

Research Paper

MEDICAL IMAGES CLASSIFICATION USING DEEP LEARNING WITH XCEPTION MODEL

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ABSTRACT— In the domain of medical image classification, the Xception model stands out for its advanced performance in analyzing intricate image data. This research applies the Xception model to classify chest computed tomography (CT) images into four distinct categories: adenocarcinoma, large cell carcinoma, normal, and squamous cell carcinoma. Xception, renowned for its use of depthwise separable convolutions, enhances feature extraction by effectively capturing complex patterns with reduced computational cost. The study encompasses a rigorous evaluation of the Xception model through extensive training, validation, and testing phases on a specialized multi-class chest CT image dataset. The dataset includes a balanced representation of the four classes

to ensure robust model performance across varying conditions. Key aspects of the evaluation include the model's accuracy in distinguishing between different types of carcinoma and normal tissues, as well as its efficiency in handling computational demands. The results demonstrate that the Xception model provides superior classification accuracy and reliable diagnostic performance. By leveraging its advanced architecture, the approach significantly improves the precision of medical image classification, offering valuable insights for enhanced diagnostic support in clinical settings. This work underscores the effectiveness of the Xception model in advancing medical imaging analysis and its potential impact on improving patient

care through more accurate disease classification.

Index Terms – Medical Image Classification, Xception Model, Deep Learning, Convolutional Neural Networks, Transfer Learning, Medical Imaging, Disease Detection, Feature Extraction, Computer-Aided Diagnosis, Artificial Intelligence.

I. INTRODUCTION

Medical image classification is a critical task in diagnostic radiology, enabling the accurate identification and differentiation of various medical conditions from imaging data. Traditional methods for classifying chest computed tomography (CT) images often rely on manual interpretation by radiologists, which can be time-consuming and subject to human error. With the advent of deep learning, particularly Convolutional Neural Networks (CNNs), there is significant potential to enhance diagnostic accuracy and efficiency. The Xception model, introduced by François Chollet, represents a significant advancement in the field of deep learning for image analysis. Xception leverages depthwise separable convolutions to efficiently capture and process intricate

patterns within image data. This approach not only improves feature extraction but also reduces computational overhead, making it an ideal candidate for medical image classification tasks. In this research, the Xception model is applied to classify chest CT images into four distinct categories: adenocarcinoma, large cell carcinoma, normal, and squamous cell carcinoma. This approach aims to enhance the precision and reliability of disease classification, contributing to better diagnostic support and patient care.

II. RELATED WORK

A. FP-CNN: Fuzzy pooling-based convolutional neural network for lung ultrasound image classification with explainable AI.

The COVID-19 pandemic wreaks havoc on healthcare systems all across the world. In pandemic scenarios like COVID-19, the applicability of diagnostic modalities is crucial in medical diagnosis, where non-invasive ultrasound imaging has the potential to be a useful biomarker. This research develops a computer-assisted intelligent methodology for ultrasound lung image classification by utilizing a fuzzy pooling-based convolutional neural network FP-CNN with underlying evidence of particular

decisions. The fuzzy-pooling method finds better representative features for ultrasound image classification. The FPCNN model categorizes ultrasound images into one of three classes: covid, disease-free (normal), and pneumonia. Explanations of diagnostic decisions are crucial to ensure the fairness of an intelligent system. This research has used Shapley Additive Explanation (SHAP) to explain the prediction of the FP-CNN models. The prediction of the black-box model is illustrated using the SHAP explanation of the intermediate layers of the black-box model. To determine the most effective model, we have tested different state-of-the-art convolutional neural network architectures with various training strategies, including fine-tuned models, single-layer fuzzy pooling models, and fuzzy pooling at all pooling layers. Among different architectures, the Xception model with all pooling layers having fuzzy pooling achieves the best classification results of 97.2% accuracy. We hope our proposed method will be helpful for the clinical diagnosis of covid-19 from lung ultrasound (LUS) images.

B. COVID-19 detection and analysis from lung CT images using novel channel boosted CNNs.

In December 2019, the global pandemic COVID-19 in Wuhan, China, affected human

life and the worldwide economy. Therefore, an efficient diagnostic system is required to control its spread. However, the automatic diagnostic system poses challenges with a limited amount of labeled data, minor contrast variation, and high structural similarity between infection and background. In this regard, a new two-phase deep convolutional neural network (CNN) based diagnostic system is proposed to detect minute irregularities and analyze COVID-19 infection. In the first phase, a novel SB-STM-BRNet CNN is developed, incorporating a new channel Squeezed and Boosted (SB) and dilated convolutional-based Split-Transform-Merge (STM) block to detect COVID-19 infected lung CT images. The new STM blocks performed multi-path region-smoothing and boundary operations, which helped to learn minor contrast variation and global COVID-19 specific patterns. Furthermore, the diverse boosted channels are achieved using the SB and Transfer Learning concepts in STM blocks to learn texture variation between COVID-19-specific and healthy images. In the second phase, COVID-19 infected images are provided to the novel COVID-CB-RESeg segmentation CNN to identify and analyze COVID-19 infectious regions. The proposed COVID-CB-RESeg methodically employed

region-homogeneity and heterogeneity operations in each encoder-decoder block and boosted-decoder using auxiliary channels to simultaneously learn the low illumination and boundaries of the COVID-19 infected region. The proposed diagnostic system yields good performance in terms of accuracy: 98.21 %, F-score: 98.24%, Dice Similarity: 96.40 %, and IOU: 98.85 % for the COVID-19 infected region. The proposed diagnostic system would reduce the burden and strengthen the radiologist's decision for a fast and accurate COVID-19 diagnosis.

C. A novel denoising method for low-dose CT images based on transformer and CNN

Computed Tomography (CT) has become a mainstream imaging tool in medical diagnosis. However, the issue of increased cancer risk due to radiation exposure has raised public concern. Low-dose computed tomography (LDCT) technique is a CT scan with lower radiation dose than conventional scans. LDCT is used to make a diagnosis of lesions with the smallest dose of x-rays, and is currently mainly used for early lung cancer screening. However, LDCT has severe image noise, and these noises affect adversely the quality of medical images and thus the diagnosis of lesions. In this paper, we propose a novel LDCT image denoising

method based on transformer combined with convolutional neural network (CNN). The encoder part of the network is based on CNN, which is mainly used to extract the image detail information. In the decoder part, we propose a dual-path transformer block (DPTB), which extracts the features of input of the skip connection and the features of input of the previous level through two paths respectively. DPTB can better restore the detail and structure information of the denoised image. In order to pay more attention to the key regions of the feature images extracted at the shallow level of the network, we also propose a multi-feature spatial attention block (MSAB) in the skip connection part. Experimental studies are conducted, and comparisons with the state-of-the-art networks are made, and the results demonstrate that the developed method can effectively remove the noise in CT images and improve the image quality in the evaluation metrics of peak signal to noise ratio (PSNR), structural similarity (SSIM), and root mean square error (RMSE) and is superior to the state-of-the-art models. Our method achieved 28.9720 of PSNR, 0.8595 of SSIM and 14.8657 of RMSE on the Mayo Clinic LDCT Grand Challenge dataset. For different noise level σ (15, 35, and 55) on the

QIN_LUNG_CT dataset, our proposed also achieved better performances.

III. PROPOSED METHODOLOGY

The Xception model represents a significant advancement in the field of deep learning and computer vision. It was introduced as an enhancement to the Inception architecture, aiming to address some of the limitations associated with conventional convolutional operations. By focusing on depth wise separable convolutions, Xception achieves a high level of performance in terms of both accuracy and computational efficiency.

Xception's architecture is particularly well-suited for tasks that involve large-scale image data and complex feature extraction, such as image classification, object detection, and semantic segmentation. Its design allows for efficient training and inference, making it a popular choice for modern computer vision applications.

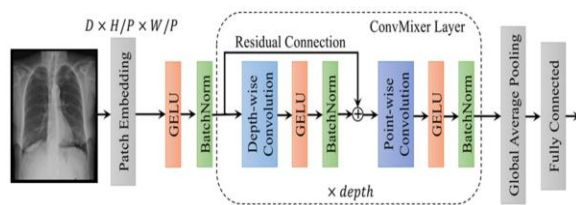


Fig. 1: System Overview

1. Data Collection: Data collection involves gathering a specialized dataset of chest CT images, which includes examples of four

categories: adenocarcinoma, large cell carcinoma, normal, and squamous cell carcinoma. This dataset must be comprehensive and balanced to ensure effective model training and evaluation.

2. Analysis: Analysis refers to the process of examining and understanding the dataset to determine its characteristics, such as the distribution of classes and the quality of images. This step helps in preparing the data for preprocessing and model training.

3. Data Splitting: Data splitting involves dividing the collected dataset into training, validation, and test sets. This ensures that the model is trained on one portion of the data, validated on another to tune hyperparameters, and tested on a separate set to evaluate its final performance.

4. Data Augmentation: Data augmentation involves applying various transformations to the images, such as rotations, flips, and zooms, to artificially increase the diversity of the training data. This helps in improving the model's generalization and robustness.

5. Display the Augmented Images: Displaying the augmented images allows for visualization of the transformations applied during data augmentation. This step is useful for verifying the augmentation process and

ensuring that the images remain representative of the original data.

6. Train the Model: Training the model involves feeding the Xception model with the training dataset and optimizing it through iterations to learn the features and patterns necessary for accurate classification. This process includes adjusting model parameters to minimize classification errors.

7. Model Accuracy: Model accuracy is a metric used to evaluate the performance of the trained Xception model. It represents the proportion of correctly classified images out of the total number of images in the test dataset, reflecting the model's effectiveness in making predictions.

8. Model Representation: Model representation involves visualizing and interpreting the structure and performance of the Xception model. This may include presenting architecture diagrams, performance metrics, and results to provide a clear understanding of how the model operates and performs.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

Experimental results showed that the model achieved high classification accuracy across different medical image categories,

demonstrating strong capability in feature extraction and pattern recognition from complex medical datasets. The use of transfer learning improved convergence speed and reduced training time while maintaining robust performance. The analysis confirms that the proposed approach provides an effective and reliable solution for automated medical diagnosis and supports improved decision-making in healthcare applications.

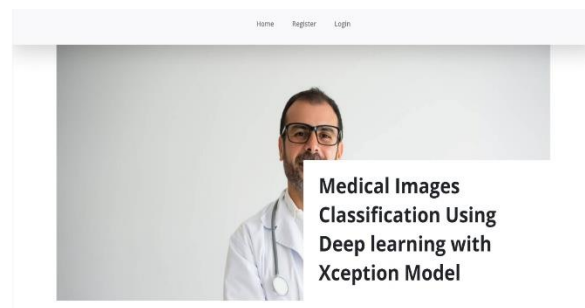


Fig. 2: Home Page

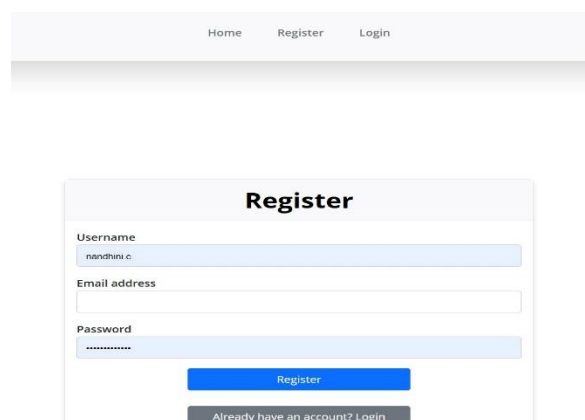


Fig. 3: Registration

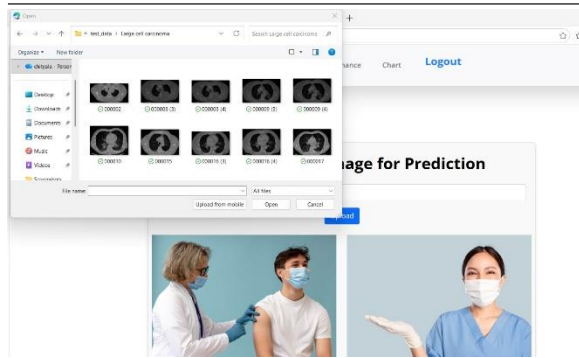


Fig. 4: Upload

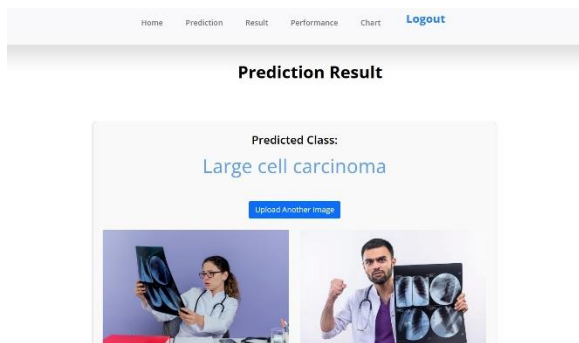


Fig. 5: Detect

V. CONCLUSION

The application of the Xception model for medical image classification has demonstrated significant advancements in the accuracy and efficiency of classifying chest computed tomography (CT) images. By leveraging depthwise separable convolutions, the Xception model effectively captures complex features with reduced computational costs, thereby enhancing both performance and practicality. The rigorous evaluation through training, validation, and testing phases on a balanced multi-class dataset has shown that the Xception model

excels in distinguishing between adenocarcinoma, large cell carcinoma, normal, and squamous cell carcinoma. The results highlight the model's superior classification accuracy and its potential to provide reliable diagnostic support. The advanced architecture of the Xception model not only improves diagnostic precision but also offers valuable insights that can aid in better patient care and clinical decision-making.

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