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A Review: Detection of Dental Caries Using Traditional Techniques of Medical Images

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ABSTRACT
Detection of dental caries in the early stage is most important in the dental field. But identifying the severity in caries help to take the action according to severity levels, According to ICDAS (International Caries Detection andAssessment System) guidelines for clinical images. The main aim is to identify the severity levels of the caries with different colors or shades which can be easily noticed by practitionerusing. Mainly the images taken are radiographic or clinical because these are the cheap, easy to extract, save and modified by using digital image processing and machine learning. Most of the previous research is done by analysing radiographic images of Occlusal and Buccal surfaces, but there are both advantages and disadvantages in this detection methods which is explained here in detail.

Keywords: Dental Caries, Occlusal and Buccal surfaces, Otsu's method, GLCM, SVM.

INTRODUCTION

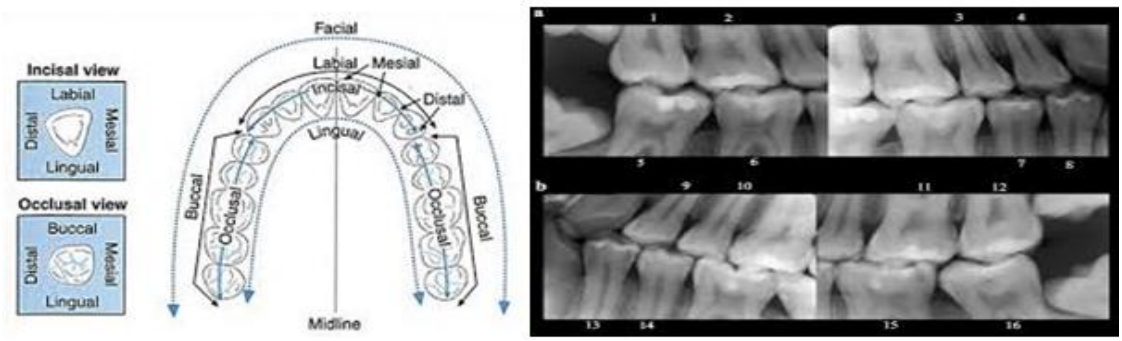
This Dental Caries is the most common in not only in children but also in the adults these days because of the changing life style and food habits. As this is increasing since fewdecades, so Doctors are seeking the help of the technology for the detection of the caries in a faster and the most accurate and presise results. This technology not only saves the precious time of Doctors but also patient's. The caries are easily identified by clinical images but most of the caries can't be visible by this clinical images for this case doctors uses the radiographic images and most of them also not clearly identified by naked eyes so here the technology comes into the picture where different types of enhancement methods are used for the enhancement of radiographic images again we can't simply say this enhancement methods are enough for the detection so the in addition to the image processing techniques the machine learning is used for more clear identifications. Some of the most used techniques are SVM,PCA etc.

DIFFERENT TYPES OF CARIES ARE FOUND WHICH ARE AS FOLLOWS.

Table: 1. Types of dental caries

Types of caries	Description
Incipient caries /Primary caries	Caries at the first time.
Recurrent caries /Secondary caries	Caries occurring at the same location where it had previously.
Arrested caries	Inactive caries

Figure 1. Surfaces of the Teeth.



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Most of the caries occurs in the part of Occlusal and Buccal surfaces.

Types of detection methods used in the different reference papers

- Radiography
- Magnetic resonance imaging
- Nuclear medicine
- Ultrasound
- Elastography
- Photoacoustic imaging
- Tomography
- Echocardiography
- Functional near-infrared spectroscope
- Magnetic Particle Imaging.

In general we use radiographic and clinical images for the detection for the caries, these methods are the most suitable and cost efficient and for the image processing these images can be easily extracted and modified.

Table: 2. Difference between radiographic and clinical images

Radiographic images	Clinical images
We don't need to convert into the gray images	We have to convert into gray image for further process
It is will show the interior caries also	We it won't detect interior caries
We get varies intensity	We get less intensities comparing to radiographic images
Easy to make histogram	Not easy for histogram

ENHANCEMENT METHODS USED IN VARIOUS PAPERS

Image enhancement techniquesare used in most of the applications of image processing. The image is enhancement deals with the contrast levels. The change in the contrast levels of the image makes the image more clear which can be clearer than the original one. Some of the most used techniques are histogram equalization, Noise removal using a Wiener filter, median filter etc.

CLASSIFICATION METHODS

S.NO	ALGORITHM	FEATURES	LIMITATIONS
1	Support vector machine algorithm	• Highest accuracy rate. • No need of linearly separable data.	• Huge data set is required • Highly complex.
2	Naive BayesAlgorithm	• Simply implemented,high efficient and high speed.	• Huge data is required. • Less training data set effects the precision.

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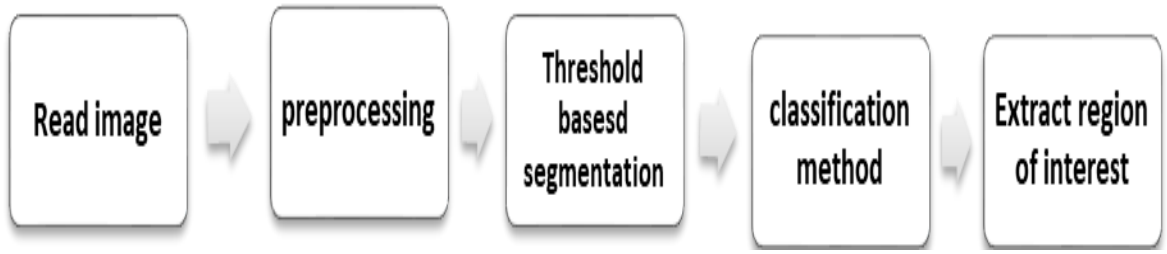
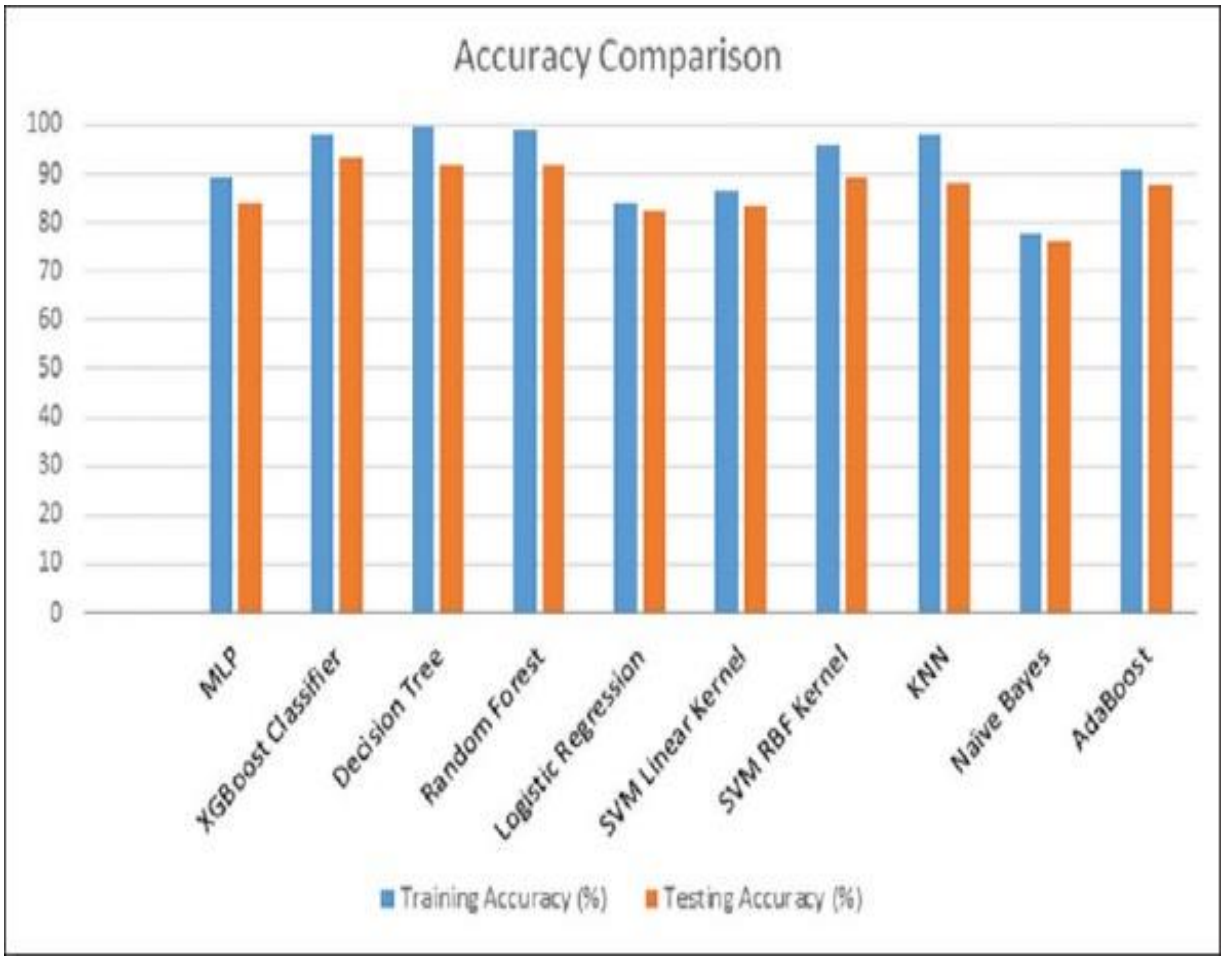
Vol-22-Issue-41-December-2019

3	K-Nearest neighbor Algorithm	• Classes need not be linearly separable • Zero cost learning process. • Complex while using to noisy training data.	• ime find the nearest Neighbours in a large training data set can be excessive. • ensitive to noisy or irrelevant attributes.

FLOW CHART TO SHOW PROCESSES OF DETECTION





By studying the previous news of National Cancer Institute, this oral cancer is accountable for 2.5% of all cancers in the United States. Research shows, if oral cancer is detected in early stages, the death rate can be reduced to 10% - 20% then later stages, which causes 40% - 65% death. Dentists use different kinds of oral radiographs for the distinct diagnostic purpose. Radiographs can be classified into two categories.

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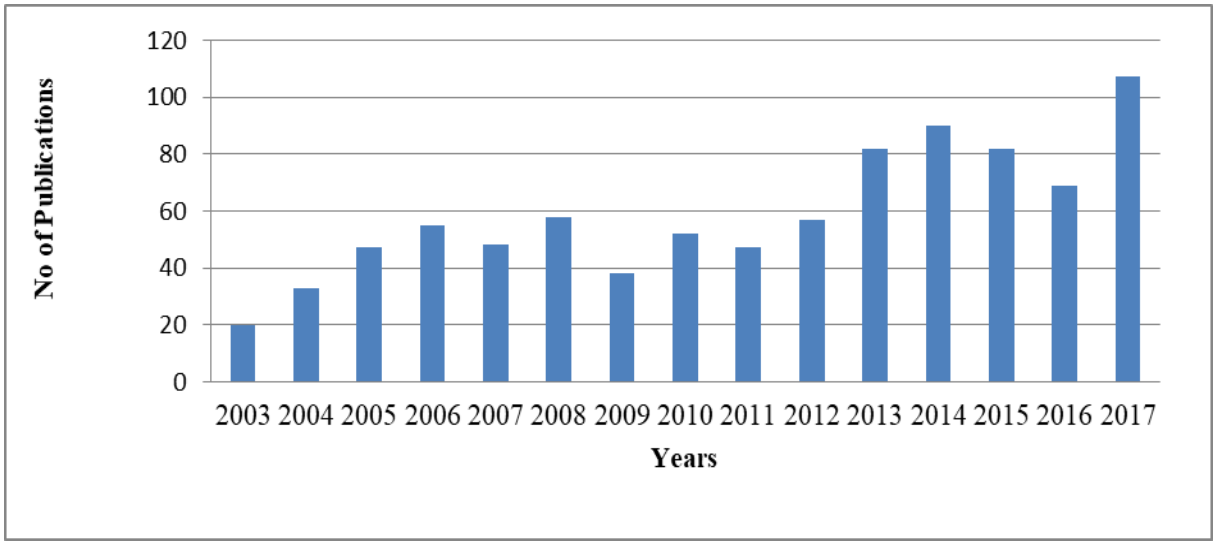

LITERATURE SURVEY

S.NO	Author & year	Methodology	Remarks	Data set
1	Anuj Kumar [1] et al 2018	• Median Filter. • Fuzzy Clustering.	• Future works can identify the root canal and related caries.	12 X-ray images.
19	Guangchen Ruan [11] et al 2014	• QLF Analysis by Image Assessment Templates • DENVISserver	• 99% compression ratio is done because only contours are remained untouched.	CT images
3	Konstantinos Moutselos[9] et al 2018	• superpixels, • occlusal caries, TWS, SLIC. • Random Forests.	• Deep learning is used for classification.	Clinical images
4	Arman Haghanifar [12] et al 2018	• fuzzy cognitive maps; • real-coded genetic algorithm; • Hebbian-based algorithms.	• latest FCM techniques are introduced.	
5	Sabbir Ahmed[16] et al 2017	• K-means clustering method. • Threshold method. • 3D construction.	• Greatly explained by graphical and numerical data.	CT images
6	Keith Angelino[3] et al 2017	• dental caries • near-infrared imaging • transillumination.	• Cost efficient.	X ray image
7	Veska M. Georgieva [7] et al 2017	• Image enhancement, Wavelet transform • Histograms of the X-ray-images	• Severity levels are clearly identified	x-ray-images with cervical caries and root caries

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Vol-22-Issue-41-December-2019

8	Anif Hanifa Setianingrum [19] et al 2017	• Otsu Method, • Otsu Threshold Value	• Threshold values are modified for the required results.	X-rays of teeth
9	Dr.M.Sornam [5] et al 2017	• BPNN; • GLCM; • SVM and KNN.	• Promise to provide 99% of accuracy and minimized error rate of 0.008 %	Dental x-ray 120 images
10	Snehal Patel [2] et al 2017	• k-meanclustering • Region Growing Method • Level Set Method • Fuzzy C-Means Clustering • GLCM (Gray-level co-occurrence matrix).	• The caries area is highlighted according to the contrast levels of the image.	56 dental x-ray images
11	Jatti [14] et al 2017	• Gray Level Cooccurrence Matrix (GLCM). • hybridized negative transformation	• The caries area is highlighted according to the contrast levels of the image.	dental panoramic images
12	Aisyatur Radhiyah [17] et al 2016	• Gaussian Filter, • Histogram Equalization.	• Gaussian filter gave 80.58% accuracy and the histogram equalization provided 81.88%.	X-ray images
13	Renee Christian R[10] et al 2016	• Near –infrared(NIR) • Histogram equalization • OTSU method • GLCM • SVM	• This algorithm can be further developed as an Automated system to detect caries.	Infrared images
14	Mrs. Shubhangi Vinayak Tikhe[13] et al 2016	• image segmentatio; caries detection; • histogram.	• It produced satisfactory results for 25 test images. This algorithm involves three modules viz. preprocessing, segmentation and identification.	25 digital periapical radiographic images
15	Raghav Agarwal [15] et al 2016	• edge detection • gray level, • spatial resolution • contrast perceptibility.	• Contrast adjusted according to the image.	Clinical images Occlusal Caries, Approximal Caries
16	Soma Datta [6] et al 2015	• Cluster Based Segmentation, • ECM, Erosion, HIS Color Model, QLF • Wiener Filter.	• Wiener filter provided great results.	Clinical image
17	Leila Ghaedi[4] et al 2014	• Wavelet Transform • Fourier Transform.	• It can be developed for other advance use also.	x-ray images
18	Li Liu 2014[8] et al	• laser induced fluorescence, • backscattering light.	• Fluorescence reflects radiation and backscattering gives image.	Clinical fluorescence image

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DISCUSSION

Most of the caries occurs in the part of Occlusal and Buccal surfaces .In general we use radiographic and clinical images for the detection for the caries, these methods are the most suitable and cost efficient and for the image processing these images can be easily extracted and modified. Nearly all the reviewed papers used OTSU,GLCM method for the enhancement and SVM,PCA, K-Means for the classification.

CONCLUSION

This paper gives a brief over view about caries detection. The most of the researchers have concentrated on detection of caries in the Occlusal and Buccal surfaces and they left the other surfaces such as mesial and distal. The detection of such surfaces can be the future work that is to be noted. Sometimes caries can occur on the same tooth where already the treatment had done so this treated area will obviously showed in the different contrast in radiographic image so the algorithm should be developed for identify such already treated regions if it is not done so there might be information mismatch.

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