

Detection of Dental Diseases using Classification Algorithms



K.Manjula, G.Durga Devi, K.Vijayarekha

Abstract- Dental diseases may be caused if the food taken stays in the corners of the mouth. It is important to analyze the dental images to improve and qualify medical images for correct diagnosis. The teeth abnormalities may fall into different categories such as dental implants, gum diseases, crack, bone grafting, and root canal. This work aims to identify the type of abnormalities using classification algorithms — image Processing Techniques, namely Enhancement, Segmentation, and Classification involved in this process of dental disease detection. Decorrelation Stretch, Wiener Filter, and Contrast Enhancement are some of the enhancement techniques which were used to improve the clarity of a dental image. Edge Detection, Otsu's Threshold, Region-Based Segmentation, and Texture filters are few of the image segmentation techniques. These are used to identify the defected area of an image, and then the type of abnormalities was classified using K-NN and SVM.

Keywords--Decorrelation Stretch, Edge detection, K-Nearest Neighbor, Region of Interest.

I. INTRODUCTION

Image Acquisition is the process, used to capture the image using a mobile camera, digital camera, etc. Enhancement techniques are used to suppress the noise. Decorrelation Stretch is used to enhancing the intensity separation of an image. Wiener filter is used to filter the image and reduce the noise. Contrast Enhancement techniques are varying poor illumination in improper images like blurring, noise image to increase contrast in low contrast image. The performance of all the methods is finally identified using its accuracy between the input image and the enhanced image. Image Segmentation techniques are used to segment the image by intensity. Edge detection uses shape information of an image. Otsu's thresholding method evaluates the global threshold value. Interclass variance computes the class and segments the dental image. The output of this method is obtained by separating black and white pixels of a dental image. Region of Interest gives a polygonal shape of an image. Select a seed point and view the polygonal region of interest. Segmentation techniques are used to identify the defected area of a teeth

image.

The feature Extraction process is done using Gray Level Co-occurrence matrix. In the feature extraction process, the segmented image is used to extract the features like the contrast, run percentage, gray level non-uniformity, etc. Then the classification techniques used these features to identify the type of abnormalities. K-NN algorithm is used to identify a similar distance in the training dataset. Classification mostly compares the training dataset and testing dataset.

II. METHODOLOGIES

This section deals with the methods involved in dental disease identification, which is shown in Fig. 1.

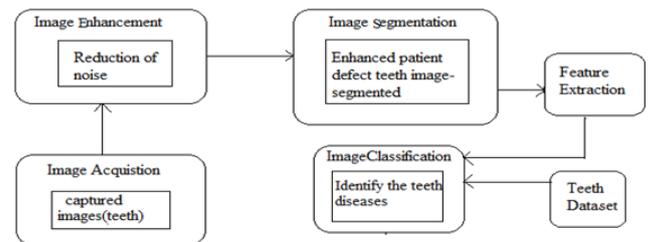


Fig: 1 Architecture diagram - Dental Disease Identification

A. Image Enhancement

A.1. Decorrelation Stretch

Decorrelation Stretch is used to enhancing the color intensity separation of a band to band correlation. It is a way to enhance the pixel of an image to make feature discriminant easier. Enhancement techniques mostly used to convert the RGB color to a grayscale image.

The authors [4, 5, and 6] have used decorrelation using the band to band autocorrelation in an image.

Syntax: $S = \text{decorrstretch}(\text{image}, \text{'name'}, \text{value});$

The code to enhance the image using Decorrelation Stretch in Matlab is

```

a = imread('teeth1.jpg');
S = decorrstretch(a, 'tol', 0.01);
imshow(S).
  
```

A.2. Wiener Filter

Wiener Filter is a linear filter, used for enhancing images. It retains the essential image features during its image de-noising process. It is used to suppress the noise and also invert blurring simultaneously. It executes optimal tradeoff between invert blurring and noise smoothing [3, 5, 7 & 9].

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A.3. Contrast Enhancement

The quality of images is essential for human interpretation. Contrast is an important factor for evaluating the image quality. It is used to increase contrast in low contrast images and improve the pixel intensity [1, 2 & 10].

B. Image Segmentation

B.1. Edge Detection

Edge detection detects an object and its background from the image. It divides the image using the intensity of pixels of an image. In edge-based segmentation technique, initially all the edges are detected, and then all are connected together to form the object boundaries to segment the required regions. Most of the shape information is enclosed in the edge. The enhanced output contains edges. The sharpness of these images will increase the clarity of the edges. This technique identifies the shape of a teeth image [1, 3 & 7].

B.2. Otsu's Threshold

It estimates the global threshold value and minimizes the interclass variance of black and white intensity. Otsu's threshold method is used to separate the defected area of a teeth image. It mostly refers only black and white intensity of a teeth image. The lower bound is certainty only by images having a single gray level image, and the upper bound is certainty only by the two-valued image [2, 3 & 6].

B.3. Region of Interest

Region of interest is a portion of an image. ROI is used to create a polygonal region of a teeth image and identify the defected teeth image. It selects a seed point to the structure of dental images. Segmentation separates the defected part of an image, i.e., it identifies the defected area of an image using image segmentation techniques [2, 5 & 7].

B.4. Texture Filter

The segmented objects in the black and white (BW) image are white. The top texture is overly segmented and the bottom texture is segmented the almost entire image. A threshold value is selected in an image because it is roughly the intensity values of pixels along the boundary between the texture [4 & 5].

C. Feature Extraction

C.1. Gray Level Co-occurrence Matrix(GLCM)

The features such as contrast, correlation, homogeneity, gray level non-uniformity, run percentage, and entropy are extracted using GLCM of an image. Contrast identifies the number of structured variation present in the image. The sharpness of a dental image refers to the crack type of dental abnormalities. Correlation gives the quantity of gray level linear dependency of the image. Correlation refers to the teeth image and views the peaks and valleys of the dental images. Homogeneity grows with lower contrast in the image. It is used to identify the root canal diseases. Gray level non-uniformity is used to obtain the similarity of value through the image. Run Percentage gives the distribution of an image.

D. Image Classification

D.1. K-Nearest Neighbor

K-NN techniques are used to find the distance between the

training dataset and new sample data using Euclidean and Manhattan distances. Image Classification techniques are used to classify the type of abnormalities based on the extracted features and training dataset [1, 2 & 8]. Finally, it finds the nearest distance measurement using the distance function such as euclidean (Eqn.1) and manhattan (Eqn.2).

$$\text{Euclidean, } K - NN = \sqrt{\sum_{i=1}^n (q_i - p_i)^2} \text{ ----- (1)}$$

$$\text{Manhattan: } K - NN = \sum_{i=1}^n |q_i - p_i| \text{ ----- (2)}$$

D.2. Support Vector Machine (SVM)

SVM is a supervised learning algorithm and it can be used for both regression and classification. It differentiates the classes and identifies the right hyperplane. Then, all the classes are segregated for well. It is popular in applications such as computer vision, natural language processing, speech recognition and image recognition [11].

E. Evaluation Criteria

The performance of the enhancement techniques is calculated using Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

PSNR is defined in Eqn.3.

$$\text{PSNR} = 10 \cdot \log_{10}(\text{MAX}^2 / \text{MSE}) \text{ ----- (3)}$$

MSE is given in Eqn. 4.

$$\text{MSE} = \frac{1}{m \times n} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [\text{Input}(i, j) - \text{Enhanced}(i, j)]^2 \text{ --- (4)}$$

The accuracy is used to identify the performance of the classification algorithms towards the identification of dental abnormalities. Accuracy is calculated using Eqn.5.

$$\text{Accuracy} = \frac{\text{tp} + \text{tn}}{n} \text{ ----- (5)}$$

where tp denotes True positive; tn denotes True negative, and n represents p+N;

III. RESULTS AND DISCUSSION

For identifying the teeth abnormalities (crack, bone grafting, and root canal), 20 real images each were collected from the dental laboratories. In general, the input images may be of color or gray-level x-ray dental images. The color images were converted into gray-level images. The tooth image with abnormality, bone graft is shown in Fig.2.



Fig.2: Bone Graft- Input Tooth Image



(a) Using Decorrelation Stretch



(b) Using Wiener Filter



(c) Using Contrast Enhancement

Fig.3: Image Enhancement Using Various Techniques

To improve the visual interpretation of tooth image and to increase the image quality, the images were enhanced using enhancement techniques such as decorrelation stretch, wiener filter, and contrast enhancement. The improved images of Fig.2 are displayed in Fig.3 (a) – (c). Contrast enhancement techniques are used to improve the contrast of the input image. Then it is used to clarify the image that is white contrast in this gray level image. Wiener filter is used to reduce unwanted data.

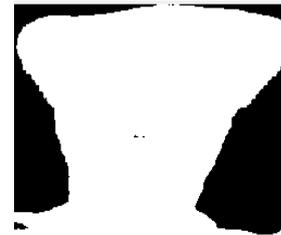
Table I: Performance Analysis of Enhancement Techniques

ENHANCEMENT TECHNIQUES	PSNR	MSE
DECORRELATION STRETCH	62.3393	0.037945
WIENER FILTER	69.9188	0.006625
CONTRAST ENHANCEMENT	49.4096	0.744932

Table I shows the performance of these three enhancement techniques. The better enhancement is achieved using wiener filter compared with the rest because the PNR is high and MSE is low at wiener filter.



(a) Using Canny Edge Detection



(b) Using Otsu's Threshold Segmentation



(c) Using Region Of Interest



(d) Using Texture Filter Segmentation

Fig.4: Image Segmentation Using Various Techniques

Edge detection techniques are used to find the shape of a dental image. It contains the detected edges of the dental image. It is easy to identify the part which is affected. Fig.4(a) represents the affected part of an image using a canny edge detection technique. Otsus' method computes the global threshold value. This method makes the dental image as a binary image.

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Structure of the dental image is in white and outside of it, is in black color. The output of the Otsus' method is a black and white image that is shown in Fig. 4(b). Region-based segmentation is used to select the polygonal shape of the dental image. In Fig. 4(c), six seed points have been selected and viewed the polygonal shape or teeth structure using this technique. Image Segmentation techniques are used to divide the image into sub-images. The result of the segmentation technique provides the defected area of an image which separates the top and bottom of a texture image and selects the polygonal region of an image. The input image is segmented using texture filter, as shown in Fig. 4(d).

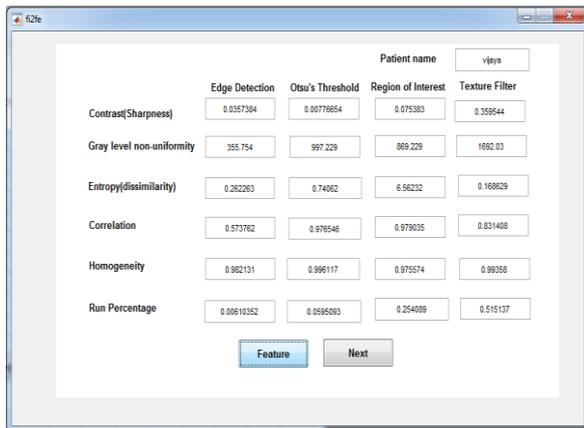
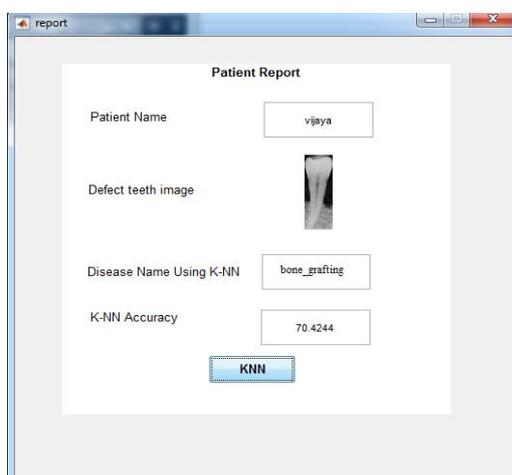
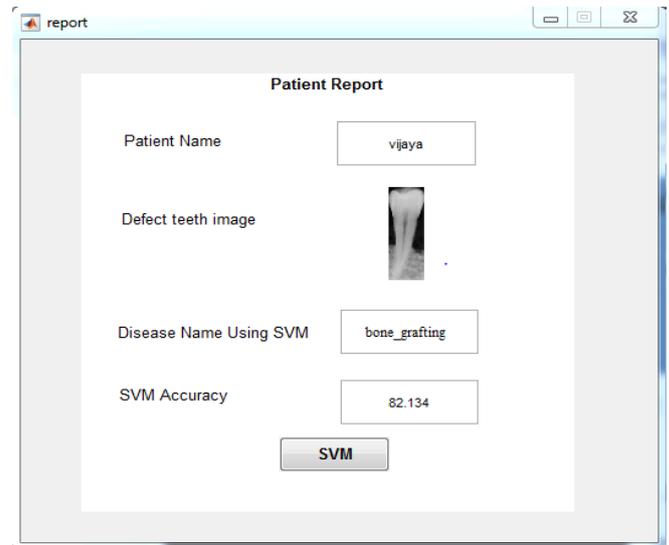


Fig.5: Feature Extraction Using Segmentation Techniques

The features such as contrast, correlation, gray level non-uniformity, homogeneity, run percentage, and energy have been extracted from the dental images. Therefore the dimension of the feature set is of 60 x 6. These features were used to identify dental diseases. The type of tooth abnormality is determined using classification algorithms such as SVM and k-NN. From the input image (Fig.2), features were extracted using the wiener filter then segmented using segmented techniques. The segmented output was classified using SVM and k-NN. The accuracy of the classification algorithms have been measured, and the corresponding results are displayed in Fig.6(a) and Fig.6(b). The accuracy performance of SVM classifier is high, whereas it is low using the k-NN classifier.



(a) Using k-NN



(b) Using SVM

Fig.6: Final Report of Patient's Dental Image

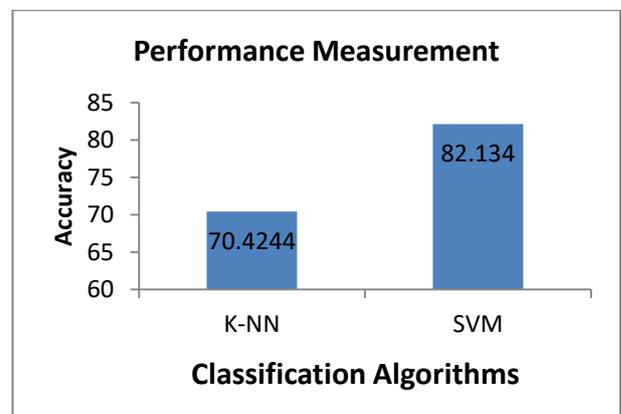


Fig.7: Performance of Classification Algorithms

The performance of classification algorithms is shown in Fig.7 where SVM gives 87% of accuracy, whereas K-NN offers only 70% of accuracy towards the classification of dental diseases. Thus it is proven SVM classifier provides better accuracy of results in the identification of dental diseases.

IV. CONCLUSION

This paper is aimed at the detection of dental diseases using classification algorithms. Gray level co-occurrence matrix attributes in the dental images, features have been extracted, and it is given as input for the classifiers such as KNN and SVM for classifying the defects. Then, the performance of classification algorithms was analyzed. SVM gives 82% of accuracy, whereas KNN gives only 70% of accuracy towards classification. Thus, it is concluded that the SVM classifier gives better classification than the KNN classifier.

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