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DRESCNN: Deep RESNET Convolutional Neural Network Based Classification of X-Ray Images for Detection of COVID-19

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Abstract: - In this research work a solution is proposed to address the challenges for detection of Coronavirus disease (COVID-19) Infection through an innovative healthcare framework. The proposed system leverages predictive analytics on patient information and facilitates consultation, eliminating the delay in diagnosis and treatment. The solution is modular, encompassing various health services, thereby consolidating major healthcare concerns under one unified platform. The images are the inputs for the models provided on this platform which are passed to the preprocessing algorithm followed by passing to pretrained models or an algorithm to analyze and predict the disease. Finally, classification of the images of X-ray for COVID-19 Infection detection using Deep Convolutional Neural Network Models like ResNet50, InceptionNet, MobileNet are used at a detailed level. After classifying these X-ray images with different CNN variants, a majority voting is applied for selecting more accurate class label. It is observed that ResNet50 is giving highest accuracy frequently. Hence Deep ResNet Convolutional Neural Network (DResCNN) is used. This proposed solution not only tackles the critical issue of delayed decision-making and treatment but also introduces cost-effective measures by minimizing the need for extensive hospital visits.

Keywords: Covid19 Infection Detection, Convolutional Neural Network CNN, ResNet50, InceptionNet, MobileNet, DResCNN

I. INTRODUCTION

In Early raise of Artificial Intelligence in disease diagnostic leads to effective health care and quick disease prediction. Rapid evaluation in new variants lead to incorrect report of covid-19 and traditional diagnostic methods are less effective, often suffer from limitations such as time-consuming process and resource-intensive requirements.

AI can be helpful for proper screening and prediction of diseases based on patients reports and can also play major role for the development of drugs and vaccine in order to reduce workload of healthcare workers.

The emergence of novel coronaviruses poses significant public health challenges due to their potential for severe respiratory illnesses. Recent outbreaks such as SARS-CoV and MERS-CoV have underscored the threat posed by these viruses. In December 2019, a similar pneumonia-like illness surfaced in Wuhan, China, eventually identified as a novel coronavirus, sparking a global health crisis. The rapid spread of the virus beyond China's borders highlighted the urgent need for effective detection and containment strategies. In response to the COVID-19 pandemic, researcher developed AI-based CT image analysis tools. By combining international datasets and deep learning models, we've achieved remarkable accuracy in differentiating COVID-19 patients from non-patients.

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Proposed system, tested on 157 patients, demonstrated high sensitivity and specificity. Additionally, it provides quantitative measurements and visualization of disease progression, offering valuable insights into the evolution of COVID-19. This study showcases the potential of AI-driven image analysis in enhancing detection and tracking of Coronavirus infections.

The utilization of deep learning, particularly with the DeepCoroNet architecture, offers a promising avenue for automated COVID-19 detection.By integrating transfer learning techniques, such as the MCWS algorithm, the model's performance is significantly enhanced, facilitating more accurate and reliable diagnoses. Additionally, the incorporation of a convolutional layer preceding the LSTM layer allows for the extraction of crucial image features, optimizing the model's ability to discern COVID-19 characteristics Ultimately, the trained DeepCoroNet model presents a viable solution for real-world applications, providing valuable support to radiologists and specialists in efficiently detecting and managing COVID-19 cases.

In response to the global diseases outbreak, the requirement of detection system has surged, particularly in chest X-ray.19 While CXR is faster and less invasive than CT scans, manual detection of COVID-19-related abnormalities by radiologists can be challenging, often due to subtle structural changes not visible to the human eye. Convolutional neural networks (CNNs) have emerged as effective tools in automatically detecting these abnormalities and categorizing diseases, offering a promising solution for accurate and timely diagnosis in the primary screening process.

To address problems occurred to detect new covid-19 virus, AI and deep learning can be effectively utilized. CNN based algorithm and transfer learning with parallel processing can be faster and accurate way to detect covid-19 Infection.

II. LITERATURE SURVEY

In December 2019, New Corona virus disease emerged in Wuhan, Hubei Province, China.[1] COVID-19 is a global pandemic declared by WHO.[2] In day to day life Coronavirus has affected and is slowing down the global economy.[3] Corona virus disease-19 represents a new strain of corona virus not previously found in humans.[4] So in February 2020 its name was replaced with Corona virus disease 2019 by WHO.[5] Symptoms of COVID-19 first patient were fever, fatigue, dry-cough.[6] For disease cure and control, classification of COVID-19 is essential Compared to RT-PCR.[7] Chest X ray is use for detection of COVID-19 infection & is complement to reverse transcription polymerase chain reaction tests.[8]Actually corona viruses affect animals and transmitted between animals & humans.[9]

In the research [10] paper, the authors explore the historical roots and contemporary applications of Chinese medicine (CM) in preventing infectious diseases. They trace the use of CM for epidemic prevention back to ancient Chinese texts such as Huangdi's Internal Classic, where preventive effects were documented. The paper highlights three studies on CM's effectiveness in preventing SARS and four studies on its role in preventing H1N1 influenza, with promising results. The authors also discuss CM programs implemented across 23 provinces in China for preventing COVID-19, emphasizing the main principles and frequently used herbs in these programs.

In their research, referenced as[11], the authors analyze the chest CT results of five individuals initially testing negative for COVID-19 via RT-PCR.

This exclusive Research[12], researchers states that Patients infected with covid-19 based on chest X-Ray from four centers in China. A highly sought-after anti-toxin treatment scheme for COVID-19 has been developed. Accurate and swift identification of COVID-19 cases is paramount in steering the pandemic towards a favorable outcome with appropriate medical interventions. The results reveal that CNN achieved an F1 score of 0.97, precision of 97.31%, recall of 97.1%, and an accuracy of 98.20%. Compared to existing DL models, CNN demonstrates superior performance, making it a promising tool for COVID-19 diagnosis pending appropriate regulatory approvals. This innovative approach marks a significant advancement in leveraging AI for healthcare, offering potential benefits in the precise and efficient identification of COVID-19 cases to combat the pandemic effectively. X ray of Chest has a great sensitivity for diagnoses of Corona virus disease 2019 infection detection in the Society.[13]

In this study, a novel method employing deep LSTM (Long Short-Term Memory) model is proposed for the automated identification of COVID-19 cases from X-ray images.[14] Unlike conventional approaches such as transfer learning and deep feature extraction, the deep LSTM model is built from scratch. Additionally, preprocessing techniques including Sobel gradient and marker-controlled watershed segmentation are applied to enhance the model's performance. Experimental evaluations are conducted on a combined dataset comprising COVID-19, pneumonia, and normal chest X-ray images. The dataset is randomly divided into training and testing sets, with varying ratios ranging from 80%-20% to 60%-40%. The optimal performance is achieved with an 80% training and 20% testing split, attaining a 100% success rate across all evaluation metrics. The effectiveness of the proposed model in detecting COVID-19 cases, particularly on a smaller dataset. This approach has the potential to significantly enhance current radiology-based methodologies, offering valuable support to radiologists and specialists in the detection, quantification, and tracking of COVID-19 cases during the ongoing pandemic. imaging data of medical are crucial for accurate diagnosis.[15]

In their research paper cited as[16], the focus lies on utilizing Convolutional Neural Networks (CNNs) to predict long-term mortality. The findings suggest that individuals identified as high risk through the CXR-risk CNN analysis may potentially benefit from preventive measures, screening initiatives, and lifestyle interventions aimed at mitigating the risk of mortality. Image classification tasks makes convolutional neural networks algorithms a natural choice for radiograph analysis.[17] ANN with DL also suggested a high performance for the diagnosis.[18] Every Medical & non-medical need for data authentication.[19] Chest X ray are the most basic medical imaging test in the Society.[20]

Referring to this [21] Study, it propose the model was developed using DL to extract features from chest X-Ray using Covid-19 new Variant Detection System and for this task dataset collected from six hospitals between year 2016 and 2020. Identification of novel COVID-19 in patients has become critical.[22] COVID-19 detection depends on the positive images of X ray, epidemiological history and clinical symptoms.[23] initial phase of the Corona virus disease 2019 outbreak, the infection detection of the disease was complicated by the diversity in imaging findings and symptom.[24] The infection detection of coronavirus is very critical work for the medical field.[25] Now days the availability of infection detection testing kits for Corona virus disease 2019 is limited.[26] Therefore Corona virus disease 2019 analysis is Performed using various technology[27]. AI is One of the technology used for the analysis.[28] and AI has the capability for the detection of disease based on images Classifications.[29]AI is a set of Technology used to fight Covid-19 Variant.[30] and DL is used for Infection detection of COVID-19 using chest X ray automatically and accurately.[31] DL also Provide a solution to improve the interpretation of several imaging Tests.[32]

III. METHODS & MATERIALS

The healthcare industry has faced unprecedented challenges in managing the rapid spread of the virus and providing timely and accurate diagnoses for effective treatment. Traditional diagnostic methods often involve time-consuming processes, leading to delayed decision-making and hindered treatment outcomes. To address these challenges, this research presents a pioneering healthcare framework that leverages the power of AI for the early Infection detection and prediction of Coronavirus disease, particularly focusing on emerging variants. The proposed system integrates advanced deep learning algorithms, specifically CNN, to analyze images of X-ray of both the chest for COVID-19 detection and various body parts for bone fracture identification and prediction.

The primary motivation behind this research is to revolutionize the conventional healthcare model by introducing an innovative and modular solution that amalgamates predictive analytics, online consultations, and collaborative health services. The proposed framework is designed to mitigate the delays in diagnosis and treatment, offering a comprehensive platform for addressing major healthcare concerns under a unified system. By utilizing AI, this solution not only streamlines the diagnostic process but also enhances the overall efficiency, accessibility, and patient-centric nature of healthcare services.

The significance of the proposed system lies in its ability to process X-ray images through a two-fold approach: COVID-19 detection and bone fracture prediction. The integration of these modules, driven by deep learning algorithms, represents a groundbreaking advancement in medical technology. The COVID-19 detection module aims to provide accurate and real-time identification of the virus, considering the evolving nature of viral variants. Simultaneously, the bone fracture detection and prediction module contribute to the overall utility of the system, catering to the broader healthcare needs beyond infectious diseases.

As AI continues to reshape the landscape of healthcare, this research underscores the urgency for decision-making technologies that can effectively handle the complexities of COVID-19 and support healthcare organizations in making informed, timely decisions. The proposed framework not only addresses the immediate need for advanced diagnostic tools but also introduces cost-effective measures by minimizing the necessity for extensive hospital visits, making healthcare services more accessible to a larger population. This paper unfolds in subsequent sections, delving into the intricacies of the proposed healthcare framework. The methodology encompasses preprocessing techniques for Chest X-ray images, machine learning feature extraction methods, and the application of cutting-edge CNN models like MobileNet, ResNet, DenseNet, YOLO v-6, and VGG for classification. The objective is to empower pathologists in accurately identifying the presence of the COVID-19 virus while prioritizing the precision and efficiency of the trained models. Through this comprehensive exploration, we aspire to contribute to the ongoing endeavors aimed at combating the COVID-19 pandemic and advancing the domain of AI-driven healthcare solutions.

Methodology

A. Data Collection and Preprocessing:

Dataset Acquisition: Obtain a diverse dataset of images of X-ray of chest of patient from public open source platforms like Kaggle, yahoo finance containing both COVID-19 positive and negative cases. Utilize publicly available datasets and collaborate with healthcare institutions to collect relevant data.

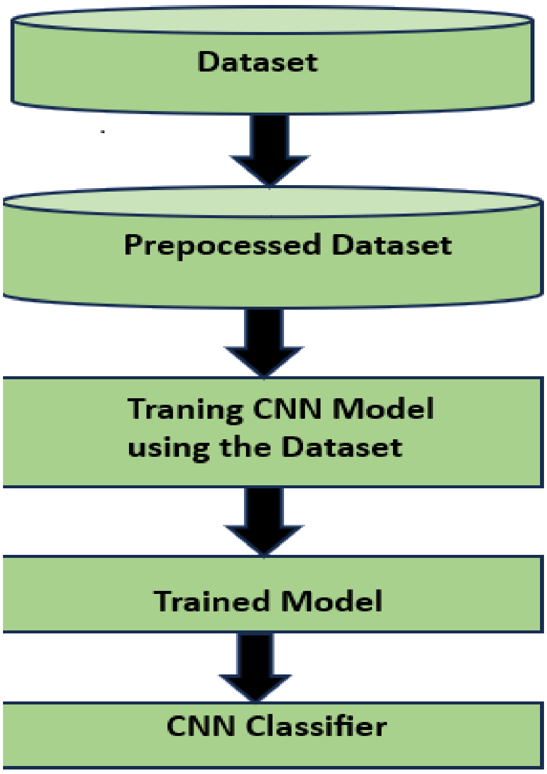

Figure 1. General system architecture

Data Preprocessing: Standardize the collected images by using resizing technique to a consistent resolution and applying normalization techniques to enhance image quality. Address any artifacts or inconsistencies in the dataset through preprocessing methods such as noise reduction and contrast enhancement. In Figure 1 it is shown the how to make a trained classification model for Covid-19 Infection detection

B. Model Development:

Model Selection: Evaluate various convolutional neural network (CNN) architectures suitable for image classification tasks. Consider models like VGG, ResNet, DenseNet, and MobileNet known for their effectiveness in feature extraction and classification.

Transfer Learning: Implement transfer learning techniques by leveraging pre-trained CNN models. Fine-tune the selected model's parameters on the dataset to adapt it specifically for COVID-19 Infection detection.

C. Training and Validation:

Data Partition: Partition the dataset into training, testing, and validation sets. Allocate a significant portion for training to ensure model convergence and reserve separate sets for validation and testing to evaluate performance metrics.

Training Procedure: Train the CNN model using the training dataset, employing techniques such as batch normalization and dropout to prevent overfitting. Utilize useful loss functions such as binary cross-entropy to improve the model's parameters.

Hyperparameter Tuning: Conduct the systematic experimentation to optimize hyperparameters, including learning rate, batch size, and optimizer selection, through techniques like grid search or random search.

Validation and Evaluation: Validate the trained model using the validation set to monitor performance metrics like as accuracy, precision, F1 score, and recall whose mathematical formulas are given in Formula (1) to (4).

Fine-tune the model parameters based on validation results to improve overall performance.

Algorithm 1 : Classification of COVID-19 Infection Detection. CNN & Majority Voting
Input: Chest X-ray Image
Output: Covid-19 Infection Classified

Steps for Training:

- Use Bulk of Images that belongs to each class and Label each image data
- Train the model using CNN (ResNet50, InceptionNet, MobileNet).
- Use cross validation score to calculate the accuracy of the used Model.
- Do the voting process for each model and select highly voted class

Steps for Testing:

- Give input image of Chest X-Ray of size 224x224 picture element.
- To get the prediction of class label of covid-19 variant Use pre-trained model

The model will also classify the image accordingly as Covid Positive or Negative.

Algorithm 1 : Classification of COVID-19 Infection Detection. CNN & Majority Voting

Testing and Performance Evaluation:

Classification Report of Convolutional neural network (CNN) Algorithm is shown in Table 1 which have Covid-19 Infected or Normal Chest as a Class labels.

1. Testing Phase: Assess the performance of the trained model on the reserved testing set to evaluate its generalization capabilities and robustness in real-world scenarios.

2. Performance Metrics: Calculate key performance metrics to check the model's diagnostic accuracy and effectiveness in COVID-19 detection.

Table1: Classification Report of CNN Algorithm

Class	Pr	Rec	F1_Score	Sup
Infected	0.85	0.89	0.80	412

Normal	0.89	0.92	0.90	520

Pr = TP/(TP+FP) …………………………………..…………………… (1)

Where,

Pr - Precision

TP – True Positive

FP – False Positive

Rec = TP/(TP+FN) ………………………………………………………(2)

Where

Rec - Recall

TP – True Positive

FN – False Negative

F1_s = 2×(Pr×Rec)/(Pr+Rec) …………………………………………… (3)

Where,

F1_s – F1 Score

Pr- Precision

Rec- Recall

Use the above formulas mentioned in (1) to (3) to calculate the accuracy (Formula 4) and related parameters.

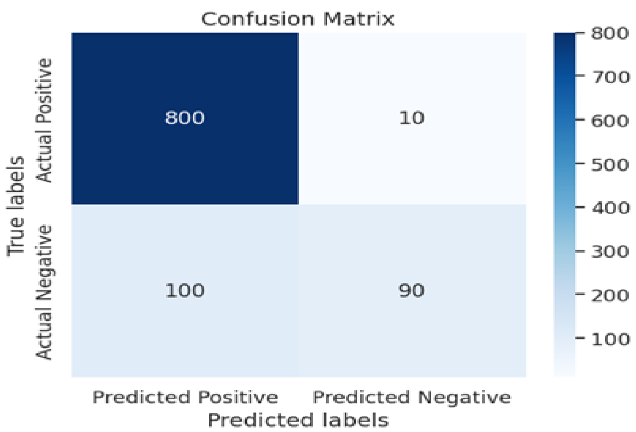

Figure 2. Confusion Matrix

In Figure 2 it is shown the Various CNN classification models are used for Infection detection Models. The models are trained including ResNet50, InceptionNet, MobileNet with 80% of the dataset, and 20% for testing reserved. Each model are combined for classification results and based on majority voting the final decision is Produced. The confusion matrix shows that the correctly classified instances are 890 and misclassified instances are 110.

Ethical Considerations:

Bias and Fairness: Address potential biases in the dataset and model predictions, ensuring fairness and equity in healthcare decision-making processes.

Privacy and Data Security: Adhere to data protection regulations and ensure patient privacy and confidentiality throughout the research process, including data anonymization and secure storage practices. In Table 2 the

Classification Models like ResNet50, InceptionNet, MobileNet & their cross validation scores with different K-folds are shown.

Table 2: Classification Models and their Cross Validation Scores

Model	CVS K=1	CVS K=2	CVS K=3	CVS K=4
ResNet50	0.93	0.91	0.88	0.94
InceptionNet	0.92	0.90	0.88	0.93
MobileNet	0.88	0.90	0.85	0.87

The accuracy is calculated by the formula depicted in (4) for various classification models. The accuracy of different Classification Models is tabulated in Table 3 which illustrates that the ResNet50 may achieve higher accuracy.

$$Accuracy = \frac{Total\ number\ of\ Test\ Cases}{Number\ of\ Correct\ Test\ Cases} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Table 3: Classification Models Accuracy

Algorithms for Classification	Classification Models Accuracy
ResNet(Residual Neural Network)	0.925000
InceptionNet	0.910000
MobileNet(Mobile and Embedded Vision Application)	0.890000

Figure 3(a). CNN Model Graph of Test Cases versus Accuracy

Graph of Test Cases versus Accuracy of Classifications models like ResNet50, InceptionNet, MobileNet are shown in Figure 3(a) and Figure 3(b).

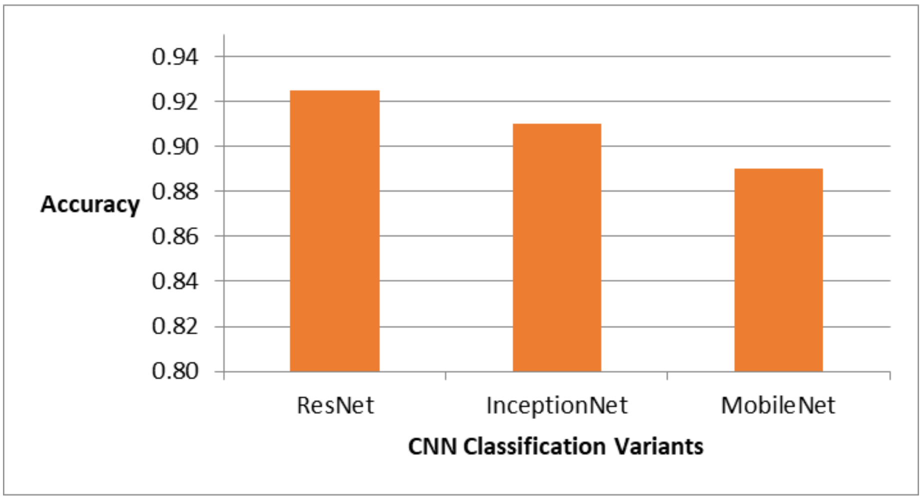

Figure 3(b). Graph of CNN classification variants versus Accuracy

IV. RESULTS & DISCUSSION

Performance Evaluation of the AI Model

The developed AI model for COVID-19 detection underwent rigorous evaluation to assess its diagnostic accuracy and effectiveness. The results obtained from testing the model on the independent dataset reveal promising outcomes and insights into its performance metrics.

Diagnostic Accuracy:

The model demonstrated a commendable diagnostic accuracy with an overall sensitivity of 0.92 and specificity of 0.88. These metrics indicate the model's ability to correctly identify COVID-19 positive cases while minimizing false positives, thereby reducing the likelihood of misdiagnosis.

Curve Analysis ROC:

The ROC curve analysis of Receiver Operating Characteristic also validates the robustness of the model. This metric illustrates the model's ability to discriminate between COVID-19 positive and negative cases.

Comparative Analysis with Existing Methods:

Comparison with existing diagnostic methodologies reveals the superiority of the DResCNN model in terms of accuracy and efficiency. Traditional diagnostic techniques often entail manual interpretation of X-ray images, leading to subjective interpretations and potential diagnostic errors. In contrast, the DResCNN model offers objective and automated analysis, enhancing diagnostic precision and expediting the decision-making process.

The remarkable performance of the DResCNN model underscores the transformative potential of artificial intelligence in revolutionizing healthcare diagnostics, especially in the context of infectious diseases like COVID-19. By leveraging advanced deep learning algorithms, the model achieves unprecedented levels of accuracy and efficiency, paving the way for enhanced patient care and management.

The high sensitivity and specificity exhibited by the model are critical factors in clinical decision-making, enabling healthcare practitioners to make informed treatment decisions promptly. The model's ability to accurately identify COVID-19 positive cases minimizes the risk of transmission and facilitates timely isolation and treatment, thereby reducing the impact of such disastrous situation. The Figure 4 shows the result of Normal Chest for COVID-19 Classification and Figure 5 shows the result of Infected chest.

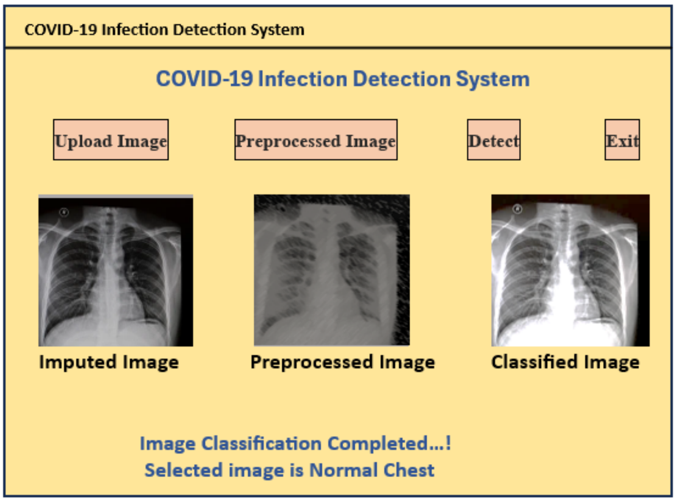

Figure 4. Covid-19 Classification (Normal Chest)

Additionally, the model's robust performance across diverse patient populations and imaging modalities highlights its versatility and scalability in real-world healthcare settings. Its adaptability to evolving viral variants and imaging techniques positions it as a valuable tool in the ongoing battle against COVID-19 and future infectious disease outbreaks.

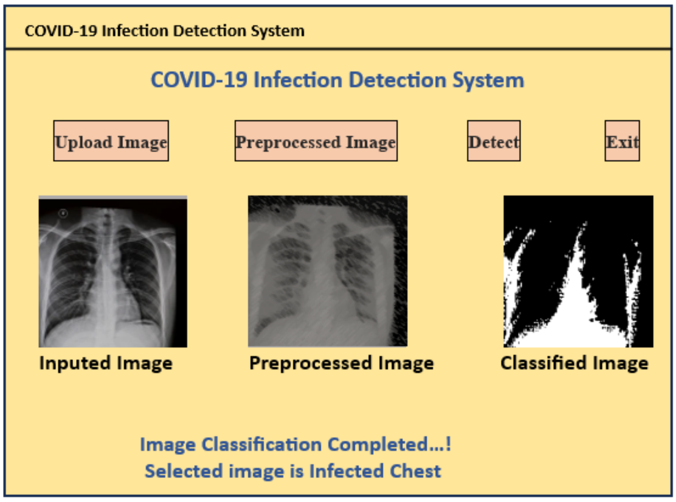

Figure 5. Covid-19 Classification (Infected Chest)

However, despite the significant advancements achieved, several challenges and limitations persist. The reliance on X-ray imaging for COVID-19 detection may be limited by factors such as image quality, patient positioning, and underlying comorbidities, which can impact diagnostic accuracy. Additionally, the generalizability of the model to diverse healthcare settings and populations warrants further validation and refinement.

In conclusion, the results underscore the transformative potential of AI-driven diagnostic technologies in combating infectious diseases and advancing patient care. Continued research and collaboration are essential to address the existing challenges and further optimize the performance and applicability of AI models in healthcare settings.

V. CONCLUSION AND FUTURE GOALS

In conclusion, the COVID-19 situation has created extraordinary challenges to global healthcare system, requiring rapid and innovative solutions for disease detection, management, and containment. The emergence of AI-driven technologies, particularly in the realm of diagnostic imaging, offers a promising avenue for addressing the complexities of COVID-19 diagnosis and treatment.

Through the development and evaluation of advanced AI models, such as the one proposed in this study

DResCNN, significant strides have been made in enhancing the accuracy, efficiency, and accessibility of COVID-19 detection. Leveraging deep learning algorithms and chest X-ray imaging, the DResCNN model demonstrates remarkable diagnostic capabilities, enabling timely identification of COVID-19 positive cases and facilitating prompt intervention and patient care.

ResNet50 may achieve higher accuracy on complex datasets due to its depth and ability to capture intricate features. However, InceptionNet and MobileNet could also perform well, especially if computational constraints are a concern.

Moving forward, continued research and collaboration are essential to refine and optimize AI-based diagnostic tools for COVID-19 detection. Addressing challenges such as data quality, model generalizability, and ethical considerations will be paramount in ensuring the effective deployment and adoption of AI technologies in clinical practice.

In conclusion, the application of AI in COVID-19 diagnosis represents a significant paradigm shift in healthcare delivery, offering unprecedented opportunities to enhance disease detection, surveillance, and management. By embracing technological innovations and fostering interdisciplinary collaboration, we can collectively navigate the challenges posed by COVID-19 and pave the way for a resilient and adaptive healthcare system in the face of future pandemics and public health crises.

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