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Heart Disease and COVID-19 Prediction Using AI/ML

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Abstract- The current pandemic of COVID-19 for global medical care has high demand on rapid and correct diagnosis, especially in a cardiac population with prior heart disease being a large proportion among these patients. In this work, a predictive machine learning (ML) model based on convolutional neural networks (CNNs) is proposed to recognize COVID-19 and heart disease from chest X-ray images. The COVID-19 positive and normal X-ray images were used to train the CNN model. The objective behind was to automate the diagnosis so that it helps in early detection of diseases which can save lives and improve patient management. The model was accurate and demonstrated promising results in clinical scenarios.

Index Terms- COVID-19, Heart Disease, Convolutional Neural Networks, Chest X-ray images, Deep Learning, Machine Learning.

I. INTRODUCTION

The COVID-19 pandemic has brought plenty of challenges to global healthcare systems, notably in its rapid diagnostic capabilities and handling more vulnerable populations. One of the most at-risk groups to be hit by this development is those with underlying heart problems (or other organs such as the kidneys), since they can develop serious complications if infected with COVID-19. COVID 19 and heart disease has resulted in a sort of dual comorbid condition as both these diseases share several common symptoms, like breathlessness and chest pain lead to diagnostic confusion.

This is helping in changing the landscape in medical diagnosis and more so with applications leading to development of solutions using deep learning concepts by leveraging on Artificial intelligence (AI) together with Machine learning (ML). Background: Convolutional neural networks (CNNs), an especially well-suited type of deep learning, have achieved prominence for image recognition tasks and are rapidly being employed in medical image analysis. Several studies have shown the use of CNNs in identifying COVID-19 from chest X-ray (CXR) and computed tomography (CT) scans during the ongoing pandemic. Nonetheless, there are very limited studies available about the simultaneous detection of COVID-19 and heart disease in a single model.

Our research attempts to fill this gap by building a CNN based model that can predict not only COVID-19 but also heart disease from chest X-rays. Trained on the publicly available dataset containing COVID19 positive and normal images. The study aims to automate disease diagnosis for quicker and more accurate screening and help healthcare providers in managing patients with comorbid conditions such as heart diseases.

AI has already been shown to help in healthcare by reducing the burden on medical professionals, increasing diagnostic accuracy and speed, and decreasing human error. So if it comes to time and accuracy of diagnosis, AI-driven solutions are critical in the ongoing battle against COVID-19 and heart ailment. Also, during pandemics healthcare systems are often overwhelmed and assistance of diagnosis automation can be resourceful.

The CNN model adopted in this work was to classify CXR images into COVID-19 and normal while also being able to highlight the surges of heart disease. Because transfer learning and data augmentation models that could generalize well in the small dataset. We assessed the system performance in terms of accuracy, sensitivity, and specificity for dual-disease diagnosis using standard evaluation metrics, demonstrating that AI was indeed capable of dual-disease detection.

In conclusion, this study presents an incremental contribution in introducing AI based diagnostic tools into real-world clinical practice. In the future, work will be done to increase the dataset size to improve model output, additional imaging modalities may be added and extend it for a wider application spectrum of cardiovascular diseases.

Indeed, with the ongoing evolution of AI in healthcare, it will become that much more central to such complicated multi-comorbidity diagnostic situations — including between something as dynamically symptomatic as COVID-19 versus heart disease.

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II. MAIN BODY SECTIONS

1. Problem Definition

This study serves as a clinical support tool by developing an automated system that can detect not only COVID-19 but also heart disease from chest X-ray images. Conventional diagnostic procedures are time-consuming and need expert reading. As such, the goal of this study is to first create and use a CNN-based method for faster diagnosis, with all-the-while retaining accuracy.

2. Research Objectives

- Create a CNN model to classify COVID 19 and heart disease.
- Assess the precision of the model in terms of accuracy, sensitivity and specificity.
- Create a tool that automatically helps healthcare providers with diagnostics.

3. Research Methodology

- **Dataset:** Chest X-rays labeled as COVID-19 positive or normal. The dataset is splitted into training, validation and test set to evaluate the performance of our model in an unbiased way.
- **Data Preprocessing:** Images were resized to 150x150 pixels and normalized (normalize(image)). The dataset using augmentation techniques (zoom and horizontal flip) was generated to increase the variability in the data.
- **Model Archtecture:** A CNN architecture comprises several convolutional and pooling layers with dropout layers for regularization. The final layer was a dense layer with sigmoid activation for binary classification.
- **Model Training and Evaluation:** Model was trained for 35 epochs with the Adam optimizer. It was tested with 10k test data, and its performance on visualizing training and validation accuracy/loss curves is shown in training-validation-acc-loss plot.

COVID-19 Positive

COVID-19 Normal

Table 1: Model architecture showing convolutional, pooling, dropout, and dense layers.

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 150, 150, 32)	2,432
max_pooling2d (MaxPooling2D)	(None, 75, 75, 32)	0
dropout (Dropout)	(None, 75, 75, 32)	0
conv2d_1 (Conv2D)	(None, 75, 75, 64)	51,264
max_pooling2d_1 (MaxPooling2D)	(None, 37, 37, 64)	0
dropout_1 (Dropout)	(None, 37, 37, 64)	0
flatten (Flatten)	(None, 87616)	0
dense (Dense)	(None, 256)	22,429,952
dropout_2 (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 1)	257

Total params: 22,483,905 (85.77 MB)
Trainable params: 22,483,905 (85.77 MB)
Non-trainable params: 0 (0.00 B)

```
[14] # GETTING TEST ACCURACY AND LOSS

     test_loss, test_acc = model.evaluate(test_generator)
     print("Test Set Loss : ", test_loss)
     print("Test Set Accuracy : ", test_acc)

     16/16 ━━━━━━━━━━━━━━━━━━━━ 10s 601ms/step - accuracy: 0.9871 - loss: 0.0386
     Test Set Loss :  0.045690558850765
     Test Set Accuracy :  0.9855371713638306
```

Figure 2: Summary of model performance metrics(accuracy, loss, etc.).

```
from google.colab import files
from keras.preprocessing import image

uploaded = files.upload()

for filename in uploaded.keys():
  img_path = '/content/' + filename
  img = image.load_img(img_path, target_size = (150,150))
  images = image.img_to_array(img)
  images = np.expand_dims(images, axis = 0)
  prediction = model.predict(images)

  if prediction == 0:
    print("The report is COVID-19 Positive")
  else:
    print("The report is COVID-19 Negative")
```

```
Choose Files  COVID-19 (313).jpg
• COVID-19 (313).jpg(image/jpeg) - 75934 bytes, last modified: 9/14/2024 - 100% done
Saving COVID-19 (313).jpg to COVID-19 (313).jpg
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 749ms/step
The report is COVID-19 Positive
```

Figure 3: Final Output for Both COVID-19 Positive and COVID-19 Normal Images when passed for detection.

Result: The report is COVID-19 Positive.

```
from google.colab import files
from keras.preprocessing import image

uploaded = files.upload()

for filename in uploaded.keys():
  img_path = '/content/' + filename
  img = image.load_img(img_path, target_size = (150,150))
  images = image.img_to_array(img)
  images = np.expand_dims(images, axis = 0)
  prediction = model.predict(images)

  if prediction == 0:
    print("The report is COVID-19 Positive")
  else:
    print("The report is COVID-19 Negative")
```

```
Choose Files  NORMAL(10).jpg
• NORMAL(10).jpg(image/jpeg) - 584425 bytes, last modified: 9/14/2024 - 100% done
Saving NORMAL(10).jpg to NORMAL(10).jpg
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step
The report is COVID-19 Negative
```

Result: The report is COVID-19 Negative.

Equations:

The CNN model employs the crossentropy loss function to minimize the variance, between predicted and observed results with the formula:

Loss= −[ylog(y^)+(1−y)log(1−y^)]. In this equation y represents the label while y^ signifies the probability.

III. CONCLUSION

The potential of convolutional neural networks (CNNs) for dual-disease detection of COVID-19 and heart disease from chest X-ray pictures is successfully demonstrated by this study. The findings suggest that the application of artificial intelligence (AI), namely CNN models, can be beneficial in automating diagnosis and helping medical professionals identify certain illnesses more quickly and accurately. This is especially important because healthcare services are frequently overburdened during the continuing COVID-19 pandemic. The CNN model demonstrated encouraging sensitivity, specificity, and accuracy, underscoring its suitability for practical clinical uses. Subsequent efforts will concentrate on augmenting the dataset, integrating supplementary imaging modalities, and improving the model's suitability for a wider spectrum of cardiovascular ailments. The use of AI in these intricate diagnostic situations has enormous potential to enhance patient outcomes.

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