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Teeth Detection Using Machine Learning Techniques: A Review

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ABSTRACT—The objectives of this work were to create a mechanism for tooth cavities to be detected automatically and to suggest quantitative methods for doing so. Recently, machine learning and deep learning algorithms have been used to segment teeth in dental pictures and support dentists in making clinical judgements. The area-of-interest (ROI), which should be the maxillofacial region, must be extracted from the source pictures by removing all irrelevant data. However, due to the poor image quality, a quick and precise maxillofacial segmentation without hand-crafted features is difficult. To solve this issue, we generate a sizable maxillofacial dataset and suggest the EED-Net encoder-decoder network architecture. There are 2602 images of teeth in this collection.

KEYWORDS—CNN, Preprocessing, Feature Extraction, Deep Learning, Image Processing.

I. INTRODUCTION

A. Overview

Human teeth are typically made of strong materials that are difficult to destroy. After a person has passed away, their shapes can hold without eroding. The most common chronic disease worldwide is dental caries. While a skilled dentist is needed for cavity detection. Due to expense or dental anxiety, 1 in 3 Americans miss out on annual dental visits. A lot of interest in machine learning has grown in the field of medical research as a result of its outstanding performance in detection, prediction, and classification. Specialists can detect issues in areas with poor sight, inside the buccal cavity, or in challenging-to-reach places by analysing panoramic dental radiographies. The diagnosis, however, may vary due to poor imaging quality or exhaustion, which may eventually make treatment more difficult. In this study, we provide a novel method for automatically identifying teeth in real photographs, which can help the medical staff decide on the most appropriate diagnosis. The annotated data was used to train a CNN to gain semantic segmentation information.

B. Motivation

- Deep convolutional neural networks and machine learning have become quite popular in medical research due to their outstanding performance in classification, prediction, and detection.
- Specialists can detect issues in areas with poor sight, inside the buccal cavity, or in challenging-to-reach places by analysing panoramic dental radiographies.

II. RELATED WORK

In this article, we elaborate on the use of Mask RCNN for autonomous tooth segmentation and detection. A novel approach for object detection and semantic segmentation has just been proposed, called Mask RCNN. Only teeth detection and segmentation are the goals of this work. We demonstrate that Mask RCNN also performs well in segmenting dense and complicated tooth features. Pixel accuracy (PA) is used to assess the outcomes [1].

The electric shovel is a common open-pit mining excavator with a bucket today. The bucket teeth may shatter and fall off early as a result of continuous direct contact with hard and abrasive materials like ore during the mining excavation



process, leading to unanticipated downtime and productivity losses. We have created a deep learning-based system for vision-based bucket teeth failure detection in response to this issue. We trained a Faster Region Convolutional Neural Network (Faster R-CNN) to determine the number of normal bucket teeth and the positions of the bucket teeth from images using a dataset based on images of both real shovel teeth and 3D-printed models. We used the additional bucket dataset from 3D-printed models to pretrain the network for improving its detection accuracy on the real bucket data. Our Faster R-CNN model outperformed the ZFNet, ResNet50, and VGG16 in our comparison with other R-CNN models in terms of accuracy and speed[2].

In this article, we elaborate on the use of Mask RCNN for autonomous tooth segmentation and detection. A novel approach for object detection and semantic segmentation has just been proposed, called Mask RCNN. Only teeth detection and segmentation are the goals of this work. We demonstrate that Mask RCNN also performs well in segmenting dense and complicated tooth features. Pixel accuracy (PA) is used to assess the outcomes [3].

The aims of this study were to develop an automatic detection technique for tooth cracks and to suggest quantitative methods for measuring gingival sulcus depth using swept-source optical coherence tomography (SS-OCT). We evaluated SS-OCT with wavelength centered at 1310 nm over a spectral bandwidth of 100 nm at a rate of 50 kHz as a new diagnostic tool for the detection of tooth cracks and gingival sulcus depth. The reliability of the SS-OCT images was verified by imaging the crack in extracted human teeth and gingival sulcus of porcine sample. The SS-OCT could automatically detect the position of various cracks and visualize the deep periodontal pockets. Therefore, the detection capability of SS-OCT images could be useful diagnostic tool for dental cracks and periodontal pockets [4].

Rope shovels are widely used in the mining industry to dig ore. During operation, one or more teeth in the bucket can be lost as a result of the force that impacts the teeth, which causes a serious problem when the broken teeth gets picked up by the haul truck and eventually ended up in the crusher and jamming it. In this paper, we present a vision system for monitoring tooth condition and detecting missing tooth for a mining shovel. Our system leverages the predictable range of motion that the bucket of a rope shovel goes through during operation due to the camera mounting. For this reason, our strategy is to use exemplar based image retrieval and a sliding window procedure to first locate a pre-defined static region of the bucket in a live frame, followed by detecting the tooth line region based on its relative position to the selected exemplar. Once the tooth line region is detected, we proceed by determining its transformation from a recently detected tooth line region, and rectify the tooth line region before conducting image differencing [5].

Complete denture CAD/CAM technology offers the prospects of drastically reducing the time to provide service to patients. The tooth arrangement and adjustment of the occlusal surface are key steps of complete denture CAD/CAM. This work presents an effective method of tooth arrangement and virtual adjustment of the occlusal surface for complete denture. After teeth features and oral features were extracted, auto tooth arrangement for complete denture based on feature-driven method was performed. Then, interference area Detection based on seed filling algorithm was taken. Finally, Laplacian local deformation was performed to minimize the over-interference on the occlusal surface. Some examples were tested in this work and the results demonstrated that the proposed method is effective and feasible [6].

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In dentistry, often dental radiography is related to teeth occlusal surface, which can be used for diagnostic and treatment purposes. Nonetheless the exposure of X-Ray dose may limit the usage of this technique. This paper presents the image construction from the occlusal surface of human teeth. The principle of the surface construction is from the exploitation of reflected light intensities along the occlusal surface of human teeth. The image of occlusal surface is constructing back using simple MatLab software. The measured diameter from the images of occlusal surface for molar A and molar B is to be 7.0 mm and 7.5 mm, respectively, which is exactly the same when measured with micrometer. The average surface roughness for each tooth sample namely molar A and molar B is obtained to be 742 μm and 975 μm , respectively. Such results are useful for detecting the occlusal topography and surface profile of human teeth [8].



The purpose of forensic dentistry is to identify individuals based on their dental characteristics. In this paper, a methodology to classify and assign numbers to teeth in bitewing dental images is presented. The goal is to use the result of this methodology in an automated dental identification system. In this way, proposed approach benefits of categorizing molar and premolar teeth and also spatial relations between teeth in jaws. The three main steps in the methodology are: 1. Deducing the exact location and size of the mesiodistal neck for each type of teeth. 2. Teeth classification using a linear model and 3. Identification of types and numbers of the missing and/or broken teeth. This methodology enables us to assign numbers to the remaining teeth using the universal number system. Experimental result obtained for this investigation on a database of 476 teeth, indicate that the proposed methodology is more advanced in neck detection, teeth classification and numbering, broken teeth detection, identification of the number and type of missing teeth in comparison with some previously published work [9].

The electric shovel is a bucket-equipped mining excavator widely used in open-pit mining today. The prolonged direct impact of the bucket teeth with hard and abrasive materials such as ore during the process of the mining excavation can cause the bucket teeth to break and fall off prematurely, resulting in unplanned downtime and productivity losses. In response to this problem, we have developed a vision-based bucket teeth fault detection algorithm with deep learning. Using a dataset based on the images of both real shovel teeth and 3D-printed models, we trained a Faster Region Convolutional Neural Network (Faster R-CNN) to obtain the number of normal bucket teeth and the positions of the bucket teeth from the images, using the additional bucket dataset from 3D-printed models to pre-train the network for improving its detection accuracy on the real bucket data. We compared the resulting Faster R-CNN model with the ZFNet, the ResNet50, and the VGG16 and found our Faster R-CNN model to perform best in terms of accuracy and speed [10].

III. OPEN ISSUES

A lot of work has been done in this field thanks to its extensive use and applications. This section mentions some of the approaches that have been implemented to achieve the same purpose. These works are mainly differentiated from the techniques for this systems.

Dental radiographs are commonly used for clinical diagnosis, treatment, and surgery. Dentists can spot cavities, bone degeneration, and hidden dental structures by analysing these photos. Dental radiographs are commonly used for clinical diagnosis, treatment, and surgery. Dentists can spot cavities, bone loss, and concealed dental features that are difficult or impossible to notice with the unaided eye by using these images. However, a skilled dentist is required for cavity detection. Due to expense or dental anxiety, 1 in 3 Americans miss out on annual dental visits. Additionally, because there are fewer dentists per patient in developing countries, there are less opportunities to identify cavities properly. Millions of people lack access to quality dental treatment due to different financial and infrastructure hurdles. Previous research has attempted to construct deep learning (DL) classifiers that can automatically identify tooth cavities on X-ray images. Unfortunately, because X-ray scans might be more expensive, these technologies are not widely available. The majority of individuals, aside from dental experts, are unfamiliar with X-ray images. As a result, end-users might find it difficult to accept a system's diagnosis that uses such images that they can't understand themselves, even if X-Ray imaging were made available at considerably reduced costs.

IV. CONCLUSION

This work presented a novel approach for dental cavity detection utilising the real image collection. To get the intended outcomes, pictures from three distinct sources and a dental facility were acquired. Images were utilised to train a semantic segmentation CNN after various strategies were applied to enrich the annotated data. A technique to find cavities in real images is suggested in this paper. This is accomplished by utilising a modest training dataset.

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