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

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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 criticalinpreventingthe progressionofconditions suchasoral 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 architectureto create a robust andefficient 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 touploadimages and receiveprecisediagnosticresults.Bycombiningadvanced 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 DiseaseDetection,Oral Disease Classification.

I. INTRODUCTION

Oral and mouth diseases pose significant health challenges worldwide, ranging from commonissueslikecavitiesandgum 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 arecrucialinmitigatingthese 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 byleveragingthe capabilities of deep learning, specifically the InceptionResNetV2 architecture, to develop an efficient and accurate classification system fororalandmouthdiseases [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.Thetrainedmodelisthenintegratedintoauser-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. LITERATUREREVIEW

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

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2) Rajee, M.V.,etal.Inthispaper,theauthorproposedanovel technique of segmentation with Curvilinear Semantic Deep Convolutional Neural Network (CSDCNN). The segmentation is followed by the proposed Inception resnetV2, which actsas 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, whichrelates to various input images as data. An examination of the x-ray images will detect the impact ofillnessonatooth.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,etal.Thispaperconsiderstheapplication of the InceptionResNetV2 architecture in the classification of pathologies of the mouth. Six classes arefocusedon:calculus, caries, ulcers, gingivitis, discoloration of tooth enamel, and hypodontia. The performance of the model isbenchmarkedon a set containing 1166 labeled images, taking into account the prevalence and severity of each condition. Theresultsindicate that, among all of the scenarios, InceptionResNetV2 has achieved an accuracy of 93%. Accuracy in distinguishing classes:calculus,0.76;caries,0.99;ulcers,1.00;gingivitis,

4) 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, and0.91, respectively [3].

5) Kumar, K. Vinay, et al. In this paper, this work aims to automatetheclassificationofbenignandmalignantoralbiopsy 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 intothispretrainedmodel.Byminingarepository of oral cancer histopathology images, we can gauge how well these tweaked models perform. We examine the modified structure of the pre-trained 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, theauthorexploredthe 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 andclassificationoforallesionsin realtime.Theproposedmodeloffersgreatpotentialasa 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 advancementsindeeplearningformedicalimageclassification to automate the early diagnosis of oral histopathologyimages, thereby facilitating prompt and accurate detection of oral cancer. A deep learning convolutional neural network (CNN) model categorizes benign and malignant oral biopsy histopathologicalimages.Byleveraging17pretrainedDL-CNN models, a two-step statistical analysis identified the pretrained EfficientNetB0 model as the most superior. Further enhancement of EfficientNetB0 wasachievedbyincorporating a dual attention network (DAN) into the model architecture [6].

8) Zhang, Hao, et al. The objective of this study was toassess 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 datasetand then independently validating on different cancer cells.The image issegmentedusingmultiscalemorphologymethods to prepare for cell feature analysis and extraction.Themethod 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. MohammadhaHussani, et al. This paper's goal is to develop a low-cost, multimodal, personal oralsensing device that perceives and classifiesdataautomatically, enablingthephysiciantodiagnosepatientsearlyandtreatthem effectively. The mouth disease prediction consists of preprocessing and classification process. The first step in mouthdiseasepredictionwienerfilterappliedtofilterthenoise in testing image of dataset. After that augmentation involved expandingthenumberofimagesfromthelimitedimages.
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,etal.Thisstudypresentsauniqueapproach 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) usingthe proposed framework. Thesuggestedmodelappliestransfer learning and ensemblelearningintwophases.Inthe1stphase, a few Convolutional neural network (CNN) models are considered through transfer learning applications for OSCC detection. In the 2nd phase, theensemblemodelisconstructed considering the best two pre-trained CNN from the 1st phase. The proposed classifier is compared withleading-edgemodels like Alexnet, Resnet50, Resnet101, Inception net, Xceptionnet, and InceptionresnetV2. Results are analyzed to demonstrate the effectiveness of the suggested framework. A three-phase comparative analysisisconsidered.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 withthatofothermodelsfrom 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 bycollectingandpreprocessingadatasetoforaldisease images, including steps such as resizing, normalization, and augmentation to enhance model performance. Thepreprocessed data is then fed into the InceptionResNetV2 model, which is trained on Google ColaborJupyterNotebook 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 andclassifythedisease,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].

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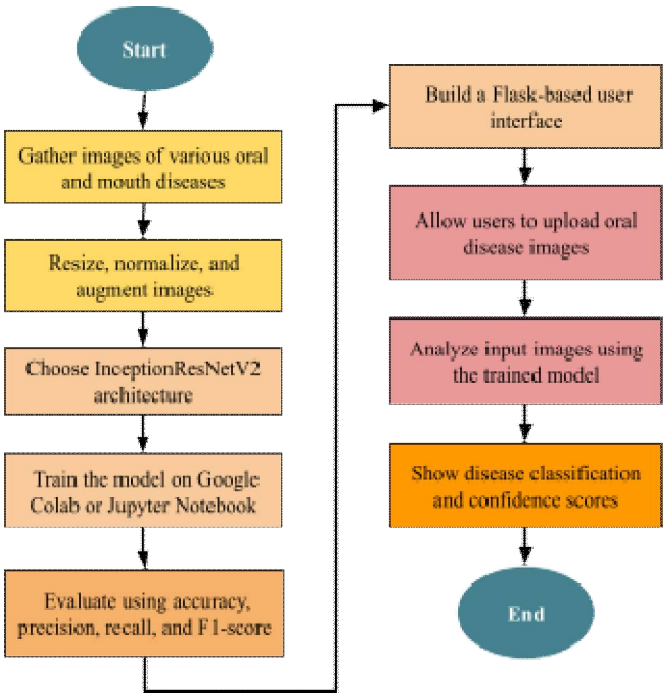

IV. SYSTEM REQUIREMENT

A. Software Requirement

Pythonsoftware

B. Module Used

Flask

V. CONCLUSION

The proposed system offers a powerful and efficientsolution 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 imagesand 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 paperholdssignificantpotential to assist in early detection and timely treatment of oral diseases,ultimatelycontributingtoimprovedoralhealthcare outcomesandreduceddiseaseprogression.Thecombination 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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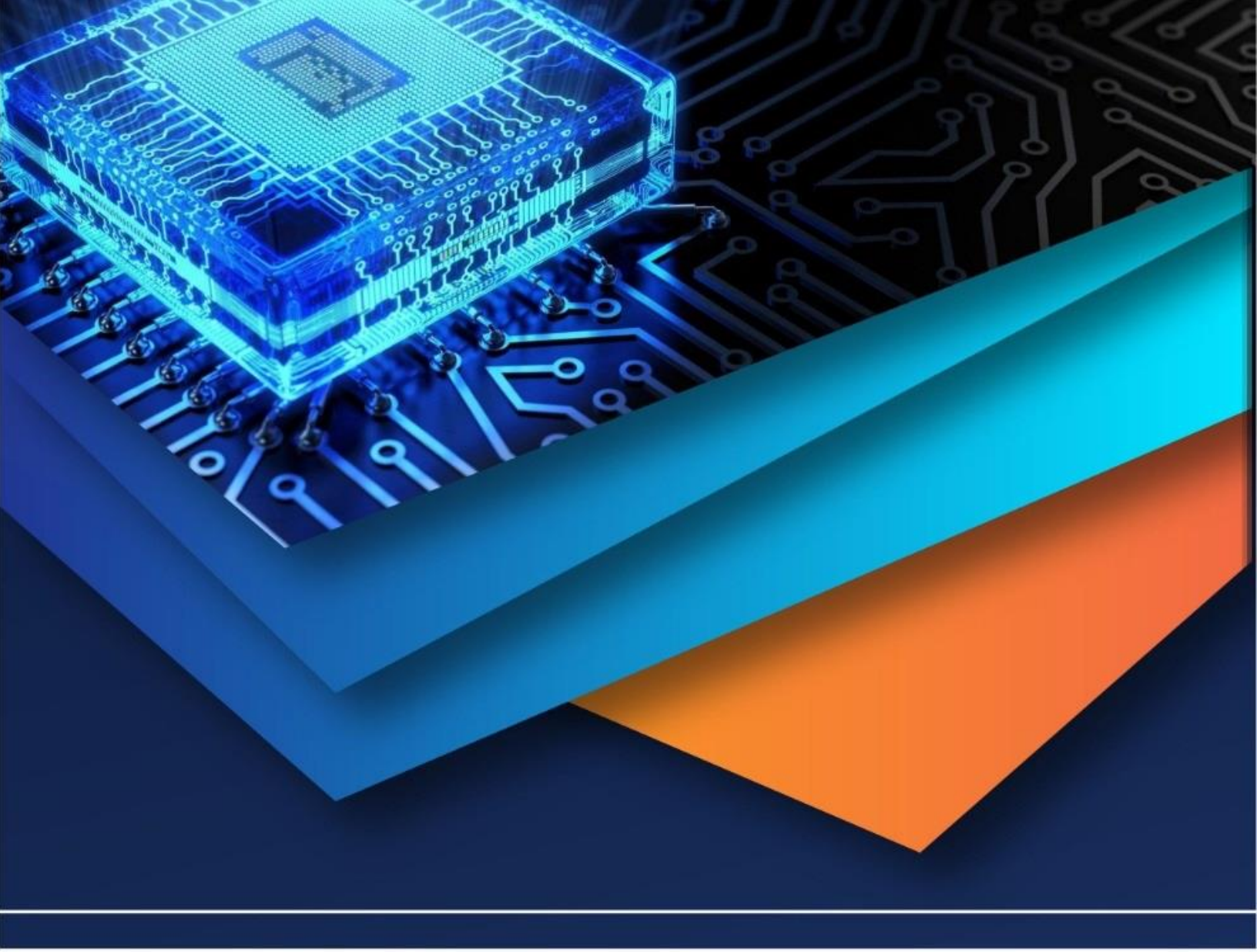

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