Automatic Detection of Restoration, Periodontal Disease, and Missing Teeth Using Dental Panoramic X-Rays Films Based on CNN

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Abstract

Dental Panoramic Radiograph (DPR) film is a vital piece of data used for the initial diagnosis of dentistry and in comprehending the state of the teeth of a patient. Although artificial intelligence (AI) technology is getting more mature in many medical applications, dentistry still relies on manual techniques to detect DPR symptoms. Dentists spend a lot of time in manually judging the dental conditions of a patient. The goal of this study is to develop a smart health system to automatically detect three dental diseases by using the convolutional neural network (CNN) technology on dental panoramic (DPR) films. This study intends to improve the detection of lesions by integrating picture enhancements and data preprocessing approaches with advanced CNN to provide assistance to the dentists in performing the diagnosis and lessen the strain on dentists. Three CNN models namely AlexNet, GoogLeNet and ResNet50 were used after performing data augmentation and preprocessing. In order to improve the accuracy of the model, several noise spots and increased symptoms were filtered out from the images using a variety of image processing techniques. According to the experimental results, without any image preprocessing or enhancement, the trained network can identify the tooth condition with an average accuracy of 90.99% as shown in Figure 1. The accuracy can be improved to 92.51% by incorporating data augmentation. From Table 1, the average accuracy of restoration, periodontal disease, and missing teeth is 92.73% which is significantly better than those in previous studies with 81.00%, 87.50%, 92.00%, 92.24%, 90.24%, and 59.09% in [1], [2], [3], [4], [5] and [6], respectively. This paper does not only provide a higher performance in terms of accuracy. It also provides more functions than those in the previous studies, such as the GUI interface of the application side, the export table and image of the recognition results. By using the proposed models and technologies in this study, the dentists can provide a more precise and objective assessment information which allows the dentists to develop better diagnosis and treatment strategies as well as promote precision medicine. The proposed strategy does not only decrease the dentists' burden of manually doing the diagnosis, it also allows them to spend more of their time in providing professional clinical treatment. This research has been approved by the Research Institution Review Board (IRB) under application number 202002030B0.

Keywords: Smart health, Medical image processing, Artificial intelligence, Dental panoramic image, Periodontitis Disease, Restoration, Missing teeth, Smart computing, CNN.

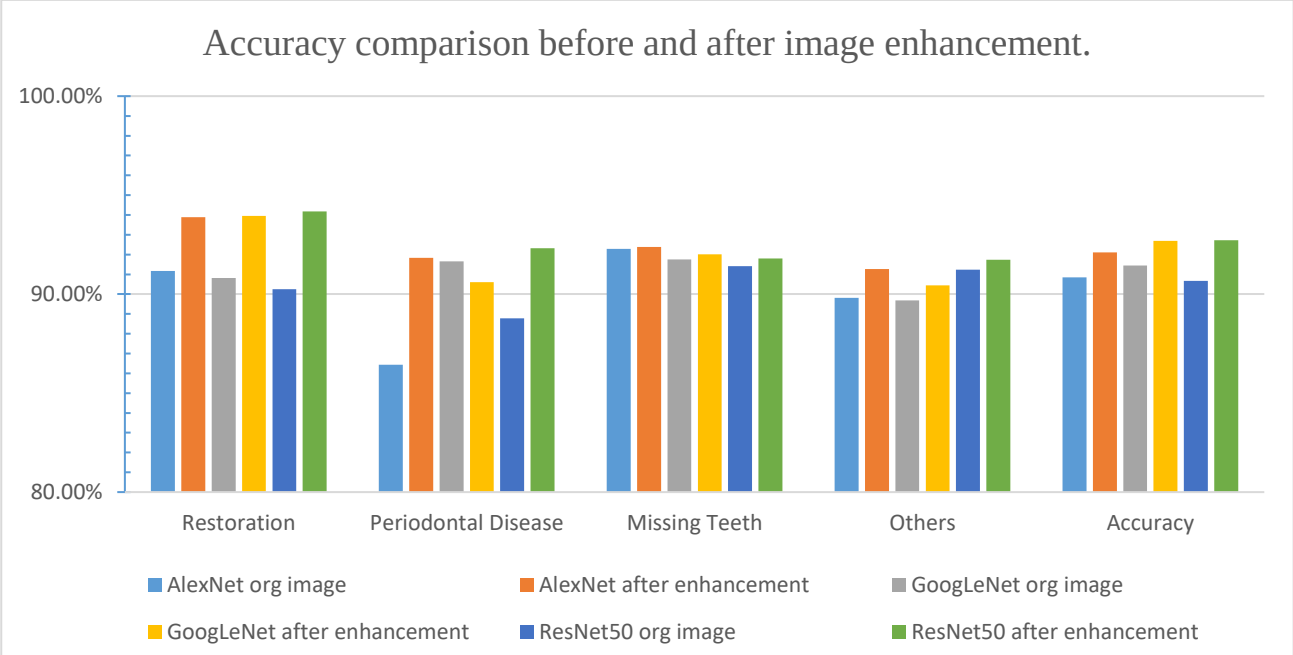


Figure 1. The three CNN models, AlexNet, GoogLeNet and ResNet50, were used in this study to compare the accuracy of each symptom before and after picture augmentation.

Table 1: Comparison of accuracy rates for three CNN models in this work with previous studies.

	Faster R-CNN [1]	Faster R-CNN [2]	SVM + Cutting Sounds [3]	Faster R-CNN [4]	CNN+ contrast enhancement [5]	Faster R-CNN [6]	This work		
							AlexNet + Gaussian and Flat Field	GoogLeNet + Gaussian and Flat Field	ResNet 50 + Gaussian and Flat Field
Restoration	NA	NA	92.00%	92.24%	84.30%	NA	93.88%	93.95%	**94.17%**
Periodontal disease	81.00%	87.50%	NA	NA	NA	NA	91.84%	90.60%	**92.32%**
Missing teeth	NA	NA	NA	NA	88.48%	59.09%	92.39%	92.01%	91.80%
Accuracy	81.00%	87.50%	92.00%	92.24%	90.24%	59.09%	**92.11%**	**92.69%**	**92.73%**

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