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Research Paper

Dental Disease Detection based on Machine Learning

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Abstract
In dentristry, Dental X-ray systems help dentists by showing the basic structure of tooth bones to detect various kinds of dental problems. However, depending only on dentists can sometimes impede treatment since identifying things in X-ray pictures requires human effort, experience, and time, which can lead to delays in the process. In image classification, segmentation, object identification, and machine translation, recent improvements in deep learning have been effective. Deep learning may be used in X-ray systems to detect objects. Radiology and pathology have benefited greatly from the use of deep convolutional neural networks, which are a fast-growing new area of a medical study. Deep learning techniques for the identification of objects in dental X-ray systems are the focus of this study. As part of the study, Deep Neural Network algorithms were evaluated for their ability to identify dental cavities and a root canal on periapical radiographs. We used tensor flow packages to detect dental caries and root canals in X-rays. This method used faster R-CNN technology

Keywords: *Dental, Xray, Deep learning, Radiology, periapical radiographs, R-CNN.*

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I. INTRODUCTION

Dental caries is one of the most common dental diseases. Dental caries result from a complex interaction between acid-producing bacteria that adhere to the dental and fermentable carbohydrates. Acids in dental plaque can demineralize enamel and dentine in the cracks and smooth surfaces of the dental. The earliest visual sign of dental caries is the white spot lesion. If demineralization continues, white dot surfaces get pitted, causing small holes called cavities to form. It is particularly typical in children, teenagers, and older adults. However, anyone who has teeth, including babies, is likely to have dental caries. If cavities are left untreated, they can grow and affect the deeper layers of your teeth. They can cause severe toothache, infection, and dental loss. Periapical radiographs (peri means ‘‘around’’ and apical means ‘‘end of the dental root’’) record images of the outlines, location, and mesiodistal size of the teeth and surrounding tissues. The intraoral periapical examination obtains the view of the entire dental and surrounding structures . Intraoral periapical radiography is a widely used intraoral imaging technique in dental radiology and provides considerable information about the teeth and surrounding bone. The film presents vital information to aid in the diagnosis of the most common dental diseases, especially dental caries, dental abscesses, periodontal bone loss, or gum disease, and shows the teeth and surrounding alveolar bone, all dental coatings, and dental roots.Caries detection based on panoramic and periapical imaging techniques is performed manually by dentists. Mostly the caries dental diagnosis seen on the radiography cannot be made correctly because the existing dental caries can be overlooked due to the physician’s inexperience or intense patient load. This situation can lead to the progression of caries, advanced dental infections, and dental loss. Automatic systems, which have been developed based on machine learning and image processing techniques to avoid these negativities and facilitate dentists’ diagnoses, have gained considerable importance.

1.2 PROBLEM STATEMENT:

A poor oral hygiene is associated with dental caries, gingivitis, periodontal diseases, bad breath, respiratory and cardiovascular diseases, and chronic kidney diseases. Moreover, a poor oral health has psychosocial impacts that diminish a quality of life and restrict activities in school, at work, and home. However, very few studies highlighted about oral hygiene practices and there is also paucity of information in Ethiopia. Normally the body's natural defenses and good oral health care, such as daily brushing and flossing, keep bacteria under control. However, without proper oral hygiene, bacteria can reach levels that might lead to

oral infections, such as tooth decay and gum disease.

II. Literature Review

Other dental x-rays are intraoral, shows only a fragment of patient's dentition whereas Panoramic x-rays shows full dentition, conveys largest amount of information. To develop a framework that extracts features efficiently. To design an efficient deep learning approach that can aid in the automatic detection of objects in the dental X-rays. To classify the detected objects in the dental x- ray images into caries and root canal. A fundamental purpose of dental education is to develop health professionals who will maintain and improve the oral health status of individuals and populations. In this research work the authors presented score-based multi-input CNN ensemble (MI-DCNNE) to detect dental caries. The proposed system consists of three phases: Pre-processing, Deep Convolutional Neural Network, and score-based fusion [1]. The authors formulated caries detection as a segmentation problem in which they were interested in segmenting a dental X-ray image into two components, i.e., background (region without caries) and foreground (region containing caries). In medical settings, data annotation is very challenging due to the annotation cost, time, and availability of human experts, e.g., physicians and radiologists. Considering such a case, the authors have formulated caries detection as a self-supervised learning problem. Proposed self-training method for caries segmentation[2].

The goal of materials should be early caries detection, removal of carious lesions, and reduction of dentin hypersensitivity. Thus, the study aims to determine the efficacy of a bioactive caries detecting dye (BCD) for the diagnosing and mechanical removal of occlusal and proximal dental caries. BCD helps in identification of dental caries clinically, radiographically, and in effective removal of denatured teeth with less pain or sensitivity[3].To investigate the detection sensitivity of the eTC-PCT, TC-PCT, and TC-PCT LIOP algorithms to the presence of dental caries, an in vitro approach was adopted to demineralize the samples in a controlled manner. All samples were collected according to the necessary ethics requirements and considerations. The chosen bacteria-based protocol closely mimicked the natural dynamics of caries formation by lactic-acid-producing cariogenic bacteria[4]. The study evaluated dental caries detection ability between the Oraycam and Oraypen on the same dental caries lesions. In this work a total of 178 teeth from 61 patients were imaged using Oraypen and Oraycam Pro devices and evaluated using analysis software(QA2). Occlusal, secondary, and proximal dental caries were evaluated and scored according to International Caries Detection and Assessment System(ICDAS II) and X-ray criteria[5].

The authors undertook a formal comparative analysis of the diagnostic accuracy of different technologies to detect and inform the diagnosis of early caries using published Cochrane systematic reviews. Forming the basis of our comparative analysis were 5 Cochrane diagnostic test accuracy systematic reviews evaluating fluorescence, visual or visual-tactile classification systems, imaging, transillumination and optical coherence tomography, and electrical conductance or impedance technologies[6]. This technique is based on low coherence interferometry that can provide three- dimensional images. This paper focuses on the principles of OCT and its application in early caries detection. Numerous in vitro and in vivo studies have revealed the efficiency of this powerful tool to detect incipient lesions. Further research is recommended to validate the clinical usefulness of this emerging diagnostic aid[7]. In this paper, conventional, contemporary, and developing approaches used in the detection of dental caries will be presented. Dental caries is an important problem for human health which is frequently seen under clinical conditions and also progresses slowly, causes severe pain and even tooth loss, and affects the quality of life. Especially in pediatric patients, with the early detection of caries,treatment procedures can be performed with uncomplicated methods[8].

Eighteen extracted human teeth (molars and premolars), with varying degrees of natural pathology and no degree of decay involving dentin were obtained. HSI system with a wavelength range from 400 to 1000nm was used to obtain images of all 18 teeth containing sound, carious and pigmented areas. We compared the spectra of the wavebands at both 500 nm and 780 nm from the different tooth states, and the re°ectance difference between sound versus carious lesions and sound versus pigmented areas, respectively[9]. In this work, a multispectral (MS) truncated- correlation photothermal coherence tomography (TC-PCT) imaging modality is introduced for the detection of bacterial-induced dental caries. MS TC-PCT provided thorough information about optimal lesion contrast and type of dental defects such as caries in teeth[10]. This in vitro study analysed potential of early proximal caries detection using 3D range data of teeth consisting of near-infrared reflection images at 850 nm (NIRR). Reliability assessments included kappa statistics and revealed high agreement for both methods. Statistical analysis included cross tabulation and calculation of sensitivity, specificity and AUC[11].

III. PROPOSED METHODOLOGY

The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. Several algorithms exists, and this worksheet focuses on a particular. Even though it is quite old, it has become one of the standard edge detection methods and it is still used in research.

The aim of JFC was to develop an algorithm that is optimal with regards to the following criteria:

1. **Detection**: The probability of detecting real edge points should be maximized while the probability of falsely detecting non-edge points should be minimized. This corresponds to maximizing the signal-to-noise ratio.
2. **Localization**: The detected edges should be as close as possible to the real edges.
3. **Number of responses**: One real edge should not result in more than one detected edge (one can argue that this is implicitly included in the first requirement).

With Canny's mathematical formulation of these criteria, Canny's Edge Detector is optimal for a certain class of edges (known as step edges). A C# implementation of the algorithm is presentedhere.

The readers are advised to do more research on canny edge detection method for detailed theory.

The Canny Edge Detection Algorithm

The algorithm runs in 5 separate steps:

1. Smoothing: Blurring of the image to remove noise.

Implemented through Gaussian Filtering with Specific Kernel Size (N) and Gaussian EnvelopeParameter Sigma.

2. Finding gradients: The edges should be marked where the gradients of the image haslargemagnitudes.

Sobel X and Y Masks are used to generate X & Y Gradients of Image; next function implements differentiation using sobel Filter Mask

3. Non-maximum suppression: Only local maxima should be marked as edges.

We find gradient direction and using these direction we perform non maxima suppression.

4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges thatare not connected to a very certain (strong) edge.

This is performed by a recursive function which performs double thresholding by two thresholds High Threshold(TH) and Low Threshold (TL) and 8-connectivity analysis.

IV. RESULT AND DISCUSSION

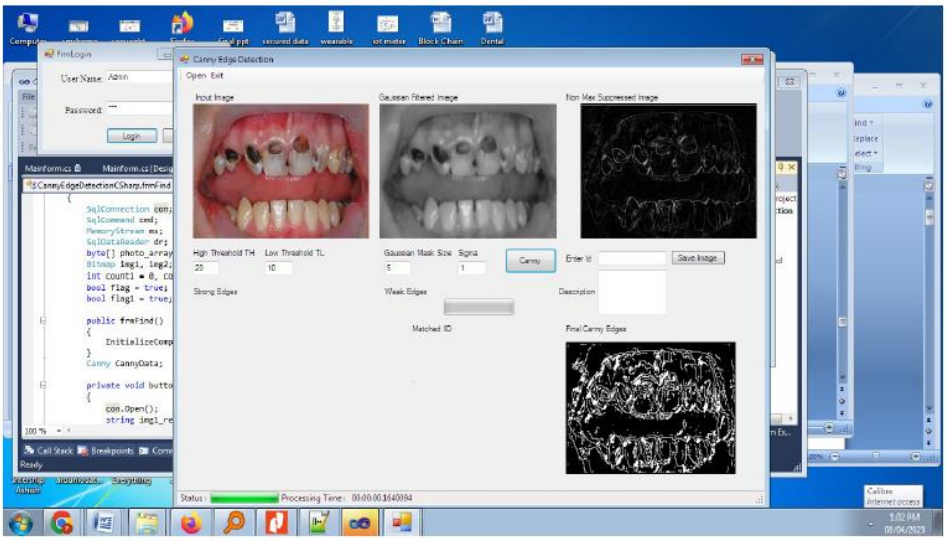

Figure. 1 Disease Detection

Figure 1. AI AND ML OUTPUT

The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. Several algorithms exists, and this worksheet focuses on a particular one developed by John F. Canny (JFC) in 1986. Even though it is quite old, it has become one of the standard edge detection methods and it is still used in research. With Canny's mathematical formulation of these criteria, Canny's Edge Detector is optimal for a certain class of edges. A C# implementation of the algorithm is presented here.

V. CONCLUSION

As well as reducing the expense of oral health care, accurate identification of dental decay and root canals improves the chance of natural tooth preservation in the long run. In this research, deep learning techniques are used to recognize and classify dental X-ray items. In order to recognize generic objects, we have utilized the Edge detection which features feature concatenation, multi-scale training, hard negative mining, and correct tuning of anchor sizes for RPN, amongst other things. Because this framework combines a variety of approaches, it is able to overcome many of the limitations of single methods. Both dental cavities and root canals have been detected.

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