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RayScan AI: Pneumonia Detection Using X-Ray

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A B S T R A C T

Pneumonia is a critical respiratory infection that causes inflammation of the air sacs in one or both lungs, potentially leading to severe health complications if not detected and treated promptly. This study presents an effective pneumonia detection system utilizing the Gemini API, which integrates machine learning techniques to classify chest X-ray images as normal or pneumonia-affected. The objective of this research is to provide an efficient, accurate, and user-friendly diagnostic tool to assist healthcare professionals in early diagnosis. The system offers high accuracy, precision, and recall rates, demonstrating its potential as a reliable tool for pneumonia detection. The platform also includes an appointment booking feature, enabling users to schedule consultations with available doctors for further evaluation and treatment. The Doctor panel allows healthcare professionals to review AI-diagnosed cases, confirm or provide additional insights, and manage patient appointments. Additionally, users can provide feedback on their experiences with both the system and the doctors, which helps improve platform functionality and service quality. The admin panel oversees system operations, manages users, doctors, and feedback, ensuring smooth functionality and security.

Keywords: Pneumonia detection, respiratory infection, chest X-ray classification, Gemini API, machine learning, healthcare diagnostics, accuracy, healthcare professionals.

Introduction

Pneumonia is a life-threatening lung infection that predominantly affects children, elderly individuals, and immunocompromised patients. It remains a major cause of mortality worldwide, particularly in developing countries with limited access to advanced medical facilities. Conventional methods of pneumonia diagnosis involve clinical examination, radiological assessments, and laboratory tests, which can be time-consuming and costly. The proposed system leverages the Gemini API, a robust deep-learning-powered tool, to detect pneumonia from chest X-ray images. This paper aims to evaluate the system's performance in terms of accuracy, precision, recall, and usability.

Recent advancements in artificial intelligence (AI) have opened new possibilities for improving medical imaging. AI-driven solutions can enhance image quality, assist in automated diagnosis, and provide reliable second opinions to radiologists. The RayScan AI module utilizes generative AI techniques to refine chest X-ray images, ensuring clearer visualization of lung abnormalities. This approach aims to address challenges associated with traditional diagnosis, such as human error and limited radiologist availability.

A patient experiencing pneumonia has fast breathing, fever, dry hack, hypertension, and a high heartbeat rate. In the manual test, specialists would check fast breathing, pulse, and high heartbeat rate which could likewise be side effects of weakness, circulatory strain, or essentially hyper pressure. So, there are chances that the specialist is mixing up exhaustion, high BP, and hyper pressure for pneumonia. This cycle of the manual test is right off the bat tedious. Furthermore, it would be deluding such that specialists would botch the genuine minor illness or disease for something genuine as pneumonia. Thirdly, in the manual test, the specialist can commit an error in record keeping or he can miss any minor detail. In the manual test, more staff necessity would cost a ton. The patient's clinical history would not be known to the specialist. Moreover, the human blunder is consistently impending which would cause the issue. So, as opposed to treating the minor illness, treatment of pneumonia would begin and it would have some results, i.e., some unfavorably susceptible responses and unsettling influence in ordinary metabolic cycles.

This study focuses on the integration of generative AI-based image enhancement with pneumonia detection. By leveraging advanced AI models, we aim to:

- Enhance X-ray image clarity for better diagnosis.
- Reduce the dependency on large labelled datasets through synthetic image generation.
- Improve diagnostic accuracy while minimizing false positives and negative.

Literature Review

Pneumonia detection using chest X-rays has been extensively studied in the field of medical imaging and artificial intelligence. Several research efforts have explored deep learning, machine learning, and AI-based enhancement techniques to improve diagnostic accuracy.

Usman et al. (2025) proposed a machine learning approach using CNN and ResNet-50 for pneumonia detection on the RSNA dataset, which consisted of 26,684 chest X-ray images [1]. Their study demonstrated that CNN-based models could achieve an accuracy of 79%, but generalization remained a challenge due to dataset limitations. Becker et al. (2022) evaluated a commercially available deep learning model for pneumonia detection in chest radiographs and found that AI-based approaches could achieve an AUROC value of 0.923, with high sensitivity (95.4%) and specificity (66.0%) [2]. This study highlighted the potential of AI models to improve diagnostic efficiency in emergency settings.

Rajpurkar et al. (2017) developed CheXNet**,** a 121-layer convolutional neural network trained on the ChestX-ray14 dataset (112,120 images), achieving radiologist-level performance in pneumonia detection [3]. Their work demonstrated the effectiveness of deep learning in medical imaging but also emphasized the challenges related to data quality and interpretability.

Despite these advancements, conventional deep learning models rely heavily on large labeled datasets, making them less effective in real-world scenarios with limited data availability. Generative AI has emerged as a promising solution to enhance X-ray image quality and generate synthetic data for better model generalization. By incorporating our proprietary Rayscan AI module**,** we aim to build upon previous research while addressing key limitations such as dataset scarcity and diagnostic accuracy.

Methodology

A. Generative AI for Image Enhancement

The RayScan AI module leverages generative AI to enhance chest X-ray images, making pneumonia detection more efficient and accurate. Unlike traditional deep learning models that rely solely on classification, generative AI improves image quality before feeding it into diagnostic models.

B. Image Preprocessing with Generative AI

To ensure high-quality input images, the system:

- Uses Pillow (PIL) to resize, convert, and normalize chest X-rays.
- Applies generative AI-based enhancement to improve contrast and remove noise.
- Generates synthetic X-rays to increase dataset diversity, ensuring the model generalizes better to real-world data.

C. Synthetic Data Generation

- Simulates rare pneumonia cases to improve model robustness.
- Expands training data without requiring additional manual labeling.
- Provides balanced datasets, reducing bias in AI model predictions.

D. Integration with Diagnostic Models

- Enhanced images are fed into a pneumonia classification model.
- The system compares AI-enhanced X-rays with original scans to verify improvements.
- Results are analyzed to ensure accuracy, minimizing false positives and false negatives.

E. Evaluation Metrics

- The effectiveness of the Rayscan AI module is evaluated using:
- Image Quality Assessment: Measuring contrast improvement and noise reduction.
- Diagnostic Accuracy: Comparing AI-enhanced images against original scans for pneumonia detection.
- Data Augmentation Impact: Analyzing how synthetic images improve classification performance.

F. Dataset

- X-ray Images: Chest X-rays (CXR) are the most common type of data used for pneumonia detection.

3.1 Normal Pneumonia Chest X-ray

A normal Pneumonia chest X-ray represents healthy lung conditions without any signs of infection, inflammation, or abnormal growth. It shows clear lung fields with consistent density and proper lung expansion.

Characteristics of a Normal X-ray:

- Lungs appear dark (because they are filled with air).
- Clear lung markings with no cloudiness or opacity.
- No fluid accumulation in the pleural space (around the lungs).

Fig.1: X-Ray 1

Fig.2: X-Ray 2

Fig.3: X-Ray 3

3.2 Positive Pneumonia Chest X-ray

A positive pneumonia chest X-ray shows visible signs of infection and lung inflammation caused by bacterial, viral, or fungal agents. The infection causes fluid or pus to fill the alveoli, leading to lung opacities.

Characteristics of a Positive Pneumonia X-ray:

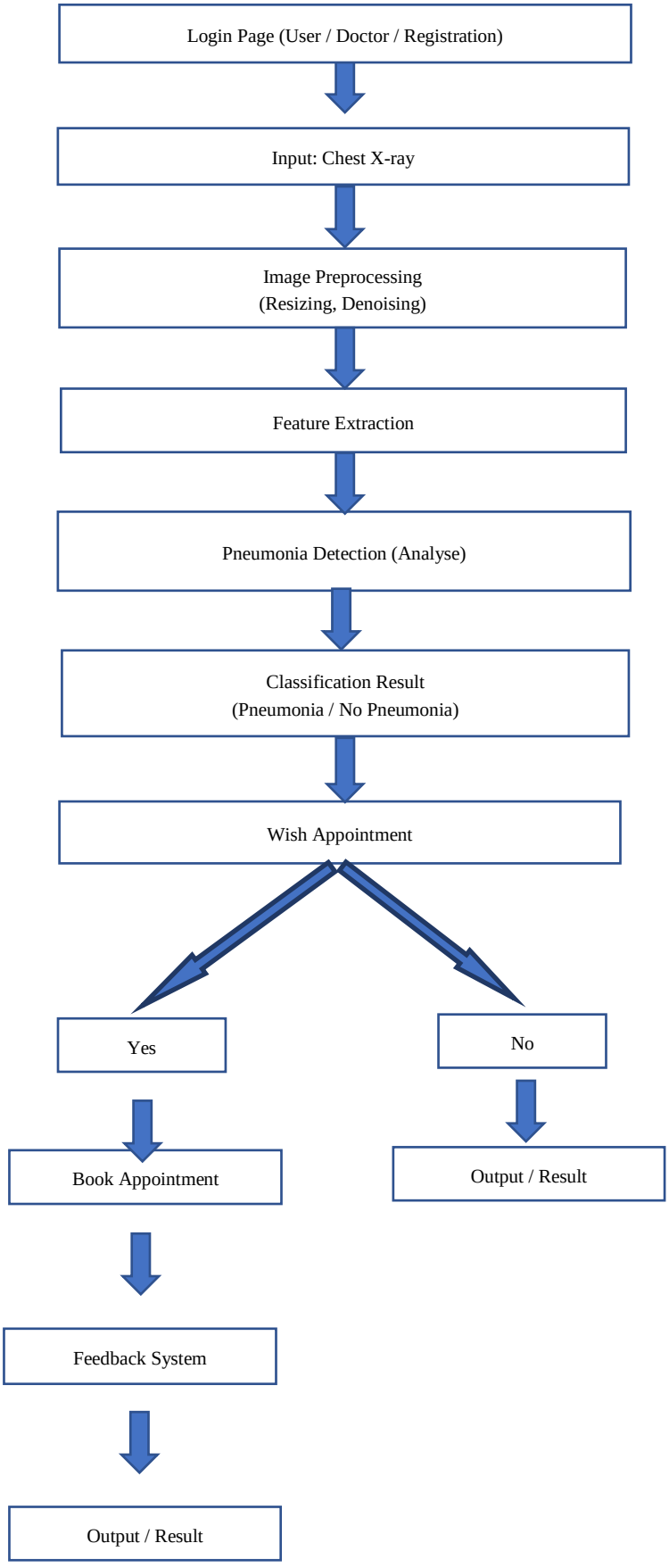
- Infiltrates – White or cloudy patches in lung fields due to fluid or pus accumulation.
- Consolidation – Dense white areas due to inflammation and fluid-filled alveoli.
- Air bronchogram – Visible air-filled bronchi surrounded by white consolidations.
- Ground-glass opacity – Hazy appearance of lung tissue (common in viral pneumonia).

Fig.4: X-Ray 1

Fig.5: X-Ray 2

Fig.6: X-Ray 3

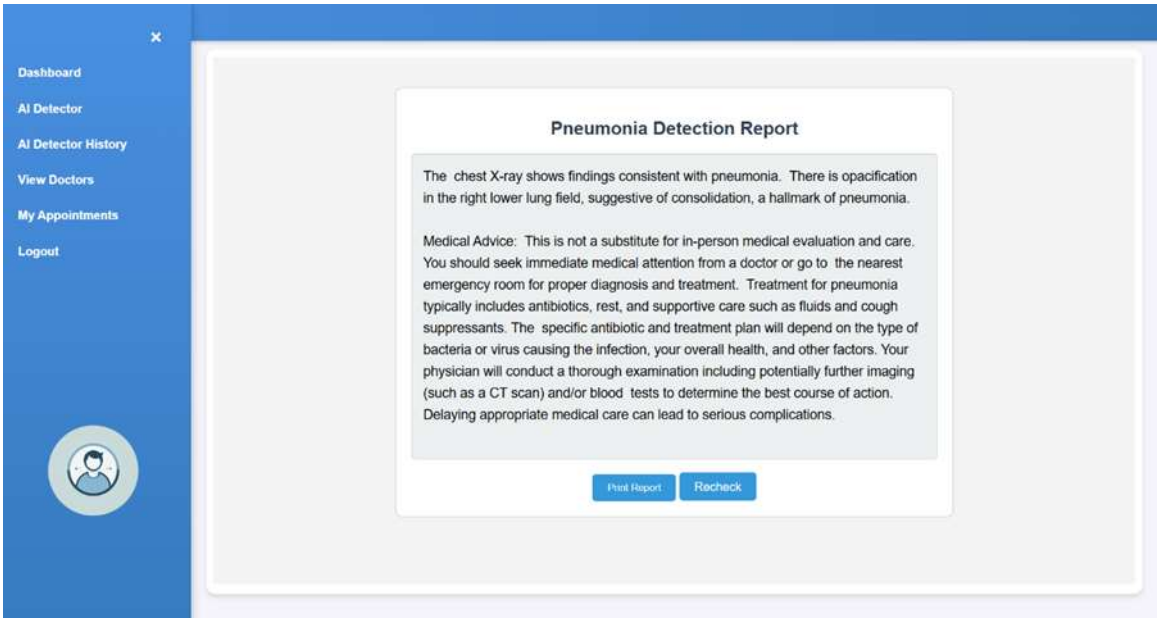
Flow Chart


Login Page (User / Doctor / Registration)
Input: Chest X-ray
Image Preprocessing
(Resizing, Denoising)
Feature Extraction
Pneumonia Detection (Analyse)
Classification Result
(Pneumonia / No Pneumonia)
Wish Appointment
Yes
No
Book Appointment
Output / Result
Feedback System
Output / Result

5. Result

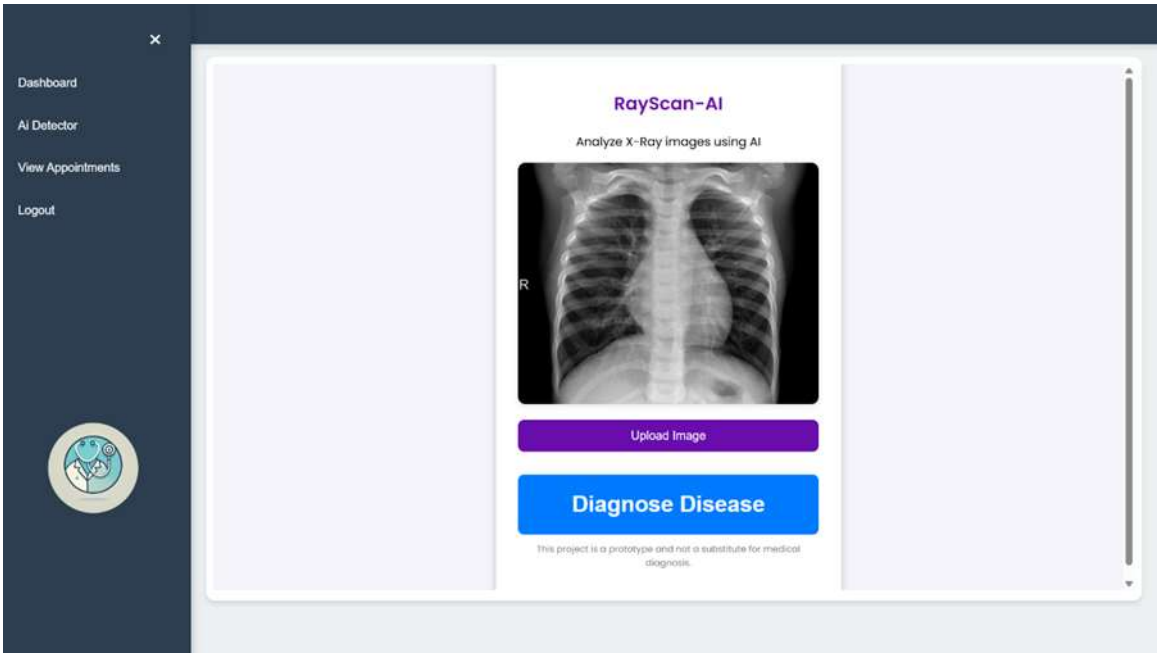
5.1 Positive Report:

Screenshot. No. 1: Uploaded X-ray Image

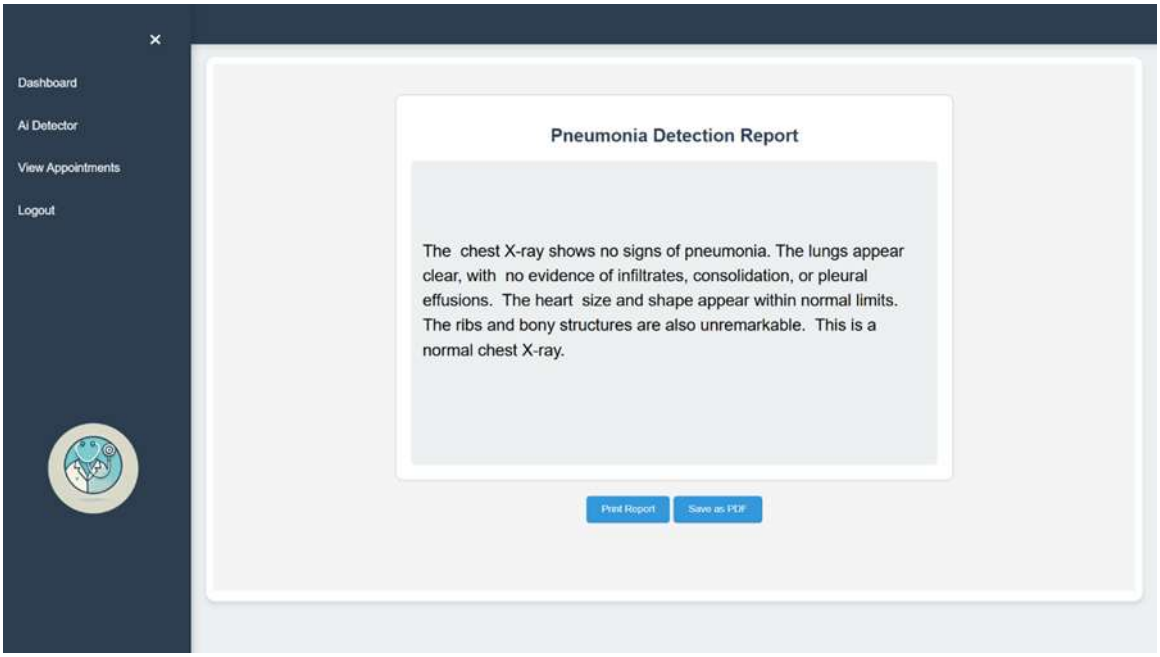


Screenshot. No. 2: Positive Report

5.2 Negative Report:



Screenshot. No. 3: Uploaded X-ray Image



Screenshot. No. 4: Negative Report

6. Conclusion

The Pneumonia Detection Online Portal successfully integrates AI technology for automated pneumonia diagnosis, appointment scheduling, and medical assistance, providing users with a convenient and accessible healthcare solution. By leveraging Gemini AI for X-ray analysis, the platform enables early detection of pneumonia, assisting users in identifying potential health risks promptly.

An AI-driven pneumonia detection platform was developed, utilizing advanced image processing techniques to analyze X-ray images with high accuracy. The system enables seamless appointment scheduling, allowing users to book consultations with medical professionals effortlessly. Additionally, it provides AI-generated home remedies for mild pneumonia cases, helping users manage symptoms effectively in the early stages. To enhance user engagement and service quality, a feedback mechanism is integrated, enabling patients to review doctors and share their experiences, fostering trust in medical consultations.

7. Future Scope

The Pneumonia Detection Online Portal has the potential for significant advancements, making healthcare more efficient, accessible, and patient-friendly. One of the key future enhancements is the integration of an online prescription and medicine delivery system, where doctors can prescribe medications directly through the portal, allowing patients to order them with ease. Additionally, AI-based severity analysis can be introduced to classify pneumonia cases as mild, moderate, or severe, guiding patients toward the appropriate level of medical care.

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