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Digital Dental X-ray Database for Caries Screening

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Abstract Standard database is the essential requirement to compare the performance of image analysis techniques. Hence the main issue in dental image analysis is the lack of available image database which is provided in this paper. Periapical dental X-ray images which are suitable for any analysis and approved by many dental experts are collected. This type of dental radiograph imaging is common and inexpensive, which is normally used for dental disease diagnosis and abnormalities detection. Database contains 120 various Periapical X-ray images from top to bottom jaw. Dental digital database is constructed to provide the source for researchers to use and compare the image analysis techniques and improve or manipulate the performance of each technique.

Keywords Dental X-ray · Online database · Caries detection · Caries treatment

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1 Background

Many researchers have been done on dental image processing and analysis but all of them had their own dataset which is difficult for other researchers to gain access for benchmarking [1–7]. In this paper, the process of data acquisition using X-ray machine to build the dental X-ray dataset will be discussed. Since there are no standard available dataset in dental X-ray imaging, providing high quality X-ray data are more challenging process.

2 Construction and Content

The dental digital dataset for medical analysis is being constructed to provide the research community with a source of data that can be used to precisely compare different image analysis techniques. This study employed Periapical dental X-ray images which are collected from the Universiti Teknologi Malaysia (UTM) Health Center, Dental Clinic. The images are periodical dental X-rays which is the common type of

dental imaging for dental disease detection and diagnosis in clinics. The aim of dental radiograph images dataset development is to supply a digital format which is available and can be used by other researchers to analysis and compare the performance of different algorithms. Analysis on the available standard dataset can improve the algorithms and methods better in a way using varying dataset which makes the performance evaluation more challenging and unreliable. Moreover, results of different methods and algorithms are acceptable as a benchmark for comparison by using the same dataset which is common and available. Many papers are published based on this dataset which is valuable for the representation of image data as standard dental X-ray dataset. Figure 1 demonstrates the sample of collected dental radiograph images. Ground truth is provided by a dental expert for each non-normal case. This data is stored as digital dental X-ray images in a computer readable format.

3 Image Acquisition

Collecting dental X-ray data uses a special X-ray machine which is common in any dental clinic in preparing for the patient dental images for any treatment or diagnosis. The machine is placed in a separate room to avoid radiation from other individuals. In this case, the intraoral X-ray machine is directly connected to the digital scanner and a software called SIDEX XG [8] which produces digital periodical dental radiograph images. The hardware and software used in this study are from a German company called Sirona (The Dental Company). However, in some other dental clinic it is not possible to obtain the data in digital format and it may be in the traditional X-ray film instead. Figure 2 shows the software and capturing X-ray digital scanner device. Figure 3 demonstrates the regular X-ray dental image which used film to produce the image.

Fig. 1 Database sample. Digital X-ray database sample

Furthermore, the images are collected from university students during their regular checkups by dental clinic and their age are between 25 and 35 years old. The patients are aware of data collection for this study, hence their personal information have not been released. This study has in compliance with the Helsinki Declaration [9] and approved by UTM medical committee.

4 Data Specification

The dataset was completed in the spring of 2013. The images collected for this study are 120 periodical digital dental X-ray images in which the abnormality of each images has been specified by dental experts. All images are grayscale digitized X-ray with a dimension of 748fi512 where the last 12 rows contain the information of images and must be removed in the analyzing process. Regularly each image contains at least one to four complete teeth. The images are digitized in the format of "jpeg" file type, which is a popular image type in image processing. Images are evaluated by the experts to ensure that all the images are suitable for the analysis process. However there are some images which are not qualified for processing due to imaging difficulties or operator's mistake during the image acquisition process. Figure 4 represented a digital dental X-ray image with spotting the abnormal location by dental expert.

The digital X-rays have a higher degree of accuracy over traditional X-ray films. When the images are represented directly on the computer screen and stored, the dental experts can then examine the images easily. The images are very clear and easy to manipulate for better viewing even by a non-computer expert. Digital imaging makes the diagnosis and treatment process reliable with more accuracy.

5 Caries Categorization

Dental caries could be classified based on several parameters such as etiology, progression rate, and

Fig. 2 Imaging equipment. Dental X-ray capturing device and software

Fig. 3 X-ray image. Traditional dental X-ray image

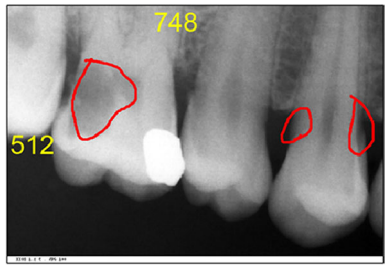

Fig. 4 Caries on image. Detected caries on image

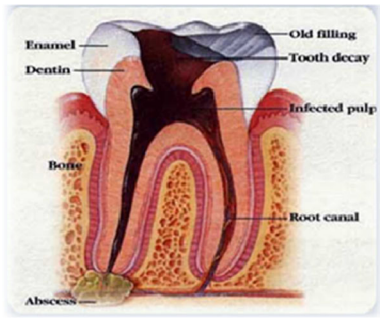

Fig. 5 Dental caries spots. Common spots of dental diseases in tooth

tissues [10–12]. There are three common types of dental diseases [6, 13, 14] such as

(a) Enamel caries represent formation of a microbial dental plaque.
(b) Dentinal caries main cause is dentinal tubules that is begin naturally.
(c) Pulpal caries that corresponds to the root caries or root surface caries.

Figure 5 shows categories of dental caries in tooth. The conditions were assigned to images according to the finding of caries position and severity by dental expert. Figure 6 demonstrates some identified sample of dental caries in its respective categories. The ground truth of detected caries on dental images is available at online database web site.

6 Utility and Discussion

All the collected data may not be the suitable for further analysis. Therefore, suitable images which have appropriate features for analysis have been selected by dental experts. A periapical X-ray shows the complete tooth, from crown to beyond the end root to where the tooth is anchored in the jaw. Additionally, these X-ray exhibits all dimension of tooth and consist of all teeth either upper or lower jaw. The main application of such X-ray is to assist specialist for detection of any abnormalities in root structure, bone structure.

7 Conclusion

Currently there are many ongoing researches on dental image analysis using image processing techniques such as image enhancement, feature extraction, and image segmentation. The database provided is applicable for the performance evaluation of any image analysis techniques.

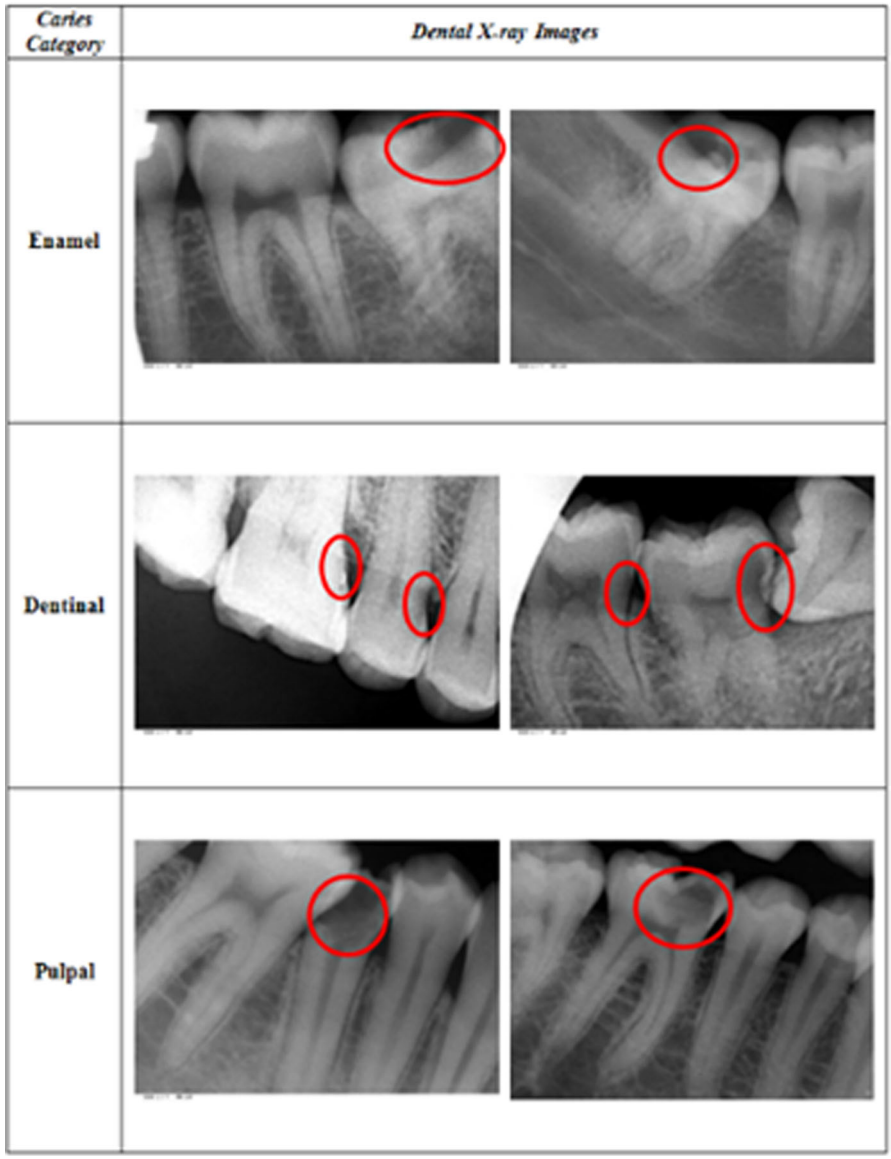

Fig. 6 Ground truth. Sample of caries detected ground truth

8 Availability and Requirements

The dataset is available online and in computer readable format for further research. Moreover, the ground truths of caries detected by dental experts are available in this link (http://dx.doi.org/10.6070/H47H1GJ4).

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