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Dental lasers applications in visible wavelength operational band

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ABSTRACT

There is no doubt that radiation has many side effects in our lives, so our goal in this study is to reduce our use of radiation in the diagnosis of tooth caries, and in order to achieve this goal we used the field of optical fiber in the detection of some diseases associated with oral and dental medicine. This diagnosis was accomplished by shedding light on the teeth, to be diagnosed and creating an image that allows the doctor to examine them and determine whether there are caries or any root problems. The principle is also used to detect oral cancer, fractures, and cracks in bones. This study also allows us to detect early caries, and this method saves time because it gives the diagnosis at the same time while the patient is in the treatment unit of the dental clinic. Thus the main advantages of this method are, enable the dentist to view images on the display unit attached to the clinic in real-time, compare current photos with old photos of the same patient. Also, the dentist can create a photo archive of each tooth individually and can retrieve and compare them whenever he wants.

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1. INTRODUCTION

Dental caries which is an infectious disease in localized destruction of tooth structure, it caused by many types of bacteria such as streptococcus mutans the presence of some acids on the tooth enamel surface demineralization. Biologically, a compatible material dentinal carious lesion on both primary (deciduous) and permanent where the enamel is still contacted [1]. Diagnosing dental caries in children is so difficult due to short attention spans and lack of cooperation but, we can diagnose it by some traditional methods as diagnostic tests as (sensitivity, probing and bitewing radiography method). Alternative methods as digital radiography direct digital images may be required by two methods that are namely the charge-coupled device (CCD) and the storage phosphor system (SP). The sensitivity is the ability of the test to predict cases relating to the total number of positive cases and specificity which is the ability of the test to predict the true negative cases relating to the total of negative cases [2]. There are new methods to detect dental caries such as diagnosis of caries simply looking at a tooth to determine if caries is a presence in an inaccurate technique whose caries progression further by spreading along the enamel and dentin junction, also caries is one of the most difficult diseases to detect. Digital imaging fiber-optic transillumination (DIFOTI) uses visible light not ionizing radiation and it is approved by the food and drugs administration. Quantitative light-induced fluorescence which uses blue light (488 nm wavelength) to illuminate the tooth, which normally fluoresces a

green color, the tooth should be dried to 15 sec produce a more consistent reading, the carious lesion appears dark [3-4].

Image sensors, which is a type of sensor converts electrons into voltage or it's an electronic device that converts optical signal to electronic signal, which is widely used in imaging devices [5]. There are two types of image sensors such as charged coupled device (CCD) and complementary metal-oxide-semiconductor (CMOS). The best image sensor depends on the application which we use the sensor on it [6]. DIFOTI technique builds on fiber-optic transillumination (FOTI) which allows the recording of images of carious lesions during illumination [7-10]. It employs high-intensity light and has an additional greyscale camera. There are two types of mouthpieces available for use with DIFOTI, the proximal surface mouthpiece and occlusal surface mouthpiece [11].

DIFOTI has sensitivity and specificity that it is important parameters, which affect the performance of DIFOTI technique. Currently, x-ray radiation is being used in dentistry, but it has a lot of disadvantages such as its side effects on the patient, complex in operation and difficult in integration [12-15]. There is another way that is more effective than x-ray radiation [16-17]. It is found that the laser can be used in dentistry instead of x-ray radiation by a new technology called dentil and this technology depends on the light, which can be applied on the patient tooth [18-20]. How does it work? A laser light source can use to direct it toward the tooth, the light passes through some areas to the camera and the light cannot pass through other areas, which gives us dark areas [21-23]. By using a digital video camera, that makes all regions visible. This technology was called DIFOTI technology. It can make all diagnostic competence like occlusal caries, proximal caries, smooth, surface caries, secondary caries and cracks [24-25].

2. MODEL DESCRIPTION AND RESEARCH METHOD

Some of the results obtained from the simulation program, compared to the proper model to determine the location and percentage of caries. As shown in Figure 1 which indicates the steps that can be followed by a compiler to enable detecting caries at the image and can then surround caries at the image by a yellow rectangle or can detect that these teeth does not affect by caries and have no infection or any type of caries.

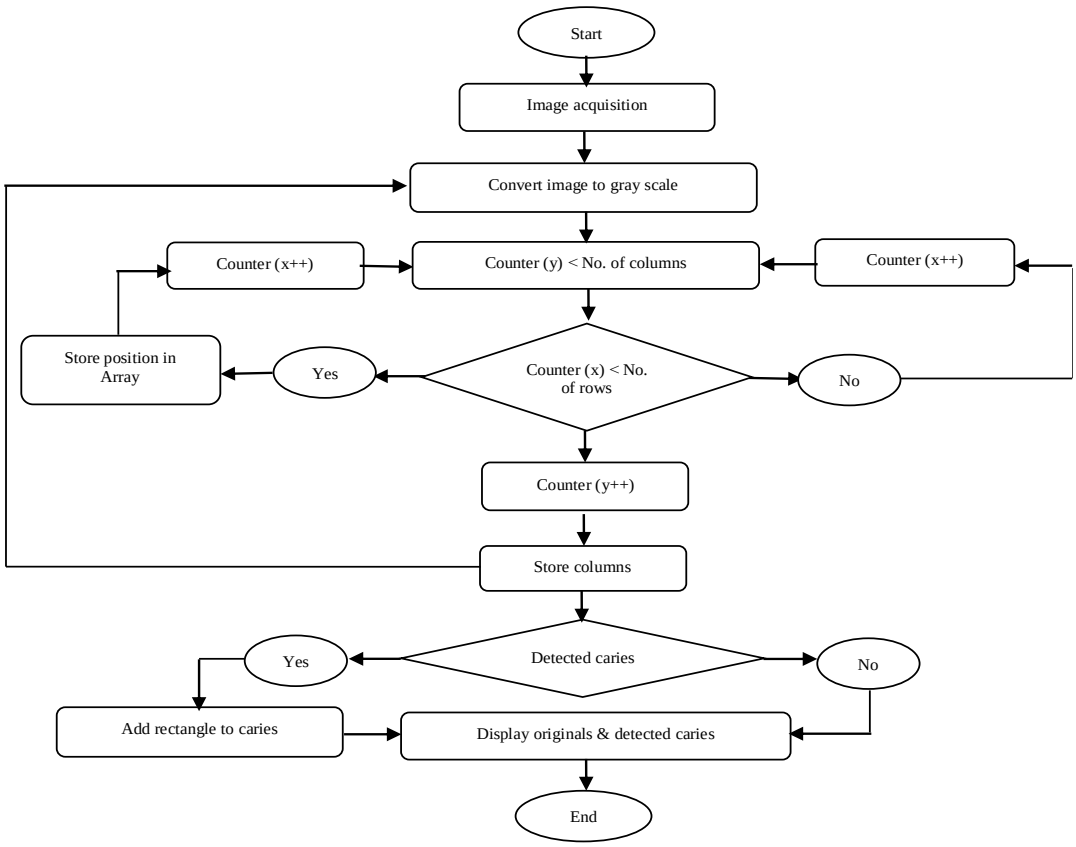

Figure 1. Flow chart of the basic steps for high biomedical image processing

Then it display both original and modified image with caries or not, the first step is image acquisition in which the capture of the image of tooth is directly done, the image may be suffering from a lot of figuration problems that may need to be treated like shadows or blurring these issues may be solved by MATLAB filters. The next step is to convert the image from three-layer RGB (Red Green Blue) format into gray scale format, which makes detection easy. The output images are passed into two loops, also there are some if conditions that can pass some pixels value and detect the values that exceed a pre-specified threshold and store the position of both values, then the position of infected parts and not infected parts could be distinguished, after that caries could be detected and display the output.

3. PERFORMANCE ANALYSIS WITH DISCUSSIONS

Figure 2, shows the original image of teeth of unknown caries which will be detected in RGB format. Before applying, any effects on the image just import the image and then display it to be capable of comparing it with the gray scale image in which caries had been detected using the MATLAB environment. There are some functions that can be used to detect caries IMREAD ('x') to read the stored image from a stored database of images, x is the image name, IMSHOW(y) to display the image y, for loops and if conditions that had been used to detect the caries at the images. Figure 3 describes the image of teeth with detected caries of (7.6893%) of the image in gray scale format, this result after passing with a lot of operations and applying many functions to detect the black colored caries in the image.

Figure 2. The original image of teeth of unknown caries

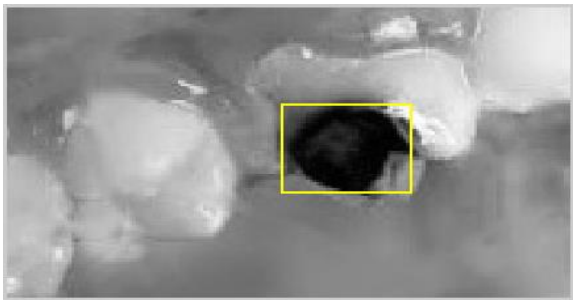

Figure 3. Image of teeth with detected caries of (7.6893%) of the image

All detected caries at the image of teeth are surrounded by a yellow rectangle shape, by using insert shape command at MATLAB environment. There are functions that can be used to detect caries, IMREAD(x) to read the stored image from a stored database of images, x is the image name. IMSHOW(y) to display the image y. Also, insertShape (image, shape type, shape dimensions) used to insert a shape in the image, uigetfile refers to the user interface to get a file using GUI (Graphical User Interface). Figure 4 shows the original image of teeth of unknown caries, which is needed to be detected if it exists in RGB format before applying any effects on the image. Figure 5 describes the image of teeth with detected caries of (0%) of the image in gray scale format after passing through a lot of operations and applying a lot of functions to detect the black colored carries in the image.

Figure 4. The Original Image of teeth of unknown caries

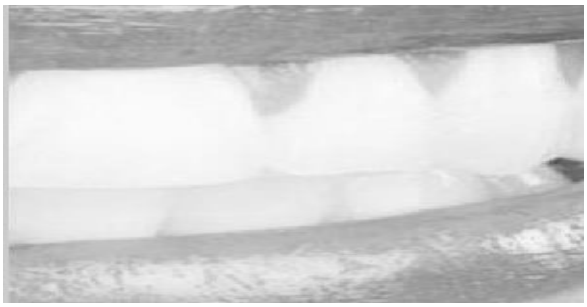

Figure 5. Image of teeth with detected caries of (0%) of the image

Figure 6 shows the original image of teeth of unknown caries, which is needed to be detected if it exists in RGB format before applying any effects on the image. Figure 7 describes the image of teeth with detected caries of (32.7407 %) of the image in gray scale format after passing through a lot of operations and applying a lot of functions to detect the black colored carries in the image.

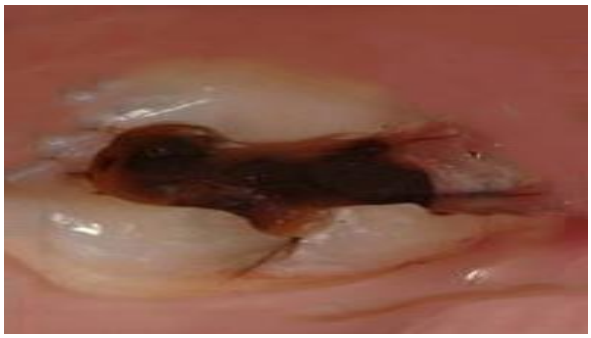

Figure 6. The Original Image of teeth of unknown caries

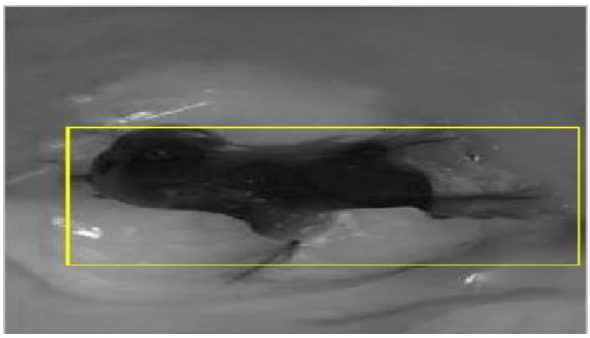

Figure 7. Image of teeth with detected caries of (32.7407 %) of the image

4. CONCLUSION

FOTI technique had been used as a caries detection technique, where the illumination principle is used to detect the presence of caries. There are many advantages in the case of using DIFOTI instead of radiography, the is no ionizing radiation nor film, the diagnosis has been accomplished in real-time, could detecting early lesions that may not appear to x-ray.

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