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Review of Classification and Early of Oral and Mouth Diseases by Using Advanced Deep Learning Methods

Sunil Zinagare¹, Ayan Lakhani², Prof. Mohit Popat³

Bachelor of Engineering, Computer Science and Engineering, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal

Abstract: *Oral and mouth diseases are among the most prevalent health issues, significantly affecting individuals' quality of life and posing serious health risks if left undiagnosed. Early detection and accurate diagnosis are critical in preventing the progression of conditions such as oral cancer and other potentially malignant disorders. Recent advancements in digital tools and deep learning have opened new avenues for improving diagnostic accuracy and accessibility.*

This paper tackles these issues by utilizing the InceptionResNetV2 architecture to create a robust and efficient classification system for oral diseases. The system leverages a comprehensive dataset of oral condition images, processed and trained on platforms like Google Colab or Jupyter Notebook to ensure scalability and computational efficiency. The trained model is seamlessly integrated into a Flask-based web application, allowing users to upload images and receive precise diagnostic results. By combining advanced deep learning techniques with user-friendly technology, this paper aims to facilitate early detection and diagnosis of oral diseases, enabling timely medical intervention and improving overall oral healthcare outcomes [1].

Keywords: *Deep Learning, Mouth Disease Detection, Oral Disease Classification.*

I. INTRODUCTION

Oral and mouth diseases pose significant health challenges worldwide, ranging from common issues like cavities and gum disease to more severe conditions such as oral cancer and potentially malignant disorders like oral submucous fibrosis (OSMF) [1]. These diseases, if not diagnosed and treated early, can lead to debilitating complications, affecting not only physical health but also an individual's quality of life. Early detection and accurate diagnosis are crucial in mitigating these risks, but traditional diagnostic methods, which often rely on manual visual inspection, are time-intensive and subjective [2]. Moreover, access to skilled professionals and diagnostic facilities is limited in remote or underserved regions, emphasizing the need for innovative solutions to enhance diagnostic accuracy and accessibility [3].

This paper seeks to address these challenges by leveraging the capabilities of deep learning, specifically the InceptionResNetV2 architecture, to develop an efficient and accurate classification system for oral and mouth diseases [4].

The system utilizes a curated dataset of oral disease images and employs advanced preprocessing techniques, such as resizing, normalization, and augmentation, to ensure optimal model performance. Training is conducted on scalable platforms like Google Colab or Jupyter Notebook, enabling computational efficiency. The trained model is then integrated into a user-friendly web application built with the Flask framework, allowing users to upload images and receive real-time diagnostic results. By combining cutting-edge AI techniques with practical healthcare applications, this paper aims to facilitate early detection, improve accessibility to diagnostic tools, and contribute to better oral healthcare outcomes for individuals across diverse communities [5].

II. LITERATURE REVIEW

- 1) Rashid, Javed, et al. In the current study Mouth and Oral Diseases Classification using InceptionResNetV2 Method was established to identify diseases such as gingivostomatitis (Gum), canker sores (CaS), cold sores (CoS), oral lichen planus (OLP), oral thrush (OT), mouth cancer (MC), and oral cancer (OC). The new collection, termed "Mouth and Oral Diseases" (MOD), comprises seven distinct categories of data. Compared to state-of-the-art approaches, the proposed InceptionResNetV2 model's 99.51% accuracy is significantly higher [1].

- 2) Rajee, M.V., et al. In this paper, the author proposed a novel technique of segmentation with Curvilinear Semantic Deep Convolutional Neural Network (CSDCNN). The segmentation is followed by the proposed Inception resnetV2, which acts as the classification technique to determine the caries in dental images. The proposed segmentation algorithm is used to determine a dental degree of membership. The inception is brought out with different scales of information, which relates to various input images as data. An examination of the x-ray images will detect the impact of illness on a tooth. Particularly for the segmentation and classification mission, they deemed four diseases: dental caries, periapical infection, periodontal, and pericoronal diseases. Based on the number of input functional parameters, the Inception resnetV2 classifies different image categories effectively [2].
- 3) Kaushik, Pratham, et al. This paper considers the application of the Inception ResNetV2 architecture in the classification of pathologies of the mouth. Six classes are focused on: calculus, caries, ulcers, gingivitis, discoloration of tooth enamel, and hypodontia. The performance of the model is benchmarked on a set containing 1166 labeled images, taking into account the prevalence and severity of each condition. The results indicate that, among all of the scenarios, Inception ResNetV2 has achieved an accuracy of 93%. Accuracy in distinguishing classes: calculus, 0.76; caries, 0.99; ulcers, 1.00; gingivitis, 0.79; discoloration of tooth, 0.99; and hypodontia, 0.99. Its macro average for precision, recall, and F1-score are 0.91, 0.92, and 0.91, respectively [3].
- 5) Kumar, K. Vinay, et al. In this paper, this work aims to automate the classification of benign and malignant oral biopsy histopathological images. For this study, the CNN model Inception-Resnet-V2 is selected using the transfer learning approach. To enhance OSCC detection, additional layers are incorporated into this pretrained model. By mining a repository of oral cancer histopathology images, we can gauge how well these tweaked models perform. We examine the modified structure of the pretrained Inception-Resnet-V2 model and suggest a DL-CNN model that uses it. With an accuracy of 91.78%, it has outperformed in terms of performance metrics [4].
- 6) Tanriver, Gizem, et al. In this study, the author explored the potential applications of computer vision and deep learning techniques in the oral cancer domain within the scope of photographic images and investigated the prospects of an automated system for identifying oral potentially malignant disorders with a two-stage pipeline. Their preliminary results demonstrate the feasibility of deep learning-based approaches for the automated detection and classification of oral lesions in real time. The proposed model offers great potential as a low-cost and non-invasive tool that can support screening processes and improve the detection of oral potentially malignant disorders [5].
- 7) Soni, Aradhana, et al. This study aimed to utilize recent advancements in deep learning for medical image classification to automate the early diagnosis of oral histopathology images, thereby facilitating prompt and accurate detection of oral cancer. A deep learning convolutional neural network (CNN) model categorizes benign and malignant oral biopsy histopathological images. By leveraging 17 pretrained DL-CNN models, a two-step statistical analysis identified the pretrained EfficientNetB0 model as the most superior. Further enhancement of EfficientNetB0 was achieved by incorporating a dual attention network (DAN) into the model architecture [6].
- 8) Zhang, Hao, et al. The objective of this study was to assess the precision and robustness of a deep learning-based method to automatically identify the extent of cancer on digitized oral images. The author presents a new method that employs different variants of convolutional neural network (CNN) for detecting cancer in oral cells. This approach involves training the classifier on different images from the ImageNet dataset and then independently validating on different cancer cells. The image is segmented using multiscale morphological methods to prepare for cell feature analysis and extraction. The method of morphological edge detection is used to more accurately extract the target, cell area, perimeter, and other multidimensional features followed by classification through CNN [7].
- 9) Sudha, G., M. Mohammad Hussani, et al. This paper's goal is to develop a low-cost, multimodal, personal oral sensing device that perceives and classifies data automatically, enabling the physician to diagnose patients early and treat them effectively. The mouth disease prediction consists of preprocessing and classification process. The first step in mouth disease prediction is Wiener filter applied to filter the noise in testing image of dataset. After that augmentation involved expanding the number of images from the limited images. Finally, the comparison algorithms such as federated learning, multilayer perceptron (MLP) and deep belief networks (DBN) to produce the outputs as precision, recall, and accuracy was analyzed [8].
- 10) Babu, P. Ashok, et al. This study presents a unique approach to the early detection and diagnosis of oral cancer that makes use of the exceptional sensory capabilities of the mouth. Deep neural networks, particularly those based on automated systems, are employed to identify intricate patterns associated with the disease. By combining various transfer learning approaches and conducting comparative analyses, an optimal learning rate is achieved.

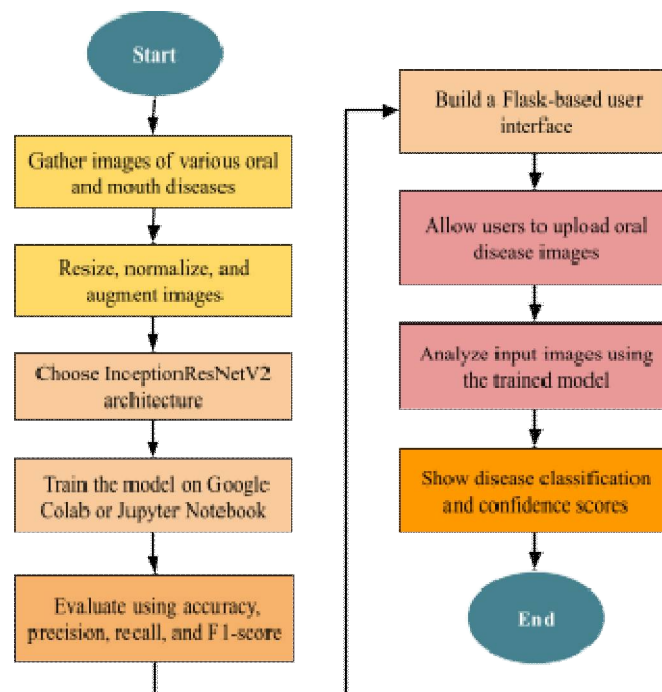
The categorization analysis of the reference results is presented in detail [9].

11) Das, Madhusmita, et al. In this study, histopathological images of oral cells are analyzed for the programmed recognition of Oral squamous cell carcinoma (OSCC) using the proposed framework. The suggested model applies transfer learning and ensemble learning in two phases. In the 1st phase, a few Convolutional neural network (CNN) models are considered through transfer learning applications for OSCC detection. In the 2nd phase, the ensemble model is constructed considering the best two pre-trained CNN from the 1st phase. The proposed classifier is compared with leading-edge models like Alexnet, Resnet50, Resnet101, Inception net, Xceptionnet, and InceptionresnetV2. Results are analyzed to demonstrate the effectiveness of the suggested framework. A three-phase comparative analysis is considered. Firstly, various metrics including accuracy, recall, F-score, and precision are evaluated. Secondly, a graphical analysis using a loss and accuracy graph is performed. Lastly, the accuracy of the proposed classifier is compared with that of other models from existing literature [10].

III. METHODOLOGY

The proposed system aims to develop an advanced classification model for oral and mouth diseases using the InceptionResNetV2 deep learning architecture. The system begins by collecting and preprocessing a dataset of oral disease images, including steps such as resizing, normalization, and augmentation to enhance model performance. The preprocessed data is then fed into the InceptionResNetV2 model, which is trained on Google Colaboratory Jupyter Notebook for efficient computation [7]. The model leverages its hybrid inception and residual layers to extract complex features and accurately classify diseases. Once trained, the model is integrated into a user-friendly web application built with the Flask framework. Users can upload images of oral conditions, and the system will analyze and classify the disease, providing results with performance metrics such as accuracy, precision, recall, and F1-score. This system aims to assist medical professionals and individuals in the early diagnosis of oral diseases, thereby facilitating timely intervention and treatment [8].

FLOWCHART



IV. SYSTEM REQUIREMENT

A. Software Requirement

Python software

B. Module Used

Flask

V. CONCLUSION

The proposed system offers a powerful and efficient solution for early diagnosis and disease identification. By leveraging the advanced capabilities of the InceptionResNetV2 architecture, the system effectively extracts complex features from oral disease images, ensuring high accuracy and reliability in classification. The integration of the trained model into a Flask-based web application provides a user-friendly platform for both medical professionals and individuals to upload images and receive real-time diagnostic results [9]. Through rigorous evaluation using metrics such as accuracy, precision, recall, and F1-score, the system demonstrates its robustness and practical applicability. This paper holds significant potential to assist in early detection and timely treatment of oral diseases, ultimately contributing to improved oral healthcare outcomes and reduced disease progression. The combination of advanced deep learning techniques, efficient computational resources, and intuitive user interaction positions this system as a valuable tool in the field of medical diagnostics [10].

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