Caries Detection Technique for Radiographic and Intra Oral Camera Images

Adhar Vashishth, Bipan Kaushal, Abhishek Srivastava

Abstract—   In the modern times, caries is one of the most prevelent disease of the teeth in the whole world. A large percentage of population is affected by them. Dentists try their level best to identify the problem at an earlier stage, but, with poor dentist to patient ratio , the problem becomes compounded. To provide them a helping hand various machines and techniques are developed. Prominent among them is the DIFOTI(digital imaging fiber-optic transillumination) technique, but it requires very expensive machinery to work with which can not be afforded by most of the dentists. We are proposing a method that can provide the needed diagnostic help without requiring the kind of machinery currently in use. We have used image processing technique to identify the caries that provide the dentists with the precise results about caries and the area affected. This method can detect caries in radiographic images as well as in intra oral camera images. This will not only help in countering the low man power problem but will also provide an accurate and cost effective method in identifying and treating caries.

Index Terms— binarization, caries, mask, RGB plane, MATLAB.

I.   INTRODUCTION

Research shows that ninety percent of adults are now-a-days suffering from various dental problems, which mostly include caries.[2] Due to a very large number of patients who are needed to be diagnosed and treated properly, makes it hard for dentists to correctly identify and treat these problems.

As we know various modalities are used in medical diagnosis and treatments planning for example, x-rays are used in detection of various features of bones and they can also provide a lot of information about the bone whether it has any fracture or any misalignment. It can facilitate in predicting proper treatment that should be given. This technique can also be extended to detect the extent of caries in the tooth. Dentists sometimes face a problem in correctly determining which technique should be incorporated for the treatment. In this paper we have discussed and have proposed a solution for such a problem.

A. What are caries?

Dental caries are also known as *tooth decay* or a *cavity*. Now-a-days, caries have become one of the most common diseases throughout the globe. A person experiencing caries may not be aware of the disease.

he earliest sign of a new carious lesion is the appearance of a chalky white spot on the surface of the tooth, indicating an area of demineralization of enamel. It is called a white spot lesion, an incipient carious lesion or a "micro cavity".

Manuscript Received on May, 2014.

   Adhar Vashishth, Department of Electronics and Communication Engineering, PEC University of Technology, Chandigarh, India.
   Prof. Bipan Kaushal, Department of Electronics and Communication Engineering, PEC University of Technology, Chandigarh, India.
   Abhishek Srivastava, Department of Electronics and Communication Engineering, PEC University of Technology, Chandigarh, India.

[4] Before the cavity forms, the process is reversible, but once a cavity forms, the tooth looses structure which cannot be regenerated. A lesion that appears dark brown and shiny suggests dental caries were once present but the demineralization process has stopped, leaving a stain. Active decay is lighter in color and dull in appearance.

B. Causes of Caries:

The cause of caries is an infection, bacterial in origin, which inflicts demineralization and destruction of enamel, dentin and cementum (the hard tissues of teeth). The bacteria produces acid by fermentation of food debris accumulated on the surface of the tooth or in between teeth. However, for the development of caries on teeth a cariogenic bio film is required. Dental caries can occur on any surface of a tooth that is exposed to the oral cavity.

C. Consequences of Caries:

The cavity becomes more noticeable, as, the enamel and dentin are destroyed. The affected areas change color and become soft. If the decay passes through enamel, the dentinal tubules, which are having passages to the nerve of the tooth, become exposed, resulting in pain that can be transient, temporarily worsening with exposure to heat, cold, or sweet foods and drinks. A tooth weakened by extensive internal decay can sometimes suddenly fracture under normal chewing forces. When the decay has progressed enough to allow the bacteria to overwhelm the pulp tissue in the centre of the tooth a toothache can result and the pain will become more constant.[5] The tooth no longer will be sensitive to hot or cold. Dental caries can also cause bad breath and foul tastes. In some highly progressed cases, infection can spread from the tooth to the surrounding soft tissues.

II.   PROBLEM IDENTIFICATION

It is not like the caries do not have an inevitable outcome, but the different individuals will face different degree of problems depending on the shape of their teeth, oral hygiene habits, and the buffering capacity of their saliva.

A.Early detection

The main issue is detection of caries at an early stage, because, if the caries keep on increasing they can reach the root and can infect the other teeth also. This can lead to further complications of the problem. So, it is required to correctly determine whether there are caries present in the teeth or not. If yes, then we need to find how much area of tooth it has affected

B.Need for computer aided detection

Even though there are new techniques which make them able to diagnose and treat caries at early stages,

still due to lower dentist to patient ratio in India (0.8 per 10,000 persons)[8] so it is necessary either to increase the number of dentists or to provide dentists with some technological help as the visual inspection is prone to human errors and can miss a high percentage of caries if used as the sole method of caries detection. Thus it has become essential to use computer aided detection and diagnosis to be introduced in this field also.

III. METHODOLOGY

Because of the severity and the health concerns associated with this problem in the long run , effective measures are needed to control it right at the onset so, our technique is mainly based on diagnosis of the caries. For this purpose we have taken the help of image processing toolbox of MATLAB (a mathworks's software).

The caries detection procedure/algorithm includes following steps:

I. Read the original image of the tooth.
II. Then generate separate planes of the given image which include all the 3 planes - red, green and blue plane and the grayscale image.[9]
III. Red plane is used to mask the boundary of the tooth (Fig. 1).
IV. The tooth image is converted to BW(Fig. 2).
V. Image is masked on the basis of area(Fig. 3).
VI. Holes in the image are filled using imfill command (Fig. 4).
VII. Area of boundary masked tooth is calculated using bwarea command.
VIII. Blue plane is taken to determine the caries (Fig. 5).
IX. This image is boundary masked (Fig. 6).
X. Image is converted to BW at the threshold value 50 (Fig. 7).
XI. Holes are filled again (Fig. 8).
XII. Area of caries masked tooth is calculated using bwarea command.
XIII. Divide the area of carieMask by area of toothMask.
XIV. This gives the ratio of the the caries to that of the whole tooth.
XV. Result shown in the form of 'percentage of area affected by the caries' by multiplying the ratio with 100.

Mechanism to detect the Tooth Boundary:
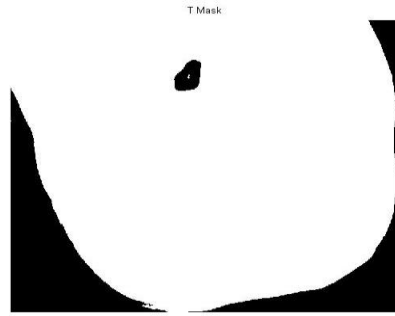

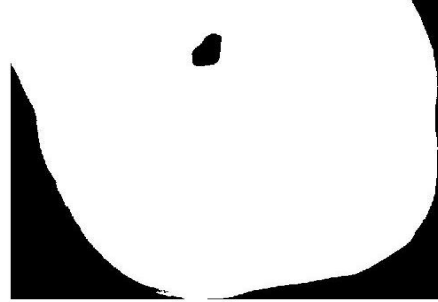**Fig. 1 Red Plane**

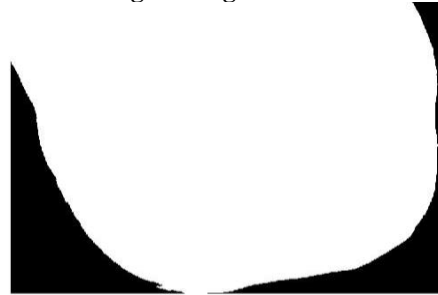Fig**. 2 Image converted to BW (Without masking)**

Fig. 3 Image Masked

Fig. 4 Holes filled using *imfill*
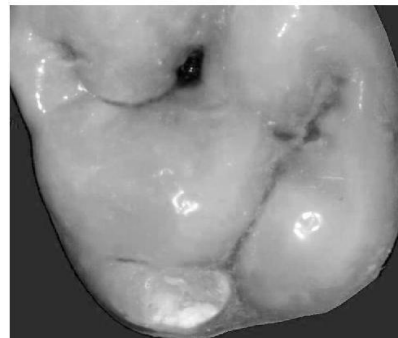**Mechanism to mask the carious portion:**

Fig. 5 Blue Plane

Fig. 6 Boundary masked image

Threshold: 50.0

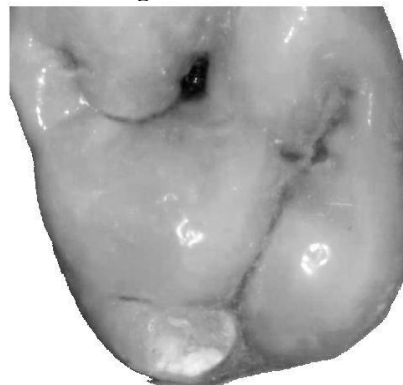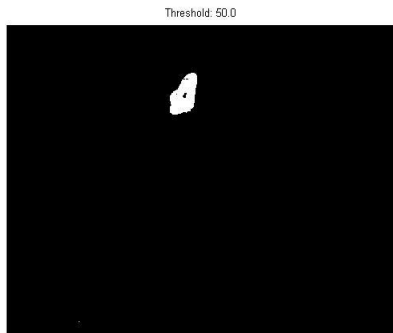**Fig. 7 Image converted to BW at Threshold 50**

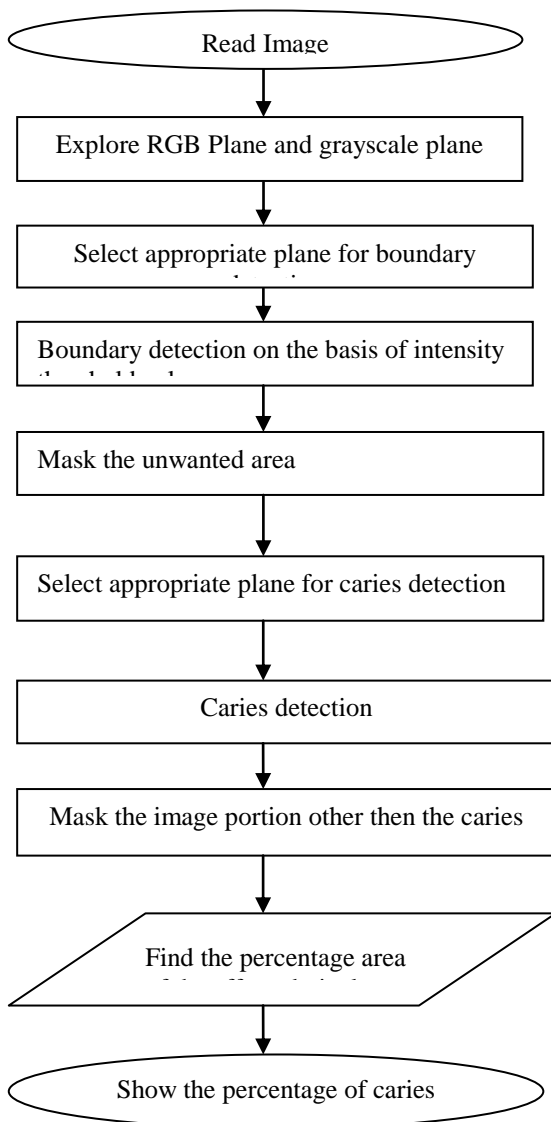**Fig. 8 Holes filled using *imfill***

Fig. 9 Flowchart for the proposed technique

IV. RESULTS

The threshold value was determined by observing the MATLAB output image on that particular value. By visual observation the threshold value of 50 was found to give the precise results. So, we have used it as default threshold value for masking the caries. The proposed technique was tested on various images to detect the area affected in them. Following are some results obtained based on the technique proposed:

Table I

S. No.	Boundary masked Tooth area	Caries masked Tooth area	Percentage of caries in Tooth
I.	3.9673e+05	2.6023e+03	0.654
II.	4.7809e+04	45.3750	0.0921
III.	53030	1.6278e+03	3.01

V. CONCLSION

Figures The proposed technique for caries detection using image processing is quite cost effective. It was found very efficient and precise in determining the tooth caries. With its use a lot of manpower and time can be saved. This technique can be used in other image processing techniques also. Also, this method can be used in reading the x-ray images.[1] The image processing technique presented here can be used in 3-D array also to determine the volume of the cavity and can precisely tell the depth of the caries in the tooth which can determine what type of treatment should be given. With some advancement this technique can be used in determining the distance between the caries and the root of the teeth, which can further help in the identification and can also suggest the treatment for that.

REFERENCES

1. Stefan Oprea, Costin Marinescu, Ioan Lita, Mariana Jurianu, Daniel Alexandru Vişan, Ion Bogdan Cioc "Image Processing Techniques used for Dental X-Ray Image Analysis " , IEEExplore , E-ISBN: 978-1-4244-3974-4.
2. Grace F. Olsen, Susan S. Brilliant, David Primeaux, and Kayvan Najarian "An Image-Processing Enabled Dental Caries Detection System" , Published in Complex Medical Engineering, 2009. CME, E-ISBN : 978-1-4244-3316-2
3. Supaporn Kiattisin, Adisorn Leelasantitham, Kosin Chamnongthai and Kohji Higuchi " A Match of X-ray Teeth Films Using Image Processing Based on Special Features of Teeth", Published in SICE Annual Conference 2008, E-ISBN : 978-4-907764-29-6.
4. "Dental Caries: The Disease and Its Clinical Management", 2nd Edition by Ole Fejerskov and Edwina Kidd.
5. Paul Fotek, DMD, Florida Institute for Periodontics & Dental Implants Published in Medical Plus, A service of the U.S. National Library of Medicine National Institutes of Health.
6. "Digital Image Processing Using MATLAB" by Rafael C. Gonzalez.
7. Programming in MATLAB ®: A problem-solving approach by Ram N Patel and Ankush Mittal.
8. World statistics published by WHO in 2013
9. By Brett Shoelson, PhD,Email: brett.shoelson@mathworks.com