MC106: MATLAB Programming (P7)

Pneumonia and COVID-19 Detection using MATLAB

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PNEUMONIA AND COVID-19 DETECTION USING CHEST RADIOGRAPH

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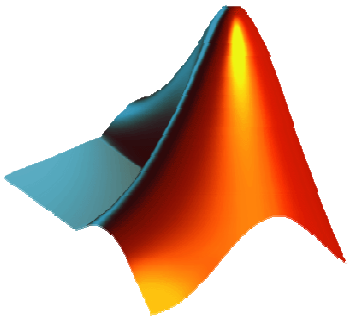


ABSTRACT

In recent years, the global health landscape has been significantly impacted by respiratory diseases, notably Pneumonia and COVID-19. Chest X-ray imaging is a widely available and cost-effective diagnostic tool, but manual interpretation can be time-consuming and prone to human error. In this project, we present a deep learning-based approach using **Convolutional Neural Networks (CNNs)** implemented in MATLAB to detect pneumonia from chest X-ray images. The model is trained using a labeled dataset of X-ray images categorized as Normal, Pneumonia, and COVID-19. By **preprocessing the data and training a custom CNN**, the model achieves accurate classification, demonstrating the potential of AI in supporting medical diagnostics.

INTRODUCTION

Respiratory infections, such as Pneumonia and COVID-19, continue to pose major health challenges worldwide. According to the World Health Organization, Pneumonia accounts for over 2.5 million deaths annually, while COVID-19 has caused a global pandemic with millions of fatalities. Early detection of these conditions is crucial for effective treatment and reducing transmission. Chest X-ray imaging remains a common diagnostic method, especially in low-resource environments. However, manual analysis of X-ray images is not only time-consuming but also highly dependent on expert radiologists. In recent years, artificial intelligence and deep learning have emerged as powerful tools in medical diagnostics. **Convolutional Neural Networks (CNNs)**, in particular, have shown remarkable performance in image classification tasks.

METHODOLOGY

1. Load and Prepare Dataset

- The dataset used in this project is a Kaggle dataset of chest X-ray images, which contains 6,432 images.
- This dataset is further divided into test and train.
- These images in the dataset are further classified into three categories: Normal, COVID-19 and Pneumonia-infected images.
- imageDatastore: Load all the image from the train folder.

```
imds = imageDatastore(trainFolder, ...
    'IncludeSubfolders', true, ...
    'LabelSource', 'foldernames');
```

2. Preprocessing

```
[imdsTrain, imdsVal] = splitEachLabel(imds, 0.8, 'randomized');
```

- The data is split into 80% training and 20% validation.

```
augTrain = augmentedImageDatastore(inputSize, imdsTrain, 'ColorPreprocessing', 'gray2rgb');
augVal = augmentedImageDatastore(inputSize, imdsVal, 'ColorPreprocessing', 'gray2rgb');
```

- Images are resized to 224x224 pixels.
- Grayscale images are converted to RGB format by using ‘gray2rgb’.

3. Defining CNN Model

A **CNN**, or **Convolutional Neural Network**, is a **type of deep learning model** that is especially good at understanding **visual data**, like images and videos. It is series of layer that process image and learn from it.

```
layers = [
    imageInputLayer(inputSize)

    convolution2dLayer(3, 16, 'Padding','same')
    batchNormalizationLayer
    reluLayer

    maxPooling2dLayer(2,'Stride',2)

    convolution2dLayer(3, 32, 'Padding','same')
    batchNormalizationLayer
    reluLayer

    maxPooling2dLayer(2,'Stride',2)

    convolution2dLayer(3, 64, 'Padding','same')
    batchNormalizationLayer
    reluLayer

    fullyConnectedLayer(3)
    softmaxLayer
    classificationLayer
];
```

A custom CNN is built using the following layers:

- **Input Layer**: Accepts 224x224x3 RGB images.
- **Three Convolutional Blocks**: Each block includes a convolution layer, batch normalization, ReLU activation, and max pooling.

Convolution layer: Detects small features using 16 filters of size 3x3.
Batch norm: Makes training stable and faster.
Each time the filters are increased (16->32->64).

This help model learn basic pattern in early layers and complex pattern like lungs in later layers.

- **Fully Connected Layer**: Outputs three class probabilities.3 means model will choose from 3 classes (Normal,Pneumonia,COVID-19).
- **Softmax Layer**: Converts the output to probability distribution.
- **Classification Layer**: Computes the loss and accuracy. Choose the class with highest probability or score.

4. Training Configuration

```
options = trainingOptions('adam', ...
    'InitialLearnRate',1e-4, ...
    'MaxEpochs',10, ...
    'MiniBatchSize',32, ...
    'ValidationData',augVal, ...
    'ValidationFrequency',20, ...
    'Plots','training-progress', ...
    'Verbose',false);
```

Optimizer: Adam

Initial Learning Rate: 0.0001

Epochs: 10

Mini-batch Size: 32

Validation Frequency: Every 20 iterations

Validation Data: augVal (Use Validation Data to check progress)

5. Training And Saving the Model

```
net = trainNetwork(augTrain, layers, options);
```

The model is trained using trainNetwork.

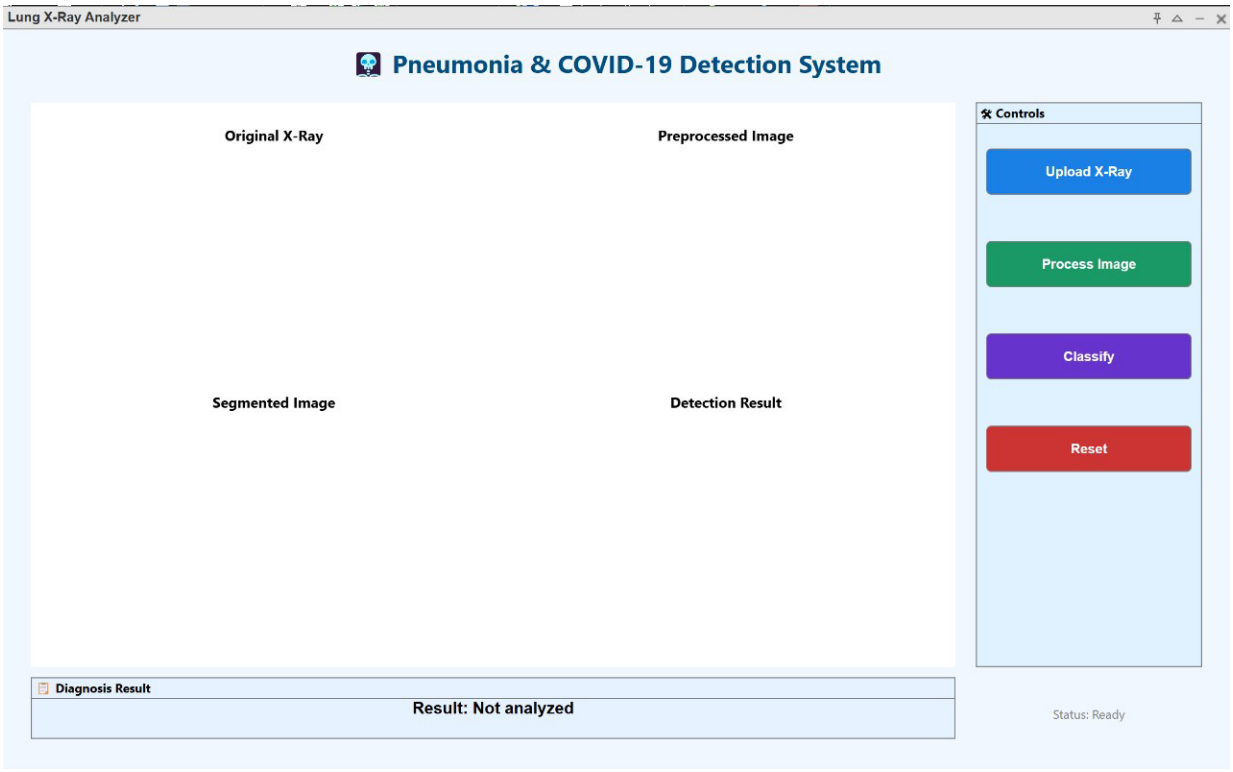
- Model looks at trainig Images.
- Learns the Pattern.
- Gets validated on Validation Images.

```
save('xrayNet.mat', 'net');
```

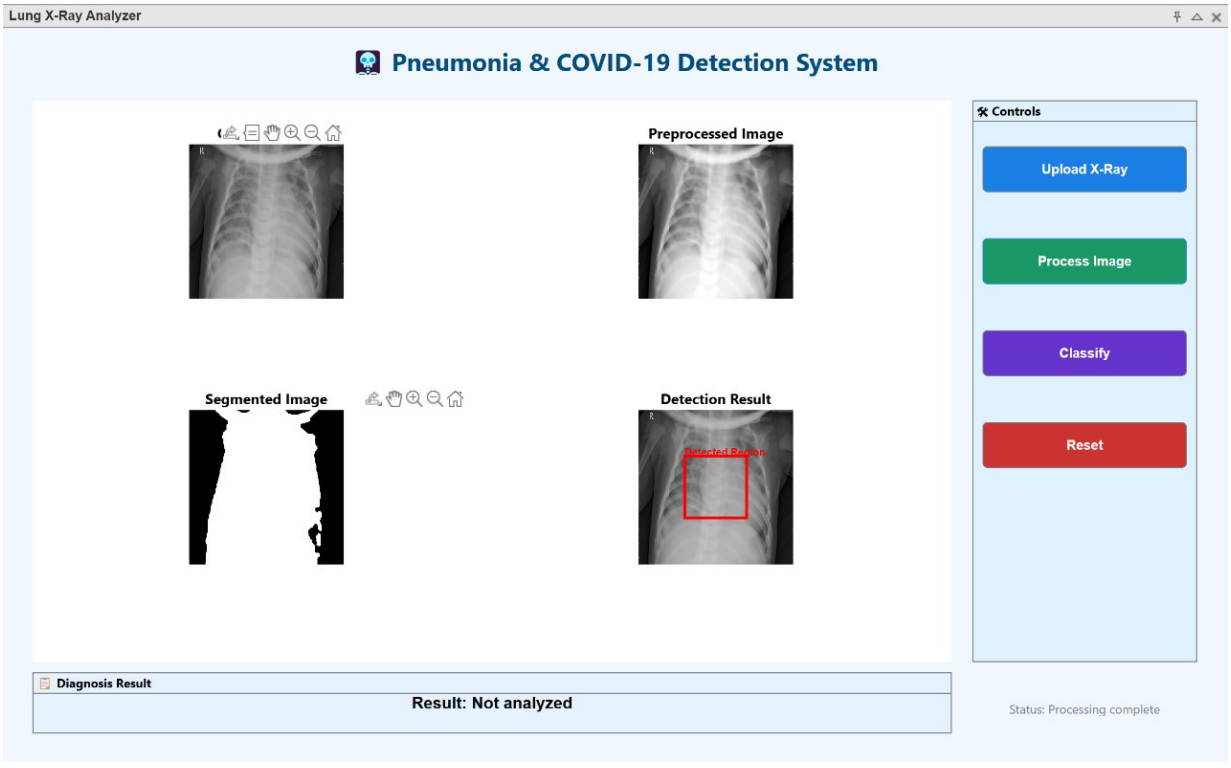
After training, the model is saved as **xrayNet.mat**

OPERATIONAL OVERVIEW

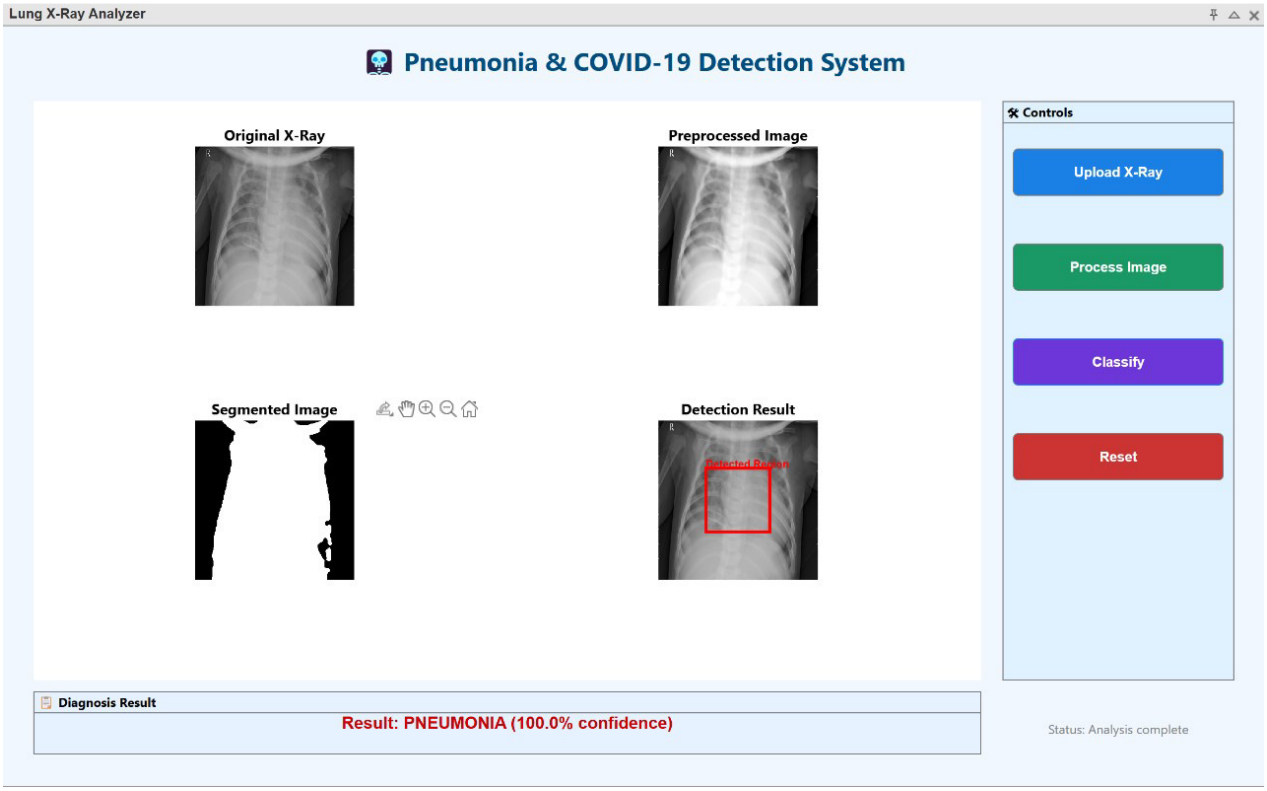
Step – 1: Basic GUI



Step – 2: Upload X-Ray and Click on 'Process'



Step – 3: Click on ‘Classify’



CONCLUSION

This study demonstrates that **deep learning models**, particularly those using transfer learning, can effectively detect Pneumonia and COVID-19 from chest X-ray images with high accuracy. The proposed system provides a **reliable diagnostic tool** that can assist healthcare professionals, especially in under-resourced areas. Future work may focus on integrating this system into hospital workflows and expanding its capabilities to detect other respiratory conditions.

REFERENCES

Got it! Here's a similar **reference table format** for your **PNEUMONIA AND COVID-19 detection project using MATLAB App Designer**, listing key websites/sources and the specific purpose or information used:

S.No.	Source	Purpose
1	www.who.int	Provided statistical and clinical background on Pneumonia and COVID-19 prevalence and importance of early detection.
2	**Wang et al. (2017)**	Additional X-ray data and benchmarks for Pneumonia detection.
3	**Kaggle**	Primary dataset containing X-ray images labeled as COVID-19, Pneumonia, and Normal.
4	**Kareem, A.; Liu, H.; Sant, P**	Review on Pneumonia Image Detection: A Machine Learning Approach.
5	**Zhang, D**	Pneumonia and COVID-19 Detection from Chest X-ray Images Based on Convolutional Neural Network

Created By **Rachit Arora & Raghav Gupta** Date **28 March 2025**