

AI-Based Biomedical Image Analysis System for Disease Diagnosis



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Abstract

In The Gambia, it usually takes days for radiologists to come up with patient diagnosis from Chest X-ray Computerized Tomography (CT) scans. This status quo and the delays that follow are not ideal especially in cases where a patient is in an emergency state waiting for results. In this paper, an Artificial intelligence based digitized System that leverages Machine learning algorithms to predict the cause of patient disease is proposed. This ranges from a predefined set of diseases such as Tuberculosis, Pneumonia and Covid-19.

In our work, we utilize CSPDarknet53-tiny, a convolutional neural network (CNN) and backbone for object detection. This CNN is used as the backbone for YOLOv4-tiny to build a model that will be used to predict a set of diseases. The results show the proposed solution is able to predict diseases with a high level of accuracy. This will greatly complement the current efforts of radiologists in reducing the volume of labor required to perform accurate diagnoses of patient disease.

Introduction

Every 15 seconds, a child dies of pneumonia somewhere on the planet. This equates to 5,500 children dying every day and 2 million children dying every year. As a result, pneumonia is the leading cause of death among children worldwide. Despite this staggering statistic, pneumonia prevention and treatment programs are inadequately underfunded, and the disease is rarely covered in the news. [1]

In 2018, the World Health Organization reported that influenza and pneumonia deaths in Gambia totaled 1,619, accounting for 11.62% of all deaths. [2]

This is a very serious situation and calls for urgent action. Research has shown that with the advent of technology tools and techniques such as AI and Machine learning early prevention can be sought and potential deaths can be averted.

According to research, medical image analysis systems are rarely available in a lot of developing countries or even so; the challenges are often underscored by the cost of acquiring such systems and training of professionals [3].

Methodology

For Detecting diseases using DarkNet-53, we utilize the CSPDarknet53-tiny convolutional neural network and backbone. It divides the feature map of the base layer into two sections using a Cross Stage Partial Network (CSPNet) approach, then combines them using a cross-stage hierarchy [4]. A split-and-merge method allows for increased gradient flow in the network [5].

To train our model, we make use of a machine with 1 NVIDIA GeForce RTX 2060 Max-Q GPU to speed up the retraining of CSPDarknet53-tiny. For making predictions using the already trained model, we developed a custom YOLOv4-tiny solution. In the custom solution implementation, we made use of libraries such as Numpy and Python OpenCV.

In Fig. 1, we show the framework for the detection of a set of diseases making use of the pretrained Darknet53 neural network. The neural network can detect chest X-rays affected with Pneumonia and those not by fine-tuning deeper layers and training the new dataset (100 PNEUMONIA and 100 NORMAL) to build a model. This dataset was collected from the Africmed international hospital in The Gambia (www.africmed-gm.com).

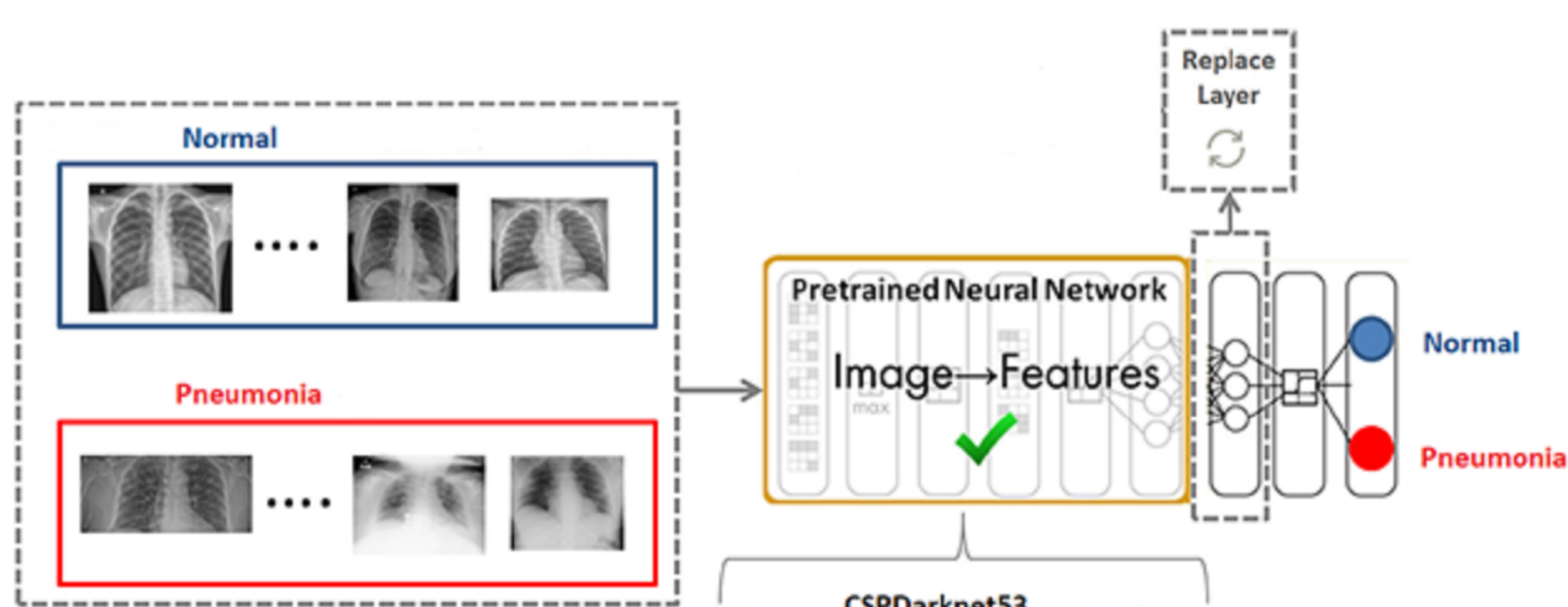


Figure 1: Framework for Disease detection leveraging YOLOv4-tiny Architecture

Results

The findings of the accuracy of our model after training and when used for inference are highlighted in this section.

Result I

We show below a graph representation of the mAP and average-Loss, after training the custom dataset for 4000 iterations.

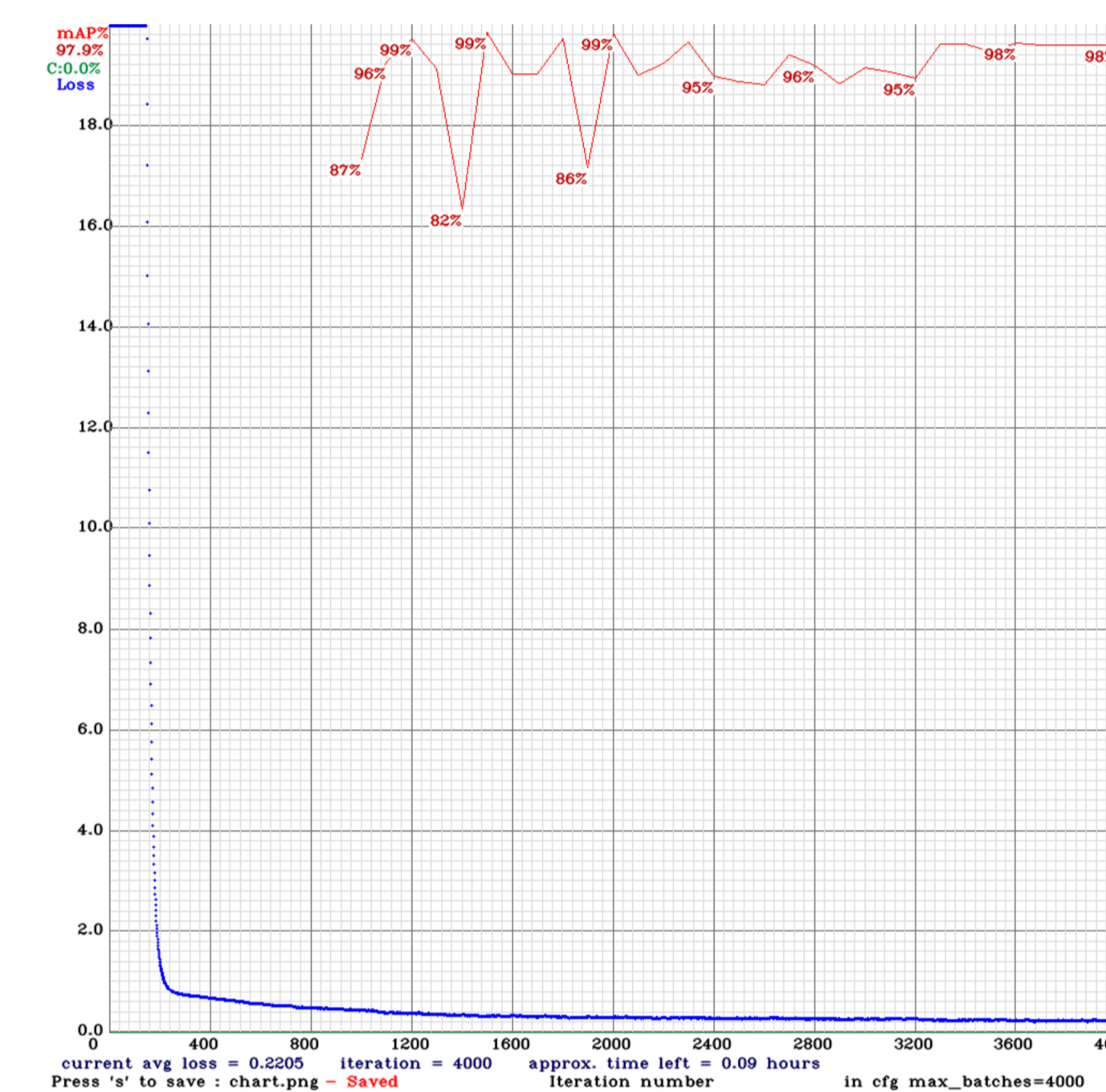


Figure 2: Graph representation of mAP and loss values

Result II

Fig. 3 shows one of the developed use cases in our YOLOv4-tiny solution.

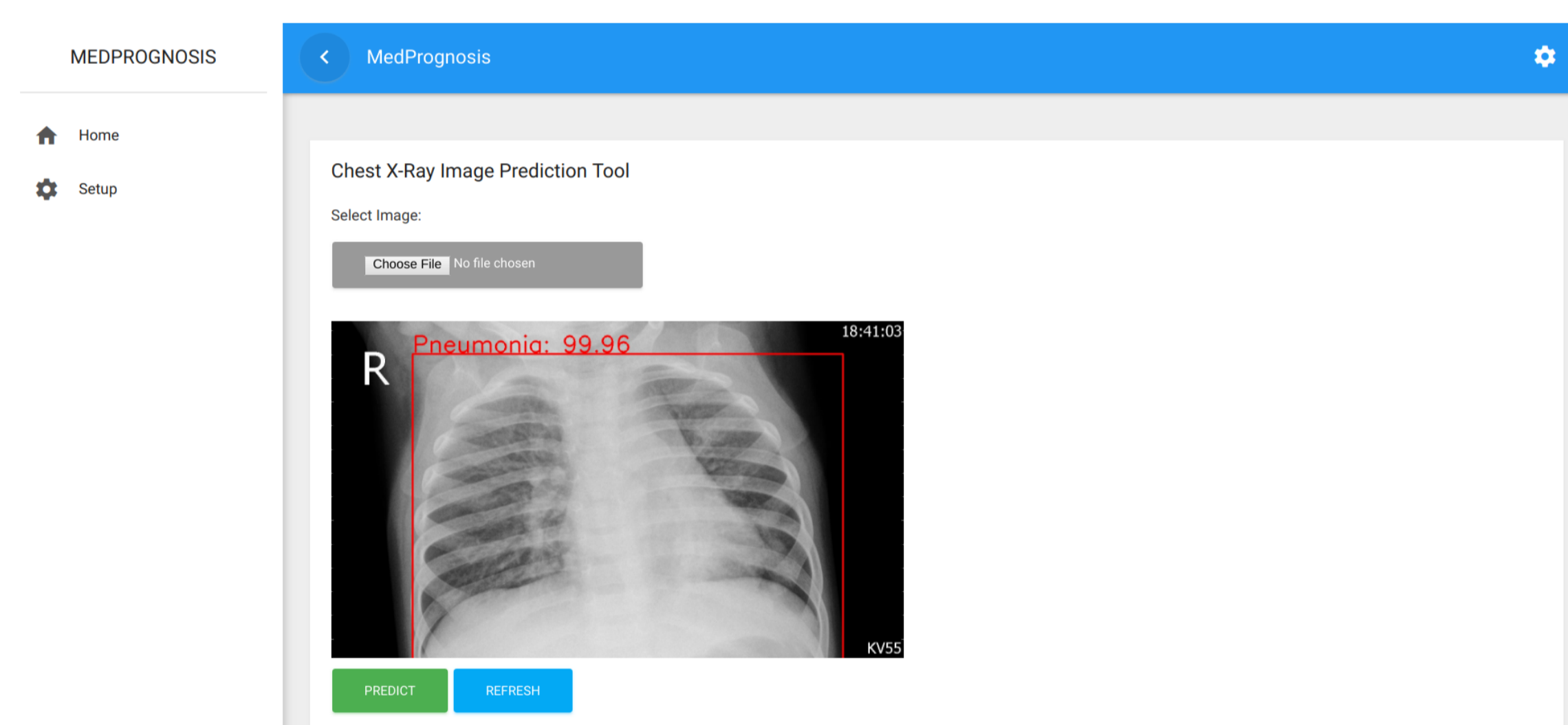


Figure 3: Pneumonia Chest X-ray detection (%)

We can see that after uploading the image and performing inference, results show that the chest x-ray is associated with Pneumonia.

Conclusion

Accurate and accessible Medical Imaging Systems are vital in complementing the efforts of radiologists in the timely diagnosis of patients' diseases. These AI systems have the potential to significantly cut waiting time of patients for CT scan results, and will greatly help a lot of developing countries with shortage of radiologists.

References

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