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Teeth Disease Detection using Deep Learning

Aarti Pimpalkar[1], Sanket Patil[2], Shubham Salunke[3], Shejal Bendre[4], Pratiksha Yadav[5]

Assistant Professor, Department of computer Engineering, Sinhgad Academy of Engineering, Pune, India [1]

Student, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, India [2,3,4,5]

SITE'S SINHGAD ACADEMY OF ENGINEERING KONDHWA BK

Abstract: Dentists use panoramic dental X-ray images as a crucial diagnostic tool to identify symptoms early on and create effective treatment strategies. Deep learning techniques have been used in recent years to segment teeth in dental X-rays, helping dentists make clinical choices. The region of interest (ROI), which should be the maxillofacial region, must be extracted from the original images because they are filled with a lot of unnecessary information. However, due to the poor image quality, a quick and precise maxillofacial segmentation without hand-crafted features is difficult. Here we use the teeth images for training and testing purposes to ease the process. In order to address this issue, we generate a sizable maxillofacial dataset and suggest an effective CNN model which will predict the infected or healthy teeth.

Keywords: CNN; Medical Imaging; Image Processing; Machine Learning; Dental Informatics; X-Ray Semantic Segmentation.

INTRODUCTION

The Teeth Detection and Dental Problem Classification in Images using Deep Learning project aims to develop a computer vision system that can accurately detect teeth in dental images and classify them based on potential dental problems. The system will utilize deep learning techniques, specifically convolutional neural networks (CNN), to analyze dental images and provide real time feedback to dentists and patients.

Oral health is a critical aspect of overall health and well-being, and regular dental check-ups are crucial in detecting and treating dental problems. However, dental exams can be time-consuming, and some dental problems may go unnoticed due to human error. This project seeks to address these issues by developing an automated system that can accurately detect dental problems and provide real-time feedback to dentists and patients.

The Teeth Detection and Dental Problem Classification in Images using Deep Learning system will provide a valuable tool for dentists and patients by providing quick and accurate assessments of dental health. The system will also help reduce the workload of dentists by automating the detection and classification of dental problems. Ultimately, this project will contribute to improving dental health and well-being.

RELATED WORK

In the field of dental informatics there are several approaches developed for teeth segmentation victimization differing types of radiographic images equivalent to bite wing, periapical and panoramic images. segmentation strategies applied in dental imaging. The author planned a way for teeth instance segmentation in panoramic images employing a mask region-based convolution neural network to accomplish instance segmentation.

For clinical diagnosis, treatment, and surgery in dentistry, dental radiographs are frequently employed. By using these images, dentists can identify cavities, bone loss, and hidden dental structure for clinical diagnosis, treatment, and surgery in dentistry, dental radiographs are frequently employed. By using these images, dentists can identify cavities, bone loss, and hidden dental structures that are difficult or impossible to see with the naked eye. As a result, dentists can identify problems at an early stage and create effective treatment strategies. The bite-wing, periapical, and panoramic conventional radiographs are the three forms used in the dental examination. The upper and lower teeth are partially visible on the bite-wing X-rays, which are used to look for changes in bone density brought on by gum diseases that are difficult or impossible to see with the naked eye. As a result, dentists can identify problems at an early stage and create effective treatment strategies. The bite-wing, periapical, and panoramic conventional radiographs are the three forms used in the dental examination. The upper and lower teeth are partially visible on the bite-wing X- rays, which are used to look for changes in bone density brought on by gum disease.

SYSTEM ARCHITECTURE

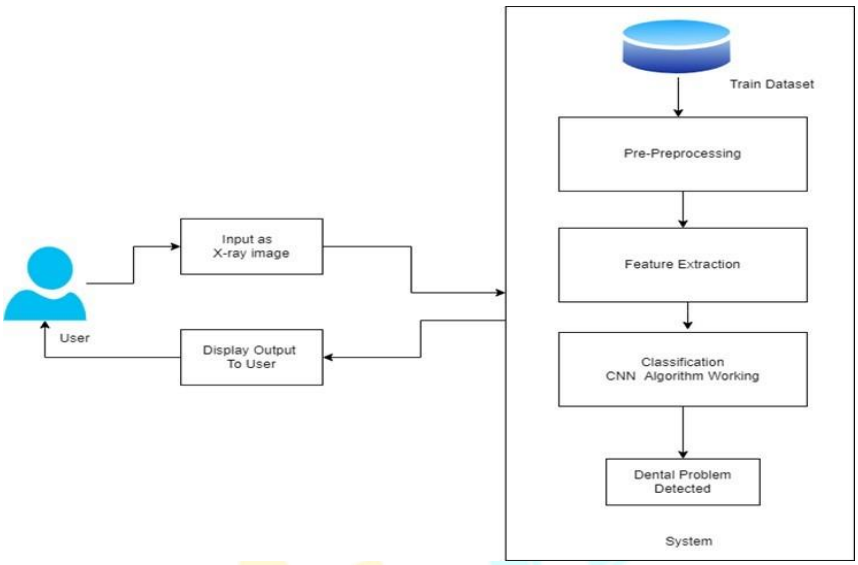

Figure 1. shows the overall system architecture. The user will upload the Teeth image and then the model will preprocess the image and followed by CNN prediction.

IMPLEMENTATION

Figure 2. shows the data set containing the healthy and unhealthy teeth.

1] Dataset: The dataset used for training the model comprises of images exhibiting both healthy and unhealthy conditions.

2] Training: The process of diagnosing teeth diseases is a multifaceted approach that involves various tasks, including image acquisition, pre-processing, feature extraction, and classification. The initial step is the image acquisition phase, where teeth images are sourced from various data sets. The second phase involves image pre-processing, where techniques are applied to enhance the quality of the image. The next step is feature extraction, where specific properties of pixels in the infected part of the teeth, such as color and texture, are analysed to extract the necessary features. Finally, statistical analysis is conducted to classify the image features, and machine learning algorithms are utilized to compare these features and diagnose the type of disease present.

3] Testing: The evaluation of the model is conducted on a set of new, previously unseen images that are distinct from the ones used for training. The performance of the model is assessed under various levels of difficulty, ranging from easy to medium and hard cases. Based on the evaluation results, an estimation of the model's performance can be made.

METHODOLOGY

Teeth detection teeth detection method uses the state-of- the-art faster R-CNN model. 15 faster R-CNN was evolved from fast RCNN architecture, which was, in turn, based on R-CNN method (region-based CNN). the challenging task of object detection is to define the regions of interest where the objects can be located.

Convolutional Neural Network is used for classification of the disease. Convolutional Neural Network is basically made up of neurons with weights and bias, that are inspired by the human brain. Architecture of CNN consists of an input layer, hidden layer, and output layer. Convolution layers and batch normalization layers form the hidden layer. The output layer is usually fully connected layer followed by SoftMax and classification layer.

LITERATURE SURVEY

In paper [1] requirements for neural network architecture are also very important in this research, so we changed the CNN architecture and the parameters of the test set many times to achieve optimal performance. The preliminary results showed the highest detection accuracy rate of the four categories were normal teeth at 87%, implants and fillings at 98% and cavities at 89%. We were able to achieve an average accuracy at 93.04%. Thus, we believed that this result could apply in periodontology dentistry field in the near future.

In paper [2], we expound the application of Mask RCNN on automatic tooth detection and segmentation. Mask RCNN is a recently proposed surprising algorithm for object detection and semantic segmentation. This paper aims at detecting and segmenting tooth only. We show that Mask RCNN also has a good segmentation effect in complex and crowded teeth structures. We use the pixel accuracy (PA) to evaluate the result.

In paper [3] work aims at creating an economical, multimodal, personal oral sensing device that automatically senses and categorizes the data which will assist the clinician in early diagnosis and effective treatment. Our proposed smart electronic device automatically captures valuable parameters like pH, temperature, CO2, and other gases to overcome the challenges in the diagnosis of the oral problem. The captured data is fed to Convolutional Neural Network for classification of oral diseases.

FUTURE SCOPE

1. Mobile Application Integration: In the future, teeth disease detection applications that use CNN can be integrated into mobile devices to enable patients to identify teeth diseases in real-time.

2. Expansion of the Dataset: Increasing the size and diversity of the dataset used for training the CNN model will result in a more accurate and comprehensive disease identification system.

3. Multi-Class Detection: Currently, most teeth disease detection applications that use CNN can only detect a limited number of diseases. Future applications can be developed to detect multiple diseases and classify them according to their severity.

4. Real-Time Detection: As technology advances, teeth disease detection applications can be developed to provide real-time detection of teeth diseases using live video feed.

5. Automated Treatment Recommendation: Future teeth disease detection applications can be developed to recommend automated treatment based on the identified disease. This can help reduce the time and resources required for manual diagnosis and treatment of teeth diseases.

6. Collaboration with Dentist Experts: Collaboration with dentist experts can help develop more accurate and comprehensive disease identification systems. By integrating expert knowledge with machine learning algorithms, teeth disease detection applications can become more reliable and effective in identifying and treating teeth diseases.

RESULTS AND DISCUSSION

The dataset is split into the training set and the validation set. 70% of the data are taken as the training dataset and 30% of the data are used for the validation purpose. Construction of the Multioutput Model. In this work, the transfer layer has been implemented by using a convolutional neural network. The convolution neural network has been constructed by incorporating different number of max-pooling layer, dropout layer, and activation functions.

The discussed work is implemented using the Python programming language. the performance parameters used for the validation of the models are accuracy and loss. the proposed Model has achieved an accuracy of 95% with data augmentation and 92 without augmentation.

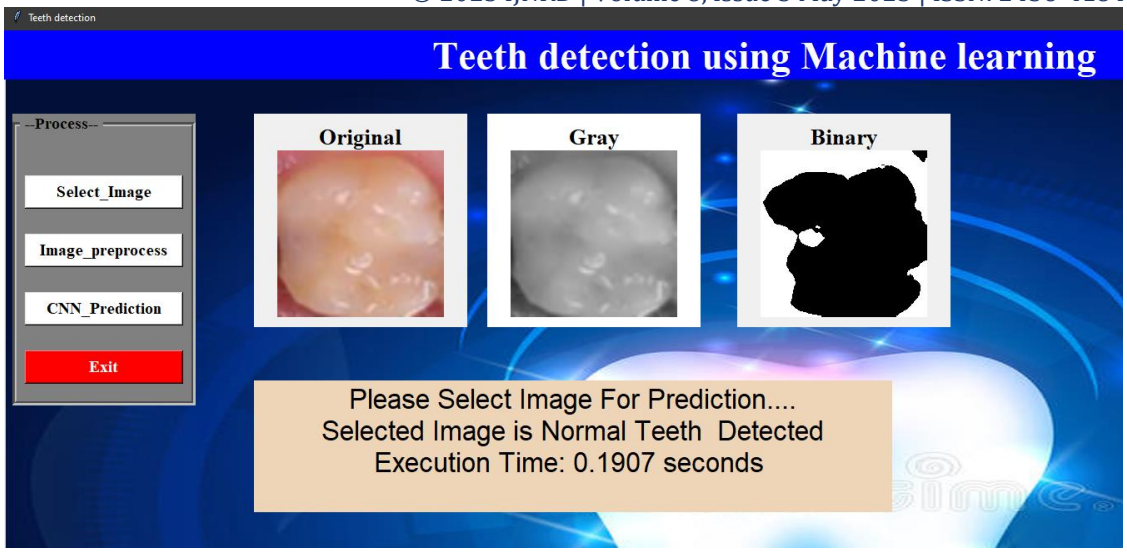

Figure 3. Normal Teeth Detected

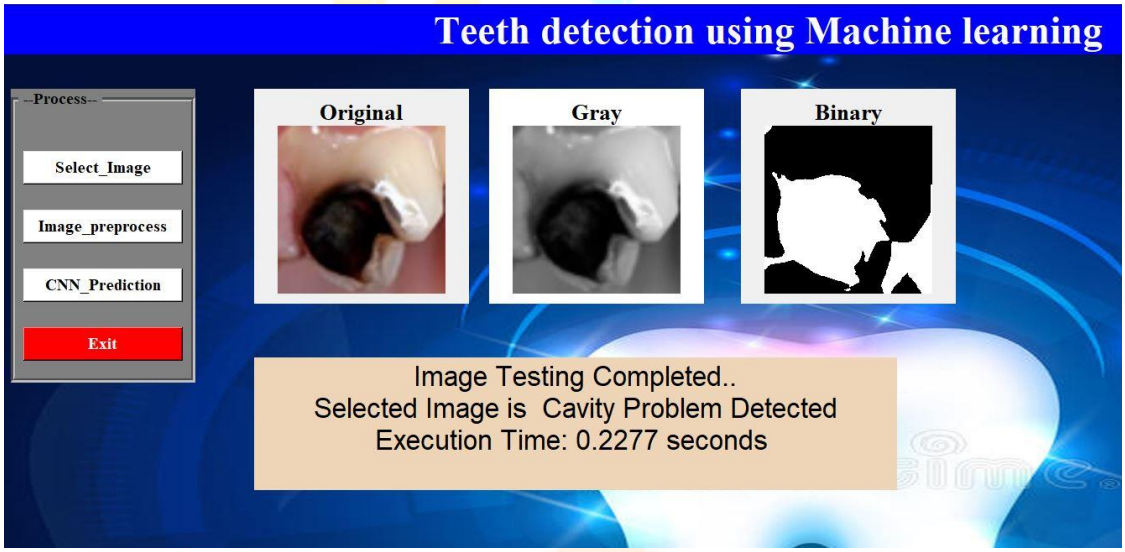

Figure 4. Cavity Problem Detected

CONCLUSION

This work assists in detecting oral diseases. So, it is possible to reduce deaths caused by Oral cancer, by detecting it in early stage. This study described a brand- new method for classifying dental issues and detecting teeth using panoramic dental radiographies. The developed system aims to benefit the Dentist sector and patient by detecting teeth diseases and suggesting appropriate remedies to improve dental health. This system, built using Python, achieves an impressive accuracy rate of approximately 96%. With early detection of teeth diseases, Patients can take preventive measures to protect the teeth from further damage. The use of classification and feature extraction techniques has improved the performance of the system, resulting in better results. To enhance the system's accuracy, it is recommended to stack the model with more layers and train the network using more image data, utilizing clusters of GPUs. Future enhancements will focus on the segmentation of larger, colored images, which will be highly useful in the image segmentation process. By increasing the training dataset and further we can increase the diseased segmentation classes in model.

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