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COVID-19 Detection from Chest X-ray Images with Ensemble Models

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INTRODUCTION :

The COVID-19 pandemic has emphasized the importance of rapid and accurate diagnostic methods. Chest X-ray imaging is widely used in medical diagnosis due to its speed, cost-effectiveness, and accessibility. With the rise of artificial intelligence, deep learning techniques have shown great promise in automating the analysis of medical images. This project focuses on using convolutional neural networks (CNNs) to classify chest X-ray images into COVID-19 and Non-COVID categories, helping in early detection and reducing the burden on healthcare professionals.

PROBLEM STATEMENT :

With the ongoing COVID-19 pandemic, early and accurate detection of the disease is critical for timely intervention and prevention. Chest X-ray images provide a rapid diagnostic tool, but manual analysis is time-consuming and requires expertise.

The challenge lies in building an automated, accurate, and robust model to distinguish between COVID-19 and Non-COVID cases from X-ray images. Additionally, the dataset is often imbalanced, leading to biased model predictions. Overcoming this imbalance and achieving generalization across different patient demographics and X-ray machines is a key concern.

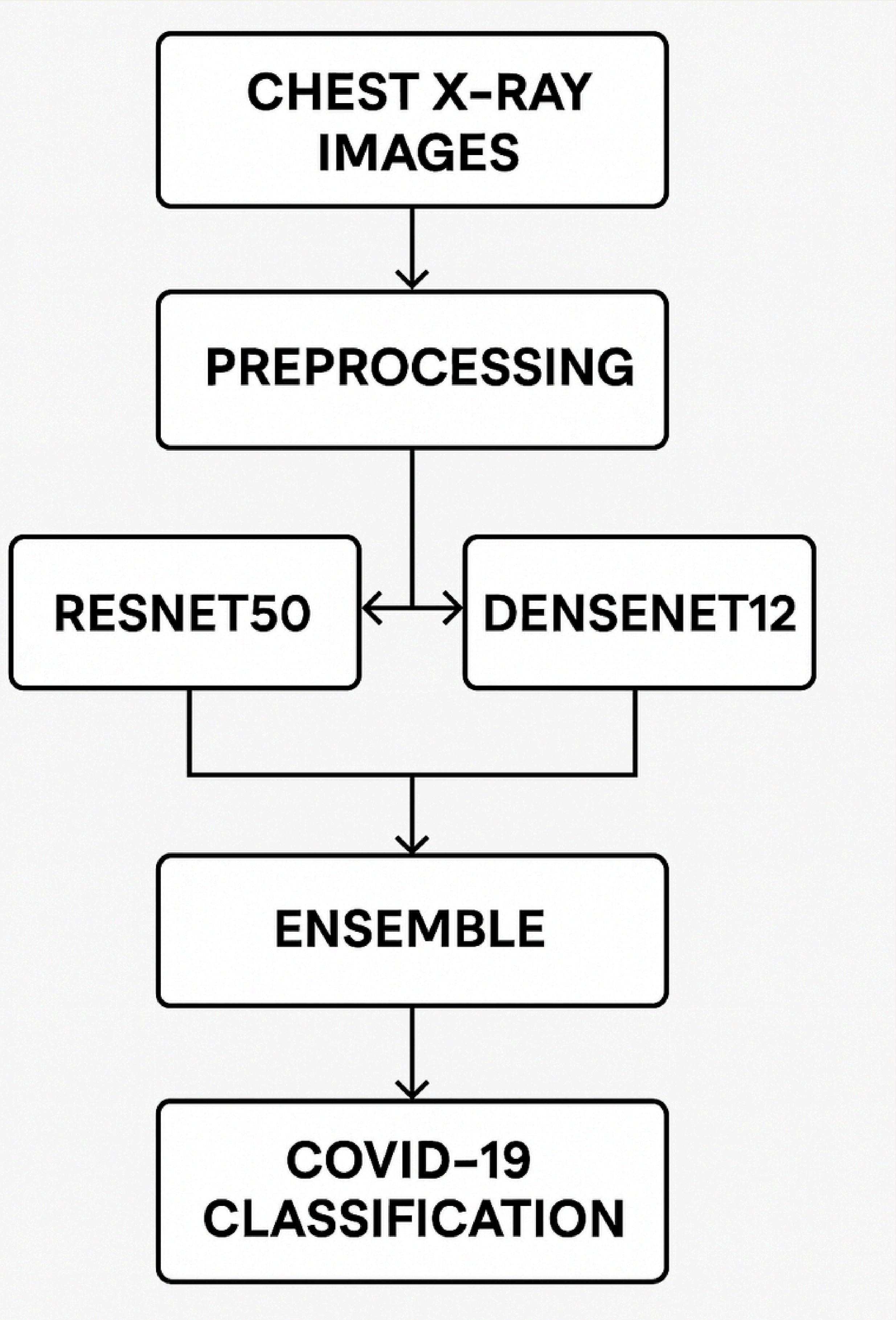
OBJECTIVE :

The primary objective of this project is to develop a deep learning-based classification model that can accurately distinguish between COVID-19 and Non-COVID cases using chest X-ray images. By leveraging convolutional neural networks (CNNs) and pre-trained models like ResNet50 and DenseNet121, the aim is to build a reliable and efficient system that supports early diagnosis. The project also explores ensemble learning to enhance prediction accuracy and provide a more robust diagnostic tool for real-world applications.

LITERATURE REVIEW :

Authors	Published Date	Main Findings	Limitations
Apostolopoulos & Mpesiana	2020	Used transfer learning (VGG19); achieved 96.78% accuracy on X-ray images.	Small dataset; lacks generalization across demographics.
Ozturk et al.	2020	Developed DarkCOVIDNet; reached 98.08% accuracy in binary classification.	No multi-class classification; potential overfitting.
Narin et al.	2020	Compared ResNet50, InceptionV3, and InceptionResNetV2; ResNet50 gave 98% accuracy.	Limited dataset size and diversity; model not tested on real-world data.
Zhang et al. (COVID-Net)	2020	Introduced COVID-Net using COVIDx dataset; open-sourced model with strong accuracy.	Training data mostly from publicly available sources; potential bias.
Khan et al. (CoroNet)	2020	Proposed CoroNet (based on Xception architecture); achieved high precision.	Evaluation done on a small, imbalanced dataset; risk of bias.

METHODOLOGY :



METHODOLOGY :

Dataset Collection:

The dataset used is the "COVID-19 Chest X-ray" dataset from Kaggle, consisting of labeled chest X-ray images. The images are classified into COVID-positive and Non-COVID-negative categories. This dataset serves as the foundation for training and evaluating the models. It provides a diverse set of images from various sources for generalization.

Data Preprocessing:

Images are resized to 224 x 224 pixels to meet the input size requirements of the pre-trained models. Pixel values are normalized to the range of 0 to 1 to improve model training efficiency. Data augmentation techniques, such as rotation, zoom, and flipping, are applied to enhance model generalization. This step ensures the model is exposed to a diverse set of transformations.

Model Selection and Architecture:

ResNet50 and DenseNet121, pre-trained on ImageNet, are used for transfer learning. These models are fine-tuned on the COVID-19 dataset by adding custom classification layers. An ensemble approach is implemented to combine the predictions of both models using majority voting or weighted averaging. This method aims to enhance the model's robustness and accuracy.

Model Training:

The models are fine-tuned by unfreezing the last layers and training on the COVID-19 chest X-ray dataset. The binary cross-entropy loss function is used, as the task involves binary classification (COVID vs. Non-COVID). Adam optimizer with a learning rate of 1e-4 is used to minimize the loss. The models are trained for multiple epochs to ensure convergence.

Model Evaluation:

Performance is evaluated using metrics like accuracy, precision, recall, F1-score, and confusion matrix. The confusion matrix helps track misclassifications between COVID-positive and Non-COVID-negative cases. A classification report is generated for a comprehensive performance overview. This helps assess the model's strengths and weaknesses.

Result Analysis:

The performance of individual models (ResNet50 and DenseNet121) is compared to that of the ensemble model. Accuracy, precision, recall, and F1-scores are analyzed to identify the best-performing model. Misclassification patterns are studied to understand the model's limitations. This analysis aids in refining the model for better real-world application.

CONCLUSION :

This project developed a deep learning-based approach to detect COVID-19 from chest X-ray images using pre-trained models like ResNet50 and DenseNet121. The models were fine-tuned with the COVID-19 chest X-ray dataset, and an ensemble learning technique was applied to combine their predictions for improved accuracy.

The evaluation metrics, such as accuracy, precision, recall, and F1-score, showed that the models performed effectively in detecting COVID-19 cases, though challenges like class imbalance and over-prediction of COVID-positive cases were noted. This work highlights the potential of using deep learning for medical image classification and provides a valuable tool for assisting in the early detection of COVID-19 in clinical settings. Future improvements can include addressing class imbalance and optimizing the model for real-time clinical application.

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Thank you!