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A Literature Survey on Deep Learning Models for Pneumonia Detection : Review

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***Abstract*—Pneumonia is a viral infection which affects a significant proportion of individuals, especially in developing and penurious countries where contamination, overcrowded, and unsanitary living conditions are widespread, along with the lack of healthcare infrastructures. Pneumonia produces pericardial effusion, a disease wherein fluids fill the chest and create inhaling problems. It is a difficult step to recognize the presence of pneumonia quickly in order to receive treatment services and improve survival chances. Deep learning, is a field of artificial intelligence which is used in the successful development of prediction models.**

There are various ways of detecting pneumonia such as CT-scan, pulse oximetry, and many more among which the most common way is X-ray tomography. On the other hand, examining chest X-rays (CXR) is a tough process susceptible to subjective variability. In this work, a deep learning (DL) model using utilized for detecting and classifying pneumonia using two CXR image datasets. The classification process carried out in this study uses the Convolutional Neural Network method. The purpose of using the CNN method in the classification process of this research is because, in the process, CNN can extract features automatically and independently, so that the data provided does not need to be pre-processing first, but the data still produces good extraction features and can provide accurate classification results.

Keywords—Chest X-Rays, Deep Learning (DL), Convolutional Neural Network (CNN), ResNet , CT-scan and MRI imaging.

I. INTRODUCTION

Numerous pathogens, including bacteria, viruses, fungi, and parasites, may cause pneumonia, a dangerous lung infection that can impact one or both lungs [1]. The illness causes inflammation in the lungs' air sacs, which may fill with pus or fluid and impede the flow of oxygen into the blood [2]. Cough, fever, chills, trouble breathing, chest discomfort, exhaustion, and sometimes nausea are the symptoms that result from this. Particularly among susceptible groups including the elderly, young children, those with compromised immune systems, and people with long-term respiratory conditions, pneumonia may vary in severity from mild to fatal. Antibiotics are usually used to treat bacterial pneumonia, which is brought on by bacteria such as Staphylococcus aureus, Haemophilus influenzae, or Streptococcus pneumonia. Antibiotics may not be effective for viral pneumonia, which may be caused by influenza, respiratory syncytial virus (RSV), or corona viruses like the one that causes COVID-19. In these cases, supportive care or antiviral medications may be required. Pneumonia is often categorized according to its location and cause. The most prevalent kind, community-acquired pneumonia (CAP), occurs outside of medical facilities. Hospital-acquired pneumonia (HAP) happens during a hospital stay and is often caused by bacteria resistant to antibiotics, whereas healthcare-associated pneumonia (HCAP) may develop in persons who have had close contact with healthcare surroundings. A form of HAP known as ventilator-associated pneumonia (VAP) primarily affects people who have spent a lot of time on a ventilator [4].

When germs reach the lungs by the circulation, aspiration, or inhalation, the pathophysiology of pneumonia starts. Once within the lungs, these microorganisms cause inflammation in the alveoli—tiny air sacs where gas exchange takes place—by inciting an immunological reaction. Normal lung function is disrupted by the collection of fluid, cells, and debris caused by inflammation. The immune reaction may be more severe in cases of bacterial pneumonia, leading to consolidation, in which the buildup of exudate causes the afflicted lung tissue to solidify and become rigid. Inflammation may be broader and more extensive in viral pneumonia, often impacting both the lung tissue and the airways [5].

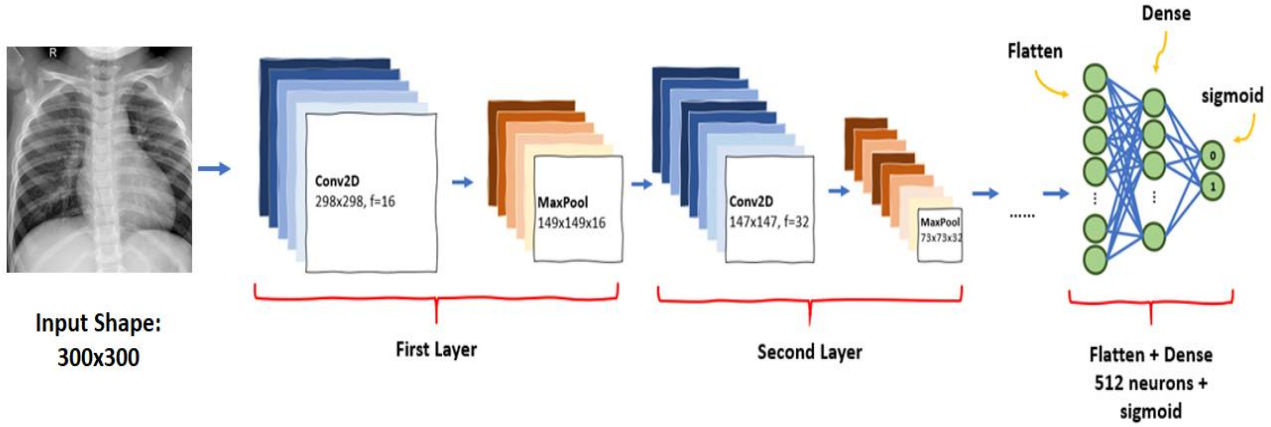

Fig. 1: Pneumonia Detection using Deep Learning [6]

Age, smoking, alcohol use, long-term health issues including diabetes, heart disease, and asthma, as well as compromised immunity from illnesses like HIV or chemotherapy, are risk factors for pneumonia. Living situations, such as in congested areas, and environmental variables, such as air pollution, might further raise the risk. Young children and the elderly are particularly vulnerable to pneumonia since their immune systems may not be as strong. Additionally, inhaling food, liquids, or vomit into the lungs may result in illnesses like aspiration pneumonia, which often affects people with neurological impairments or swallowing issues [7].

A combination of clinical evaluation, history collection, and diagnostic procedures such chest X-rays, blood and sputum cultures, and sometimes a CT scan are used to diagnose pneumonia. These tests aid in determining the causal agent, confirming the existence of pneumonia, and directing the proper course of therapy. In order to assist doctors decide on the right degree of therapy, the severity of the illness is often evaluated using instruments such as the CURB-65 score or the Pneumonia Severity Index (PSI), which include variables including age, vital signs, and concomitant disorders [9].

The etiology of the illness determines how to treat pneumonia. Antibiotics are often used to treat bacterial pneumonia; the medication selection is dependent on the presumed infection and patterns of local resistance. Antiviral drugs may be recommended for viral pneumonia, especially if influenza or the respiratory syncytial virus is the origin of the illness. To assist control symptoms, supportive therapies including oxygen therapy, fluids, and painkillers are often used. Patients may need to be admitted to the hospital in severe instances, and in the worst situations, mechanical ventilation may be required to help with breathing.

Pneumonia may be prevented by immunization and lifestyle modifications. Important preventative measures include vaccinations such as the yearly flu shot, which helps prevent influenza, and the pneumococcal vaccine, which guards against Streptococcus pneumonia. Frequent hand washing and appropriate coughing technique are two examples of good hygiene habits that can stop the spread of respiratory diseases. Quitting smoking is essential since it affects the lungs and makes one more susceptible to illnesses.

Pneumonia continues to be a major global public health issue. Even though it can be effectively treated in many situations, it is nevertheless a major cause of mortality, especially for the most susceptible. In order to manage the condition and lessen its effects, early diagnosis, suitable treatment, and preventative measures including immunization and lifestyle modifications are essential. There is optimism that the burden of pneumonia will decrease as vaccine and treatment development progresses, improving outcomes for individuals who are at risk.

II. LITERATURE REVIEW

Raheel Siddiqi, et.al. (2024) This paper addresses the serious issue of identifying the relevant background and contextual literature on deep learning (DL) as an evolving technology to analyze its application to pneumonia detection via chest X-ray (CXR), the most common and cost-effective imaging technique worldwide. This research analyzes and evaluates COVID-19's 2020–2023 pivotal phase's approach constraints and effectiveness. Details are provided on DL's assistance and automation for limited-availability expert radiography practitioners. Explaining the study's objective, resources, and importance This explanatory text and the following research seek to provide sufficient information about the topic, viable solutions, and their constraints, from specific to general. Presented investigation and analysis support the idea that transformers, particularly vision transformers are the best way to identify CXR pneumonia. ViTs need extensive research to address key limitations like biased CXR datasets, data and code availability, model explanation ease, systematic model comparison methods, class imbalance in CXR datasets, and adversarial attacks, the latter of which remains a fundamental research area **[1].**

Linghua Wu, et.al. (2024) Pneumonia is deadly, therefore experts have focused on therapy and early detection. Due to the maturity and cost reduction of chest X-ray technology and the development of artificial

intelligence, pneumonia diagnosis using deep learning and chest X-ray has garnered global interest. Although deep learning has significant feature extraction capabilities, current object identification frameworks are built on pre-defined anchors, which need a lot of customization and expertise to ensure great results for new applications or data. This research provides an anchor-free object identification framework and pneumonia-based RSNA dataset to circumvent anchor settings in pneumonia diagnosis. A data improvement technique preprocesses chest X-ray pictures, and an anchor-free object identification framework with a feature pyramid, two-branch detection head, and focus loss detects pneumonia. The average accuracy of 51.5 obtained by Intersection over Union (IoU) calculation reveals that this paper's pneumonia identification results can transcend the standard object detection framework, suggesting further study and investigation **[2].**

Mudasir Ali, et.al. (2024) Physical exams and diagnostic imaging including chest X-rays, ultrasounds, and lung biopsies are used to detect pneumonia, a potentially fatal infectious illness. Incorrect diagnosis, insufficient therapy, or absence of treatment may kill patients. Deep learning has helped doctors diagnose pneumonia by guiding their decisions. Healthcare practitioners may improve pneumonia diagnosis and treatment by using deep learning models. This research evaluates CNN, InceptionResNetV2, Xception, VGG16, ResNet50, and EfficientNetV2L deep learning models. The research uses the Adam optimizer to change the epoch for all models. CNN, InceptionResNetV2, Xception, VGG16, ResNet50, and EfficientNetV2L achieve 87.78%, 88.94%, 90.7%, 91.66%, 87.98%, and 94.02% accuracy on 5856 chest X-ray pictures. Efficient NetV2L detects pneumonia with the maximum accuracy and resilience. These results show that deep learning models can reliably identify and forecast pneumonia from chest X-ray pictures, aiding clinical decision-making and patient management **[3].**

Sadman Sadik Khan, et.al. (2024) Children and the elderly are especially vulnerable to pneumonia, making it a global health issue. Rapid and precise analysis is essential for effective treatment and avoiding serious results. CXRs are essential for diagnosing pneumonia, but deciphering them may take long and be variable. "Advances in Medical Imaging," a deep mastering device employing convolutional neural networks to improve CXR pneumonia diagnosis, is described in this research. The presented technology analyzes CXR images using cutting-edge deep learning methods to identify pneumonia more accurately and efficiently. Mobile NetV2 obtained 97% accuracy in this version. Our solution outperforms previous techniques in accuracy, speed, and dependability after extensive testing. Besides helping radiologists diagnose pneumonia better, the "Advances in Medical Imaging" system may reduce healthcare burden, especially in underprivileged areas. This study shows how AI has transformed medical diagnosis, opening the path for wider healthcare applications **[4].**

Nahid Islam, Abu et.al. (2024) In the COVID-19 pandemic, pneumonia caused the most respiratory failure and deaths. SARS-COV-2 and other germs and viruses may cause it. Variants of SARS-COV-2 are still prevalent, and COVID-19 is widespread. COVID-19 symptoms range from subtle to severe respiratory failure. Time-consuming, costly, and inaccurate illness detection procedures exist. Researchers developed a system for COVID-19 and pneumonia identification utilizing various deep learning algorithms and a deployment method. Researchers tested four popular deep learning models—VGG-19, ResNet-50, Inception V3, and Xception—on two datasets of CT scan and X-ray pictures (COVID/Non-COVID) to find the best COVID-19 identification models. Researchers obtained 86%–99% accuracy depending on model and dataset. Researchers used the four models to two additional datasets of bacterial and viral pneumonia X-ray pictures to confirm presented results **[5].**

A.Pranaya, et.al. (2023) Pneumonia is a life-threatening disease that affects the lungs in humans. Pneumonia is caused by Streptococcus pneumoniae bacterium. In pneumonia detection chest X-ray images are used as input dataset. To detect pneumonia chest X-rays need to be estimated by expert radiotherapists and it is expensive process, It would be beneficial and easy for people to use automatic system for pneumonia identification. People identify pneumonia using automatic system and get active treatment at early stages. The dataset containing chest X-ray images is obtained from Kaggle. The image characteristics are learned using pre-trained CNN (Convolutional Neural Network) models. CNN is used to analyse image features. This approach assists physicians in determining whether the patient has pneumonia or not. Early detection helps in early diagnosis **[6].**

III. PROBLEM STATEMENT

Pneumonia is a life-threatening lung infection that can cause severe health complications, particularly in children, the elderly, and individuals with weakened immune systems. Early and accurate detection of pneumonia is critical for timely medical intervention and effective treatment. Traditionally, pneumonia is diagnosed through clinical evaluation and chest X-ray interpretation by trained radiologists. However, this process can be time-consuming, subject to human error, and may not always be readily available, especially in remote or resource-limited areas. To address these challenges, there is a growing need for automated, reliable, and efficient diagnostic systems that can assist healthcare professionals in identifying pneumonia quickly and accurately.

Machine learning, particularly image classification techniques using deep learning models, offers a promising solution for automating the detection of pneumonia from chest X-ray images. This project aims to develop a

machine learning-based system capable of classifying chest X-ray images into pneumonia-positive or normal categories with high accuracy and minimal diagnostic delay. The proposed solution should be robust, sensitive, and specific, with the potential to support clinical decision-making and improve healthcare outcomes, especially in under-resourced settings.

IV. Expected Solution

The expected solution for pneumonia detection using machine learning is to develop an automated system that can accurately detect pneumonia from chest X-ray images with minimal human intervention. The system should use image classification algorithms, preferably deep learning models like Convolutional Neural Networks (CNNs), which are well-suited for medical image analysis. It should be trained on a large, diverse dataset of labeled chest X-rays to ensure high diagnostic accuracy and the ability to generalize across different patient groups. The system must deliver quick, reliable predictions with high sensitivity (to correctly detect pneumonia cases) and high specificity (to correctly identify normal cases). Additionally, the solution should include visual explanations of the model's decision, such as heatmaps, to help doctors understand and trust the results.

- Develop an automated system for pneumonia detection using chest X-ray images.
- Utilize machine learning techniques, preferably Convolutional Neural Networks (CNNs) for image classification.
- Train the model on a large and diverse dataset of labeled chest X-ray images.
- Achieve high accuracy, sensitivity, and specificity in detecting pneumonia cases.
- Ensure the model can handle variations in image quality, patient age groups, and equipment differences.
- Provide quick and reliable predictions to support faster clinical decisions.
- Integrate visualization tools (e.g., heatmaps, Grad-CAM) to show the regions influencing the model's decision, improving trust and explainability.
- Design the system to assist radiologists and healthcare providers, especially in rural or under-resourced areas.
- Minimize the risk of false negatives and false positives to ensure patient safety.
- Aim for a user-friendly interface that can be easily integrated into hospital workflows.

V. Conclusion

Pneumonia remains a major global health concern, particularly affecting vulnerable populations such as children, the elderly, and individuals with compromised immune systems. Early and accurate diagnosis is critical for effective treatment and reducing mortality rates. Machine learning, especially deep learning techniques, has shown significant promise in automating pneumonia detection from chest X-ray images. Through the use of advanced image classification models like Convolutional Neural Networks (CNNs), it is possible to achieve high diagnostic accuracy, reduce human error, and provide rapid preliminary results that can assist healthcare professionals. However, challenges such as dataset limitations, class imbalance, model interpretability, and generalization across diverse populations still need to be addressed. Future research should focus on improving model robustness, incorporating explainable AI techniques, and validating systems in real-world clinical environments.

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