Lungs Tumor Classification using Convolutional Neural Network

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Abstract

The research focuses on classifying lung cancer using the VGG-19 architecture. The datasets were sourced from Iraq-Oncology Teaching Hospital with 70% of the data allocated for training and 30% for testing. Performance metrics were computed to evaluate the effectiveness of the classification method. Python is utilized for designing the algorithm and executed using Goggle Colab. The lung tumor classification using VGG-19 offers an accuracy of 95%, sensitivity of 88.79%, specificity of 98.25 %, and F1-Score of 93.28%. However, the low sensitivity value indicates that the VGG-19 architecture is not accurately predicting benign and malignant cases.

Keywords: VGG-19, CNN, Lung Tumor, Accuracy, Loss

1. Introduction

The lungs are really important because they help us breathe by taking in oxygen and getting rid of carbon dioxide. When we breathe in, the lungs take in oxygen from the air, which is then transported to the bloodstream. This oxygen is essential for cells to function and produce energy. This process helps us get the oxygen our bodies need to function properly. The lungs are two cone-shaped organs housed within the chest cavity and protected by the rib cage. The lungs are enveloped by a protective double-layered membrane known as the pleura. The inner layer, called the visceral pleura, covers the surface of the lungs, while the outer layer, the parietal pleura, lines the chest cavity. The pleural cavity, located between the visceral and

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parietal pleurae, contains a small amount of fluid. This fluid helps the lungs move smoothly within the chest cavity during breathing. The trachea, divides into two branches called bronchi—one for each lung. These bronchi then branch into smaller tubes known as bronchioles, which ultimately terminate in small air sacs called alveoli.

In the alveoli, oxygen from the air we breathe crosses into the bloodstream through the thin walls of the alveoli and capillaries, while carbon dioxide moves from the blood into the alveoli to be exhaled. This process is known as gas exchange and is essential for maintaining the body's oxygen levels and removing waste carbon dioxide. The lungs receive blood from two main sources: the pulmonary arteries and the pulmonary veins as shown in Figure 1[1].

The lungs are vital organs in the bodies, responsible for helping us breathe by taking in oxygen and removing carbon dioxide. They work by expanding and contracting with each breath, allowing air to flow in and out. Unfortunately, like many organs, they can develop cancer. Lung cancer often starts when cells in the lung mutate and grow out of control, forming tumors that can interfere with normal lung function.

To combat this, advanced technologies like Convolutional Neural Networks (CNNs) have been employed, these CNNs are adept at analyzing medical images, such as X-rays and CT scans, to detect abnormalities indicative of cancerous growths. The proposed method employs VGG-19, as it is specifically, known for its deep architecture, allowing it to extract intricate features from medical images with high accuracy. By leveraging the power of VGG-19 and similar CNNs, medical professionals can diagnose lung cancer earlier and with greater precision, leading to improved treatment outcomes and potentially saving lives.

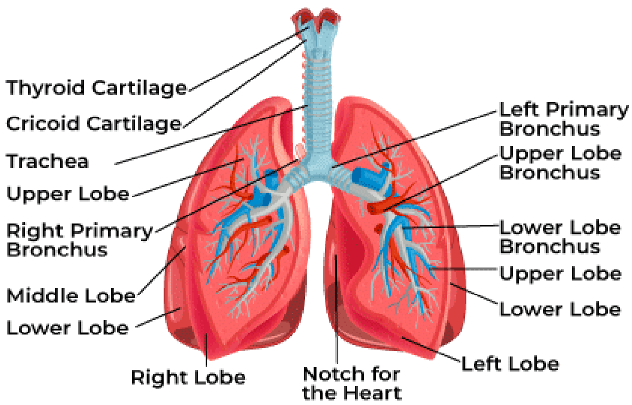

Figure 1. Anatomy of Lung

2. Literature Survey

Heewon Chung et al (2018) developed a technique to segment lungs and detect juxta-pleural nodules in chest CT images. They used the Chan-Vese (CV) model and a Bayesian approach for this purpose [2].

Paing and colleagues (2018) proposed a method for classifying lung nodules using a random forest classifier. They addressed the challenge of unbalanced data by employing the feature selection algorithms such as particle swarm optimization, genetic algorithm, and relief [3].

In 2018, Mukherjee et al introduced a method to segment and classify lung nodules using a thresholding technique. They utilized traditional histograms and iterative thresholding to segment lung images. Following segmentation, they employed a rule-based filtering method to identify lung nodules. [4].

Shi Qiu et al. (2019) introduced a method for detecting pulmonary nodules using a dynamic time warping algorithm to visualize nodule boundaries. They utilized a recursive graph visualization model and included a video similarity distance discrimination system to accurately identify nodule characteristics [5].

3. Methodology

In the study, a total of 1097 lung CT images were utilized. The Table.1 below shows the number of images collected for each class

Table 1. Dataset Samples

Class	Number of Samples
Normal	461
Benign	120
Malignant	561

The Figure 2 illustrates the flowchart of the proposed.

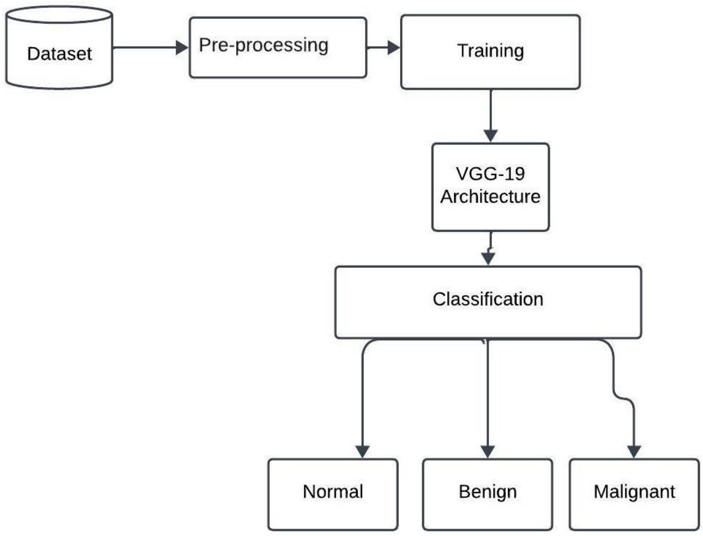

Figure 2. Proposed Block Diagram

In this study, classification is carried out using labeled images from datasets. The method employs the VGG-19 architecture to classify normal, benign, and malignant cases in lung CT images. VGG-19, an enhanced version of the multilayer perceptron (MLP), is frequently employed in convolutional neural networks (CNNs) for tasks such as image processing and video analytics, as depicted in Figure 2. The parameters of the proposed models are detailed in Table 2, which discusses various parameters utilized in the study.

Table 2. Input Parameter of Proposed Model

S.No.	Parameters	VGG 19
1	Input Shape	244*244*3
2	Learning Rate	0.0001
3	Decay	$1e^{-5}$
4	Batch Size	16
5	Optimizer	Adam
6	Loss	Categorical Cross Entropy
7	Pretraining Weights	Image Net
8	Activation Function	Softmax

“VGG-19 is a deep convolutional neural network (CNN) architecture that consists of 19 layers, including 16 convolutional layers and 3 fully connected layers [7]. It is an extension of the VGG-16 model, named for its depth. VGG-19 has gained popularity for its effectiveness in computer vision”. [6,7]

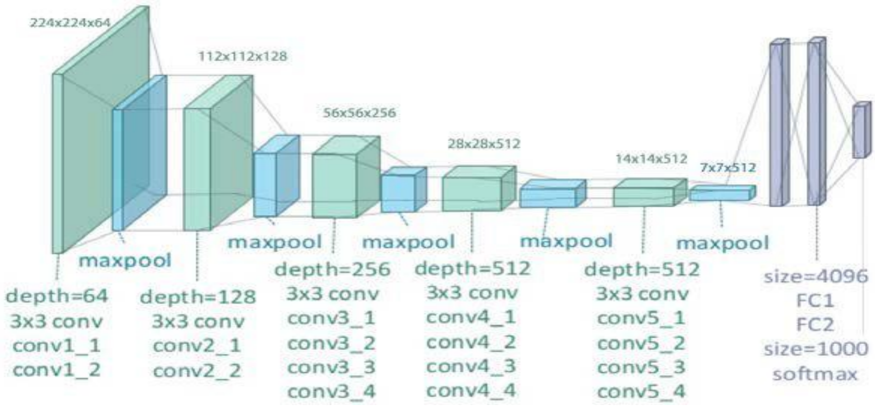

Figure 3. VGG 19 Architecture [13]

4. Result and Discussion

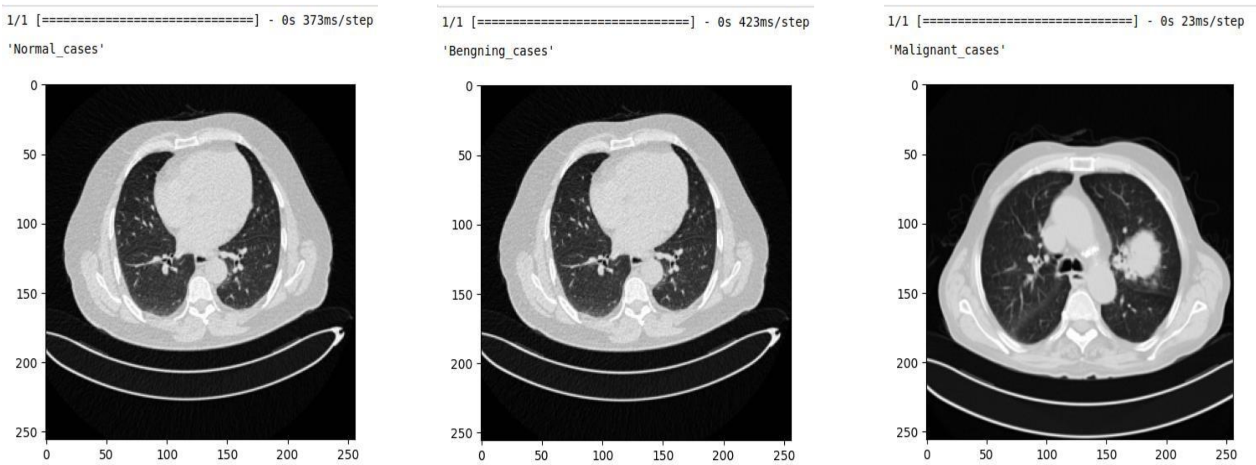

Figure 4. Outputs of Lungs Tumors

The Figure 4 illustrates the output of the proposed architecture. The accuracy and loss curve of training and validation of proposed architecture is shown in Figure 5. The performance metrics of the proposed architecture listed in Table 3 [8,9]

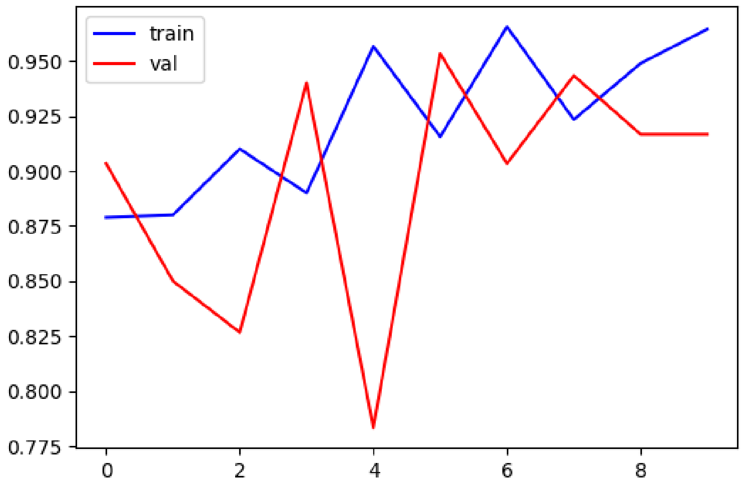

Figure 5. Accuracy Curve and Loss Curve

Table 3. Performance Metrics

S.No.	Metrics	VGG 19
1	Accuracy	95%
2	Sensitivity	88.79%
3	Specificity	98.25%
4	F1 Score	93.28%

The low sensitivity value observed in the table indicates that the VGG-19 architecture is not accurately predicting benign and malignant cases. [10-12]

5. Conclusion

The work focuses on using the VGG-19 architecture to detect lung cancer, utilizing a dataset from Iraq-Oncology Teaching Hospital. The evaluation of performance metrics yielded an accuracy of 95%, sensitivity of 88.79%, specificity of 98.25%, and F1 score of 93.28%. Moving forward, the plan is to enhance the sensitivity value by developing a customized CNN algorithm.

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