Pneumonia Detection Using Deep Convolutional Neural Networks by Using Digital Chest X-Ray

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ABSTRACT

Pneumonia is a widespread and severe respiratory disease that arises from inflammation of the lung tissue, resulting in impaired functioning. It is a leading cause of death worldwide. Prompt recognition and treatment of pneumonia are essential to mitigating disease severity and duration, improving patient outcomes, and ensuring timely and appropriate medical intervention. Instead of self-interpreting chest X-rays, which can be prone to errors, technology and artificial intelligence (AI) can help accurately diagnose pneumonia and analyze X-ray images. This project aims to develop a system that uses AI to detect pneumonia by making use of chest X-ray images as the primary data source (data is open source). The proposed system incorporates machine learning algorithms to analyze a variety of chest X-ray datasets, and the accuracy and reliability of the system in identifying pneumonia in terms of diagnostic accuracy are evaluated and compared with several similar models. The ultimate goal of this project is to create a reliable tool that healthcare professionals can use to accurately and efficiently diagnose pneumonia, thus ensuring timely treatment for patients.

Introduction

Deep learning has shown potential in accurately diagnosing diseases, especially in the medical industry, where it is used for its high efficiency. At the moment, however, it cannot completely replace doctors and experts, but supports them in time-consuming tasks. One example is the use of deep learning to examine chest X-rays to detect pneumonia. Pneumonia is pneumonia caused by bacteria, viruses, and fungi that can affect all ages, with weak immunity and children under the age of five being particularly vulnerable. Diagnosing pneumonia is complicated, especially when multiple infections are present at the same time. According to the Preventive Disease Control Practice (CDC, Atlanta, USA), more than 50,000 people died from pneumonia in the United States in 2015, with 1.7 million adults hospitalized. Artificial intelligence (AI) technology can aid in early computer-assisted diagnosis and reduce reliance on X-ray analysis. The AI can read digital chest X-rays, and based on the program training, can obtain accurate and efficient results to determine the condition of a breast cancer patient. AI can help doctors make timely decisions to save patients' lives and treat them promptly.

Literature Review

Table1. Summary of papers reviewed on ” Pneumonia Detection using Deep Convolutional Neural Networks by using digital chest X-ray.”

Title, Author, and Year	Concepts, Approach, Methods, Analysis adopted	Inconsistencies, Gaps, Contradictions, Differences	Improvements

Deep Learning on Chest X-ray Images to Detect and Evaluate Pneumonia Cases at the Era of COVID-19, Hammoudi, K., Benhabiles, H., Melkemi, M., Dornaika, F., Arganda-Carreras, I., Collard, D., & Scherpereel, A, (2021).	To determine the patient's condition through a chest x-ray, whether he is infected or normal. The method used is to use X-ray images of Covid-19 patients to train the system and change the size of the images used to (310 x 310) pixels. The data set used contains 5,863 children's x-rays.	The use of a limited data set containing X-ray images of children, and the study's dependence on images of people with Covid-19. The proposed system is based on observation only.	More images can be added for different cases of pneumonia and normal, not relying on images of people with COVID-19 only, and using X-ray images of people of different ages to train the system.
Identifying pneumonia in chest X-rays: A deep learning approach Jaiswal, A. K., Tiwari, P., Kumar, S., Gupta, D., Khanna, A., & Rodrigues, J. J. P. C. (2019).	To measure the power of deep learning technology and the performance of medical tasks to identify pneumonia through chest X-ray images, the system relies on the Mask-RCNN model. Understanding how the size of the radiological image plays an important role in the performance of the system.		
GM, H. A. R. S. H. V. A. R. D. H. A. N., GOURISARIA, M. A. H. E. N. D. R. A. K. U. M. A. R., RAUTARAY, S. I. D. D. H. A. R. T. H. S. W. A. R. U. P., & PANDEY, M. A. N. J. U. S. H. A. (2021). PNEUMONIA DETECTION USING CNN THROUGH CHEST X-RAY	This study is based on discovering the effectiveness of small CNN and comparing it with large CNN with heavy learning. The methods were followed by using a dataset consisting of 5195 chest radiographs containing 1341 normal chest radiographs and 3857 chest radiographs with pneumonia.	A sufficient amount of data was not used to train the system, but the size of the images was changed, and the images were manipulated to increase the size of the data.	Optimization can be done by increasing the size of the data set that will be used to obtain better results and accuracy.
Diagnosis of Pneumonia from Chest X-Ray Images using Deep Learning Ayan, E., & Unver, H. M. ,2019	It used two types of networks, Vgg16 and Xception, and trained them with a data set consisting of 5856 chest		Data sets can be augmented to train the system for better accuracy.

	radiographs of different quality and resolution.		

Implementation Details

The purpose of this project is to develop an artificial intelligence-based system capable of detecting pneumonia from chest X-ray images. To achieve this goal, an open-source dataset of chest X-ray images will be used, and the PyCharm program will be employed to implement and operate the project. The Python language will be utilized to create an AI model that can accurately examine and detect pneumonia based on specific lung shape changes. The detection process depends on several factors that alter the lung's appearance, which are integrated into the AI model. Moreover, the system will be trained on a large set of chest X-ray data to improve its accuracy and enhance its performance. The system will use several types of layers in the training phase to optimize its performance and minimize the risk of overfitting. In the final stage, the system's efficacy will be evaluated by testing it on an external image that was not included in the training data. This process is crucial to ensure the model's ability to generalize and perform accurately on new data. The project's ultimate goal is to create an effective tool for pneumonia diagnosis, which can assist medical professionals in providing prompt and accurate treatment to patients.

Results

```
Found 5216 images belonging to 2 classes.
Found 16 images belonging to 2 classes.
WARNING:absl:`lr` is deprecated in Keras optimizer, please use `learning_rate` or use the legacy optimizer, e.g.,tf.keras.optimizers.legacy.Adam.
Epoch 1/10
163/163 [==============================] - 170s 1s/step - loss: 4.1022 - accuracy: 0.9197 - val_loss: 0.3442 - val_accuracy: 0.9375
Epoch 2/10
163/163 [==============================] - 164s 1s/step - loss: 0.1451 - accuracy: 0.9559 - val_loss: 0.2621 - val_accuracy: 0.8750
Epoch 3/10
163/163 [==============================] - 168s 1s/step - loss: 0.1110 - accuracy: 0.9632 - val_loss: 0.5233 - val_accuracy: 0.7500
Epoch 4/10
163/163 [==============================] - 173s 1s/step - loss: 0.1133 - accuracy: 0.9599 - val_loss: 0.1471 - val_accuracy: 1.0000
Epoch 5/10
163/163 [==============================] - 175s 1s/step - loss: 0.0999 - accuracy: 0.9659 - val_loss: 0.2290 - val_accuracy: 0.8750
Epoch 6/10
163/163 [==============================] - 171s 1s/step - loss: 0.0942 - accuracy: 0.9693 - val_loss: 0.0710 - val_accuracy: 0.9375
Epoch 7/10
163/163 [==============================] - 172s 1s/step - loss: 0.1163 - accuracy: 0.9632 - val_loss: 0.1410 - val_accuracy: 1.0000
Epoch 8/10
163/163 [==============================] - 175s 1s/step - loss: 0.0908 - accuracy: 0.9693 - val_loss: 0.1073 - val_accuracy: 0.9375
Epoch 9/10
163/163 [==============================] - 177s 1s/step - loss: 0.0996 - accuracy: 0.9689 - val_loss: 0.0580 - val_accuracy: 1.0000
Epoch 10/10
163/163 [==============================] - 172s 1s/step - loss: 0.0896 - accuracy: 0.9680 - val_loss: 0.1721 - val_accuracy: 0.8750
Found 624 images belonging to 2 classes.
624/624 [==============================] - 37s 58ms/step
```

Figure1. ResNet50 training

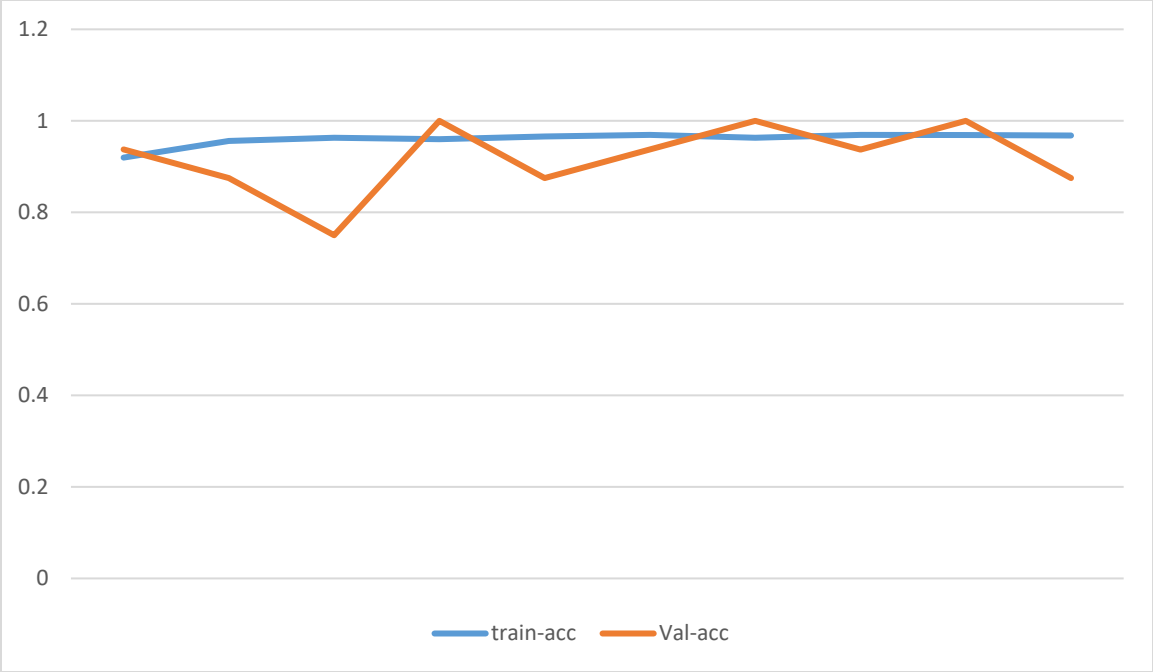

Figure2. Train and validation accuracy

The presented figure displays the outcomes of training the ResNet50 layers-based system and reports its accuracy. The system was trained using various numbers of epochs, up to ten, and each training stage was allocated a specific time period. As per the figure, the system achieved an accuracy of 96.8%. The losses, on the other hand, represent the success of the model to recognize pneumonia in the provided images. The reported results indicate that the model exhibited a loss rate of 8.96%. The utilization of ResNet50 layers-based models has been proven to be effective in numerous applications, including image recognition and medical diagnosis. The presented results highlight the potential of the model to accurately detect pneumonia, which is a critical task in medical diagnosis. However, further analysis is necessary to determine the generalizability and robustness of the model when it comes to large and diverse datasets.

Conclusion

The project aims to design a system capable of detecting pneumonia without human intervention. Despite the success of the system, it is always a good idea to work on system improvements. By reviewing the different methods that have been implemented in similar projects, as well as the advantages and disadvantages of each method, it becomes possible to make improvements, especially with technological developments. In fact, the project is designed to help doctors and specialists in the detection and to reduce pressure and time, as this reflects positively on the disease to provide appropriate treatment without delay. Overall, the project achieved all of its written objectives and carried out as planned.

Limitation

After designing and implementing the project idea, it is found that the project still has room for improvement to help the idea to be more efficient in real-time use. This is done by creating a page where the image can be inserted without

referring to the program to insert the image. In addition, the data set for chest X-rays is limited, as more images must be obtained to obtain better results.

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