helps to find two major regions of dental X-ray image: 1) gap valley 2) tooth isolation. Dental radiograph segmentation is a challenging problem .This is because of intensity variation and noise. Traditional algorithms make use of gray and binary intensity integral curves using which the regions of gap valley and tooth isolation are extracted. To find ROI for both gap valley and tooth isolation using binary edge intensity integral curves we proposed a novel method .The proposed algorithm uses region growing approach followed by Canny edge detector. It automatically finds the ROI both for gap valley and tooth isolation in 83% dental radiograph images without rotation.

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III. PROPOSED ALGORITHM

A. INPUT IMAGE FOR DIAGNOSING AND FILTERING NOISE:

Medical radiographic imaging is used to analyse the health related complex data. Now-a-days, image processing plays a vital role in diagnosing the oral disease. The x-ray image of the teeth is achieved using radiograph technique, Most X-rays has the wavelength ranging from 0.01 to 10nm, with the frequencies in the range of 30petahertz to 30 exa-hertz and energies in the range 100eV to 100keV.

INPUT IMAGE

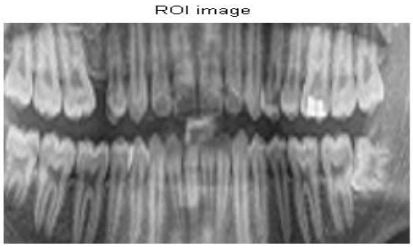
The radiographic input image is then checked for noise by using a filter known as Median filter , the non-linear filtering technique use for removing noise is median filter, the usage of filter is the foremost step to be carried out before executing the later process. The Median filter preserves edge on removing noise and this filter executes sequentially.

NOISE REMOVED IMAGE

B. THRESHOLDING AND ROI

After the noise is reduced by filter, we use threshold to extract the desired teeth. An binary image is produced by threshold to simplify the analysis. At sometimes there will be missing in information pixels if single threshold values are chosen.

When a dataset is identified for a specific purpose it is termed as ROI (Region of Interest). It is extracted from the input image after the reduction of noise. In CT scans the critical region is about 5 pixels both in and out of colon walls. We can generate practical value to the system by segmenting the critical region automatically.



C. SEGMENTATION

The segmentation algorithm is on 3-D extension, it is built on a set theory in area of image processing with many applications. Based on Pixel local neighbour it generates mappings. Segmenting from the X-ray data set consists has two steps:

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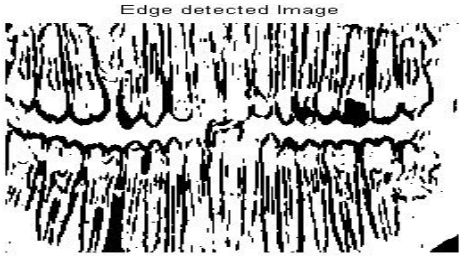
1. By intensity thresholding the air is taken away from the tissue.
2. By 3D extension of Sobel's derivative operation the colon wall that surrounds the air is extracted.

D. CANNY EDGE EXTRACTION

The Canny edge extraction algorithm is also known as a multi stage algorithm. It can be popularly known as optimal edge detector. The regions that are marked as edges in the gradient images are known by local maxima. The local maximum points in the gradient edge can be found by non-maximal suppression. The double thresholding suppresses the weak areas. The canny edge detection can be identified by gradient and magnitude. The most popular Canny edge extraction algorithm provides the edge map on dental x ray. The algorithm is producing over segmented images from which none of the root features can be identified. The optimum results are provided by Canny edge extraction



By changes in colour and intensity of image the location of edges is founded by edge detection process. The Edge play an important role as they are subjected to various major physical changes.

Since, it can be proven that the discontinuities in image brightness are likely corresponding to the discontinuities in depth, is due to discontinuities in surface orientation and image brightness, it is also caused by material properties changes and changes in illumination. If the edge detection is done in this case, then the result may leads to connected curves that indicates the object boundaries and also the surface marking boundaries, the curves that corresponds to the discontinuities in orientation of surface. Hence the complexity is more in ideal edges from real life images.

E. SEGMENTATION USING ENHANCED K-MEANS

The partitioning the index of the cluster is given to each sample as where it is allocated. When date is more, K-means clustering is used when compared to hierarchical clustering method is the other name of K-means. The date is divided by K mean (K)reciprocally limited clusters. In unsupervised clustering method K-means is used to reduce the distance between the own cluster points.

Even though the accuracy is not provided, it is easy to use and stronghold are making it practice. The k-means can be started by picking initial random centers with probabilities that can enhance the speed and exactness.

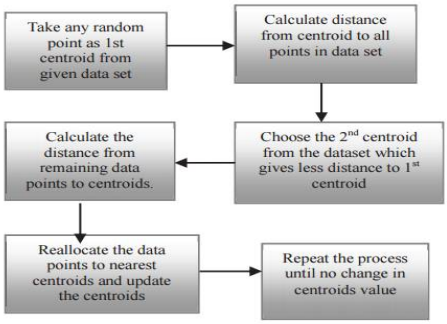


Fig. 1. Block Diagram for enhanced K-Means

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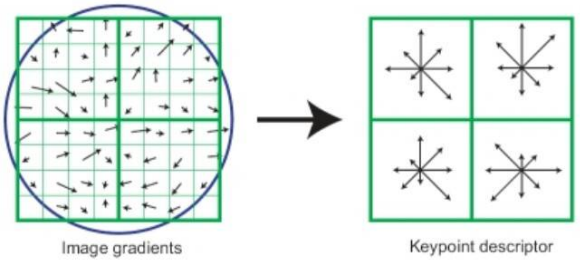
F. FEATURE EXTRACTION

HISTOGRAM FEATURE EXTRACTION

Object recognition can be done by Histograms of Oriented Gradients (HOG) . In local region the orientation histograms of edge intensity is taken and are calculated. Local object shape and appearance can be found rather well by the spreading of local intensity gradients or edge detection. At first the edge orientation and gradient at each pixel is calculated in local region. Then edge gradients and orientations are obtained by Sobel filters . The gradient magnitude m(x, y) and orientation θ(x, y) are calculated using the x-and y-directional as gradients dx (x, y) and dy (x, y) computed by Sobel filter as



$$m(x, y) = \sqrt{dx(x,y)^2 + dy(x,y)^2}$$
$$\theta = \tan^{-1} dy(x,y)/dx(x,y)$$

This local region is divided into small spatial area called "cell" as shown. The size of the cell is 4 × 4 pixels. Edge gradients of Histogram with 8 orientations are calculated from local cells.

The information of the corrected image remains the same but the intensity, texture, size are adjusted. Two images will be present , the first image will be used for reference and the other is used to match the reference image, to do this the histogram of both the images are isolated.

Edge orientation histogram is considered as the weighted pixels within the typical cell. The spacing of orientation bins are $0^\circ - 180^\circ$ which causes problem in aliasing. To avoid this bi-linearly interpolated votes between the neighbouring bins in both orientation and position.

The feature extraction step is essential as the gradient strength vary .Some blocks are overlapped by each HOG which contribute the prime idea, and by this each scalar cell is normalised with different block.

SIZE FEATURE

For each and every person the size of the teeth varies , hence the size feature is taken.

TEXTURE FEATURE

The texture feature is used to find the information of the image .The most commonly used technique to find the texture is Gabor feature extraction.

GABOR FEATURE EXTRACTION

Gabor filter is used for edge detection and it is a linear filter. Frequency and orientation of Gabor filter is particularly for texture discrimination and identification. The method consists of two types,

- Real
- Complex

The teeth consists of upper and lower jaws , since to distinguish them we go for real and complex. The features such as texture, size and Gabor are fused and send to neural network. They are based on Gabor filter responses for a given input image.

CLASSIFICATION USING ANN

Compared to most traditional classification approaches Artificial Neural Networks (ANNs) are one of the popular methods for classification. ANNs are nonlinear, nonparametric, and adaptive.

There are three reasons to use ANN:

(i) weights denoting the solution are found by iterative training

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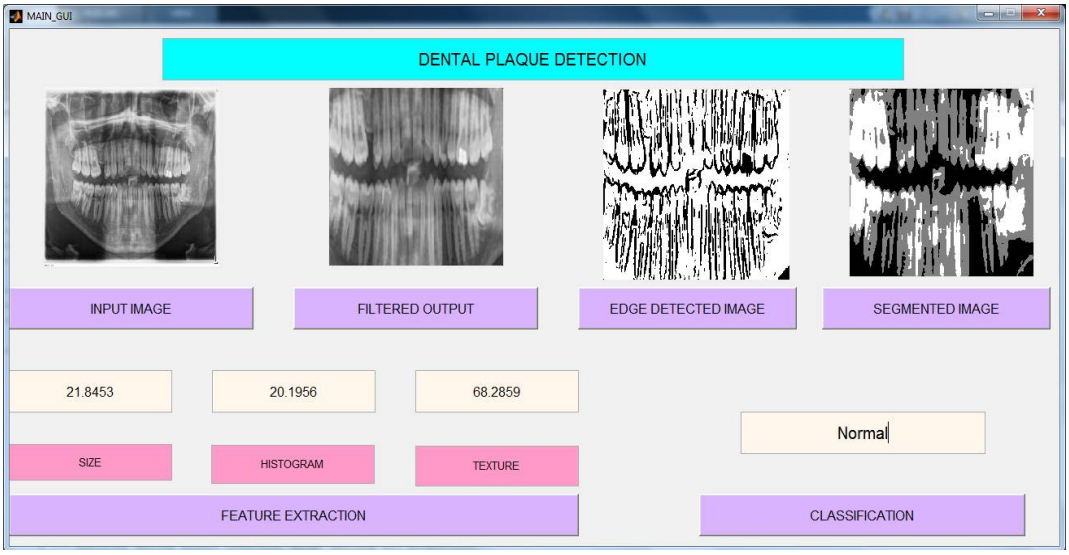
(ii) Physical implementation structure is simple
(iii) Complex class distributions can be mapped easily

In summary, individual analysis of ANN in medical imaging process should be done even though many successful model are illustrated in literature. ANN is applied to medical images to deal with the problems that cannot be solved by traditional image processing algorithms or by other classification techniques. Due to the introduction of artificial neural networks, algorithms and analysis developed for medical image processing become more intelligent than conventional techniques.
The common ANN used for classifications is the feed-forward network. In a this network, the neurons in the particular layer are connected only with the neurons in the next layer.
A neural network to perform image classification is constructed as follows,
It has three layers: input, hidden and output layer. The number of neurons in the input layer is calculated by the number of features selected. The number of neurons in the output layer is found by the number of classes in the network. The number of hidden neurons is determined by experiments.

IV. SIMULATION RESULT

The proposed algorithm is done using MATLAB.
MATLAB is used in the field of image processing.
Initially the radiograph image is given as the input for the process.
The input image is then processed to achieve noise removal.
Then edge detection is done by Canny edge detection.
Segmentation is done using this radiographic image.
Finally the images are classified using neural networks by which the result is obtained.



V.CONCLUSION

In this paper, the identification of plaque at initial stage using artificial neural networks has been discussed. Even if the radiographic image quality is low, this method produces a best result. Some features of Dental imaging techniques are extracted using texture techniques by gray-level matrix. From the results it can be seen that this is the most promising technique for segmentation
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