DETECTION OF LUNG CANCER USING CT-SCAN IMAGE - DEEP LEARNING APPROACH

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***Abstract*— Cancer is a disease that comes in many forms and is the largest cause of death worldwide for men and women alike. Early detection of cancer has the highest chance of saving a person's life. Some of the procedures used to diagnose cancer include CT scans, bone scans, MRIs, PET (Positron Emission Tomography), ultrasound, and X-rays. Cancers such as lung cancer are among the deadliest worldwide, killing approximately five million people every year. This chapter focuses on lung cancer detection. The diagnosis of Cancer is usually a very difficult task in the biomedical and the bioinformatics field. Now, computed tomography (CT) scans can provide useful information for lung cancer diagnosis. In recent advances, deep learning approaches have improved to outperform humans in some tasks like classifying objects in images and also predicting better accuracy. Therefore, these techniques have been utilized in this model for the treatment of cancerous conditions. We detect lung cancer nodules from a given input and classify cancer as Adenocarcinoma, Large Cell Carcinoma, or Squamous Cell Carcinoma in our research. To detect the location of lung nodules, researchers used revolutionary deep learning approaches. In this paper basically, we used three deep learning case studies to diagnose lung cancer such as VGG16, INCEPTIONV3 and RESNET50 and also, we are discussing various measures for evaluating the performance of our model to get better accuracy.**

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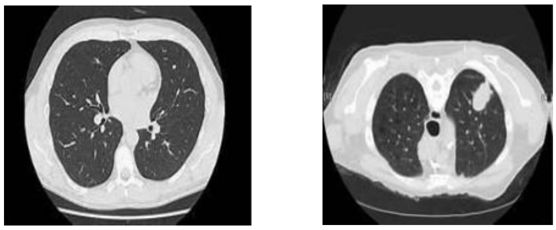
Keywords— Deep Learning, Lung Cancer, CT-scan, Convolutional Neural Networks, Confusion Matrix.

I. INTRODUCTION

Lung cancer originates in one or both of a person's lungs [1]. This causes the lungs to develop aberrant cell proliferation. Malignant nodules are the name for these types of cells [2] .The lungs, which are two spongy organs in our chest that take in oxygen and emit carbon dioxide as we breathe in and out, are a pair of spongy organs that take in oxygen and release carbon dioxide as we breathe in and out. Among the world's leading causes of death, lung cancer is the most common. Therefore, early diagnosis of cancer can help not only patients but also doctors to make an accurate diagnosis. Each person's cancer stage is different. Lung cancer can be caused by a variety of factors, including smoking, secondhand smoke, chemical exposure, and a family history of the disease. There are two main types of lung cancer: small cell lung cancer and non-small cell lung cancer. Smoking causes cancer in people. It can also happen to 4,444 people who are at high risk of lung cancer but cannot smoke. Doctors can use a variety of scans to identify lung cancer, such as chest x-rays, computed tomography (CT), MRI, PET, bone scans, sputum cytology, and more. Low-dose helix computed tomography (LDCT) is a diagnostic tool currently used. Use the form [3] to give the best results. Recently, computed tomography has been favored due to its noiselessness. Deep learning algorithms can now deliver automated patient scans. According to some estimates, 221,200 new instances of lung cancer were diagnosed in 2015, accounting for nearly 13% of all cancer diagnoses. As a result, pulmonary nodules may be seen at an early stage and should be evaluated and monitored carefully. Nodules in the lungs are small masses of tissue that can be cancerous or noncancerous, called benign or malignant. Benign tissue is the most noncancerous and slow-growing, while malignant tissue is the most dangerous and grows very rapidly and can affect other parts of the body as well [3,4]. There are different types of deep learning methods that many authors use to classify lung cancer. The best results are now obtained using low-dose spiral computed tomography (LDCT). The results of the chest CT-scan are also better.



(A) Healthy Lung (B) Cancerous Lung

Fig.1. Healthy Lung VS. Cancerous

The remainder of the work is explained in the following manner. A review of the literature is covered in the second section. The mechanism for classifying pulmonary nodules is presented in Section 3. The proposed work is discussed in section 4. And the results part is covered in section 5. This work comes to a close with section 6.

II. RELATED WORK

Brahim AIT SKOURT et al. [1] propose segmenting lung CT images and extracting high-level information and symmetric extension paths using the U-Net architecture to recover information. This results in an accurate division with a dice coefficient exponent of 0.9502.

Tulasi Krishna Sajja et al. [2] create a GoogleNet-based deep neural network. When employing dropout class, it decreases the time cost and overfitting problem. They also use three pre-trained CNN architectures on the LIDC dataset: AlexNet, GoogleNet, and ResNet50. With a 97 percent accuracy rate, ResNet50 was the most accurate of the three pre-trained networks.

Siddharth Bhatia et al. [3] proposed feature extraction using deep residual networks, such as U-Net and

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ResNet models, and then compared the performance of the algorithms using two classifiers, random forest and XGBOST. On the LIDC-IRDI dataset, XGBOST improves accuracy by 84 percent.

QingZeng Song et al. [4] use CNN, DNN, and SAE to create three deep neural networks. On the LIDCIDRI dataset, it describes the classification of benign and malignant nodules for a patient with lung cancer. With an accuracy rate of 84.15 percent, CNN outperformed the competition.

A. Asuntha et al. categories lung cancer by detecting nodules in certain input photos [5]. Lung nodules can be detected using deep learning. Different feature extraction approaches are employed in this article, including HOG, LBP, wavelet transform based features, SIFT, and Zernike moment. To categorize these traits, deep learning is applied. After feature extraction, the FPSO algorithm is used to select the best features. FPSOCNN improves performance by reducing the complexity of the CNN.

To diagnose lung cancer, Susmita Das et al. used a variety of pattern recognition and feature learning algorithms. They also compared deep learning CAD schemes to classic deep neural network CAD schemes, as well as identifying benign and malignant lung nodules in cancer patients [6].

Ruchita Tekade et al. [7] compared the results using a CUDA-enabled Tesla K20 GPU and a variety of datasets, including the LIDCIDRI, LUNA16, and Kaggle data Science Bowl 2017 datasets. They use two architectures to categories lung nodules in order to forecast whether a patient will get cancer in the next two years: U-Net and 3D multipath VGG. It consumes 0.387732 logs and has a 95.60 percent accuracy rate.

Rasool Fakoor et al. Demonstrate how cancer can be detected and classified using unsupervised feature learning. The major goal of this research is to demonstrate that the suggested method outperforms existing cancer detection methods [8]. The author employs PCA to address the original raw feature's extremely large dimensions, followed by the sparse feature learning technique.

Deep learning approaches were utilized by N Kalaivani et al. [9] to predict lung cancer. Lung images are classified as cancerous or normal using DenseNet and adaptive boosting techniques. It had a 90.85% accuracy rate.

[10] To diagnose lung cancer, R. Raja Subramanian et al. employed several pertained pictures such as LeNet, AlexNet, and VGG16. The AlexNet model was employed, and the features extracted from the final FC layer were separately submitted to the softmax classifier. The combined accuracy of AlexNet and the softmax layer is 99.52 percent.

Ms. Bhagyashree Madan et al. used a CNN model with 1623 images to get a validation accuracy of 93%. This project makes use of Matlab [11]

Sidakpal Singh et al. created an autonomous deep learning-based approach for detecting cancerous lung nodules early. They frequently offer a method for tracing cancer nodules in the lungs that has been mistreated. Convolutional Neural Networks are a special sort of neural network. The dataset utilized in this example is LUNA16, which has 754975 sample slides. They also employed Google Net and LeNet architectures. The Google Net architecture is more accurate than the LeNet architecture [12]

Yang, He, Hengyong Yu, and Ge Wang [13] develop a deep neural network i.e., CNN and apply to thoracic CT image for classification of lung nodules.

III. METHODOLOGY

A. Deep Learning

In general, "deep learning" refers to a machine learning technique that accepts input X and predicts output Y. Deep learning is based on the usage of "deep" neural networks, which have multiple hidden layers [4]. Given a huge data collection of input and output pairings, a deep learning algorithm will attempt to close the gap between prediction and exit system. Deep learning techniques use neural networks to investigate the relationships between input and output. "Nodes" make up the input, hidden, and output layers of a neural network [5]. The hidden layers are connected with much of the computation in the digital representation of knowledge (e.g., images with pixel specifications). The input layers encode digital knowledge (e.g., a photo with pixel specifications), the output layers provide predictions, and the neural network is used to perform deep learning. Mainly we can divide Deep Learning Architecture in to two types, first one is supervised and second one is unsupervised. The supervised and unsupervised are separately divided in to several categories. An artificial Neural Network is a part of a computer system that is designed to evaluate and make judgments in the same way that the human brain does. Ann is a deep learning building piece that tackles problems that are impossible or extremely difficult for humans to solve. In computer vision and image recognition, CNN is a type of supervised deep learning technique. In a supervised deep learning system termed a recurrent neural network, the output from the previous phase is delivered as input to the current step (RNN). It's utilized in natural language processing, handwriting recognition, and machine translation. The following Fig.2 shows the brief idea about deep learning

Deep Learning uses a CNN to distinguish things in an image. The use of neural networks is widely spread in a variety of activities and purposes, such as image and video processing, computer vision, obstacle detection in autonomous vehicles, and natural language processing. CNNs are especially popular in Deep Learning since they play such a significant role in these domains that are continually growing and evolving. In deep learning image convolution, image pooling like other steps is occur. This work is basically focusing on convolutional neural network (CNN) which is describing bellow

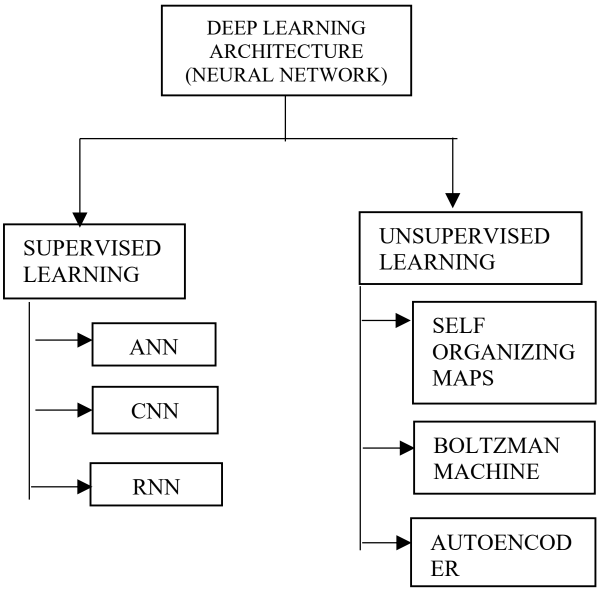

Fig.2. Deep Learning Architecture

This work focuses on Convolutional Neural Networks (CNN). There are several types of CNNs in deep neural network such as AlexNet, ResNet (ResNet50, ResNet18, and ResNet101), DenseNet, GoogleNet, InceptionV3, MobileNet, VGGNet (VGG16, VGG19), ChexNet etc., those are described bellow

B. Convolutional Neural Network (CNNs)

In image recognition and classification, CNNs are among the most commonly used deep neural networks [6]. As with a multilayer neural network, a convolutional neural network is also a multilayer neural network that comprises several convolutional layers followed by a number of fully connected layers. As previously stated, there are various sorts of hidden layers, one of which is known as convolutional. Neurons are grouped in three dimensions in this type of layer: width, height, and depth.

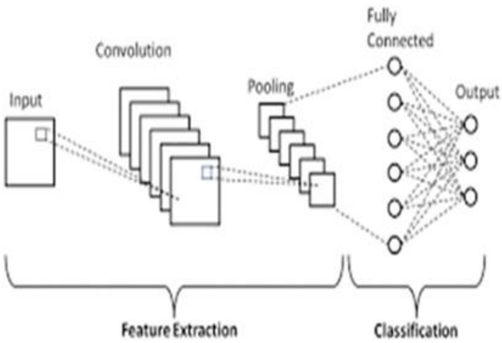

Fig.3. Convolutions Neural Network

CNN's architecture is made up of three types of levels: (1) the convolution layer is the initial layer of the convolutional network, and it is used to find features. (2) The max-pooling (subsampling) layer downsamples the image and reduces dimensionality, reducing the computational cost. Max pooling is the most used poling method, and it takes the most significant element from the feature map as an input. (3) A fully connected layer to provide categorization capabilities to the network. Convolutional neural networks can help with image and video recognition, segmentation, localization, classification, natural language processing, and even recommender systems.

C. Pre-trained Convolutional Neural Networks

A pre-trained model is one that has been trained on a large dataset and was created to solve a similar problem by someone else [7]. In deep Learning various pre-trained models are there. The following is a quick description of these pre-trained networks:

AlexNet [2]

In this first Convolutional Network, there are eight layers. Five of the layers are convolutional, while the remaining two are normalization and maximum pooling, followed by fully connected and dropout layers, and lastly the SoftMax layer. This network recognizes and extracts distinguishing characteristics from incoming photos automatically. AlexNet was able to distinguish between 1000 different data kinds. This architecture contains 62.3 million parameters.

- ResNet

ResNet stands for Residual Network could be a specific kind of neural network that was introduced by Kaiming HeXiangyu Zhang in 2015. Residual neural networks try this by utilizing skip connections, or shortcuts to leap over some layers. There are two main reasons to feature skip connections like vanishing gradients and mitigating degradation problems. ResNet comes in several types: ResNet18, ResNet50, and ResNet101. ResNet was effectively used for transfer learning in biomedical picture classification.

- GoogleNet [4]

Another sort of deep neural network is GoogleNet [2,8]. There are 22 layers buried within it. The neural network has a greater depth than AlexNet. The network accurately classifies the data more effectively as a result of the increased depth. Input images are automatically classified and attributes extracted by this network. GoogleNet identified 1000 unique classes.

- VGGNet [6]

VGG is an acronym for Visual Geometry Group. It's a multi-layered convolutional neural network. This is the foundation for cutting-edge deep neural network-based object identification models. VGG comes in a variety of forms, including VGG11, VGG16, VGG19, and others. The VGGNet is made up of 16 convolutional layers with only 3*3 kernels. The writers' designs are comparable to AlexNet. As the depth of the network grows, increase the number of features map or convolution.

- DenseNet

Dense stands for densely connected convolution networks. DenseNet is another type of convolutional neural network which utilizes dense connection between layers through dense blocks. The DenseNet architectures proposed by

Huang et al. In a feed forward approach, it connects each layer to every other layer. There are different versions of DenseNet such as DenseNet201, DenseNet169, and DenseNet121etc. The numbers indicate how many layers there are in the neural network.

- InceptionV3

It might be a 48-layer deep convolutional neural network model with pre-trained layers. It's a variant of the network that's been trained on millions of pictures from the Imogene collection. Inceptionv3 requires a 299*299-pixel input picture. Model components that have symmetric and asymmetric properties include convolutions, max pooling, average pooling, concatenation, dropouts, and completely linked layers [9]. In order to normalize the activation inputs, batch normalization is used throughout the model. SoftMax is used in order to calculate the loss.

- The LeNet [12]

Architecture for Convolutional Neural Networks is a fantastic first architecture. LeNet is a modest, easy-to-understand network that produces intriguing results. Now that LeNet and MNIST can operate on the CPU, it's much easier for beginners to get started with Deep Learning and Convolutional Neural Networks.

- U-Net [1]

For the segmentation of biological images, the convolutional neural network U-Net was created. It consists of a fully convolutional network with a tweaked and expanded architecture to allow it to function with fewer training images and provide more accurate segmentation as a result, they're perfect for image processing/generation jobs such as super resolution and colorization, as well as segmentation masks.

In this work use only VGG16, ResNet50 and InceptionV3 among the entire deep learning Pre-Trained Convolutional neural network. ResNet50 gives the higher accuracy i.e., 95% than others. In our future work we tried to implement other pre-Trained network along with different types of feature extraction techniques.

IV. PROPOSED METHOD

In this part, authors discussed about proposed work of this research. Here the three-ensemble framework is designed i.e., ResNet50, Inceptionv3 and Vgg16 which is explained in details in previous section. In this chapter we discussed about proposed method, preprocessing and augmentation technique, and performance measures.

Fig.4. is an overview of one of the proposed methods. Within the the diagram, the input part of the setup is connected to the second part which could be a pre-processing stage. In these stages, we pre-process the information and resized the pixels. In preprocessing stages, we convert the information into a clean dataset or understandable format. Then, by creating updated photos in a training dataset, we apply several data augmentation approaches to expand its dimensions. Then the various deep convolutional transfer learning models are generated to a machine.

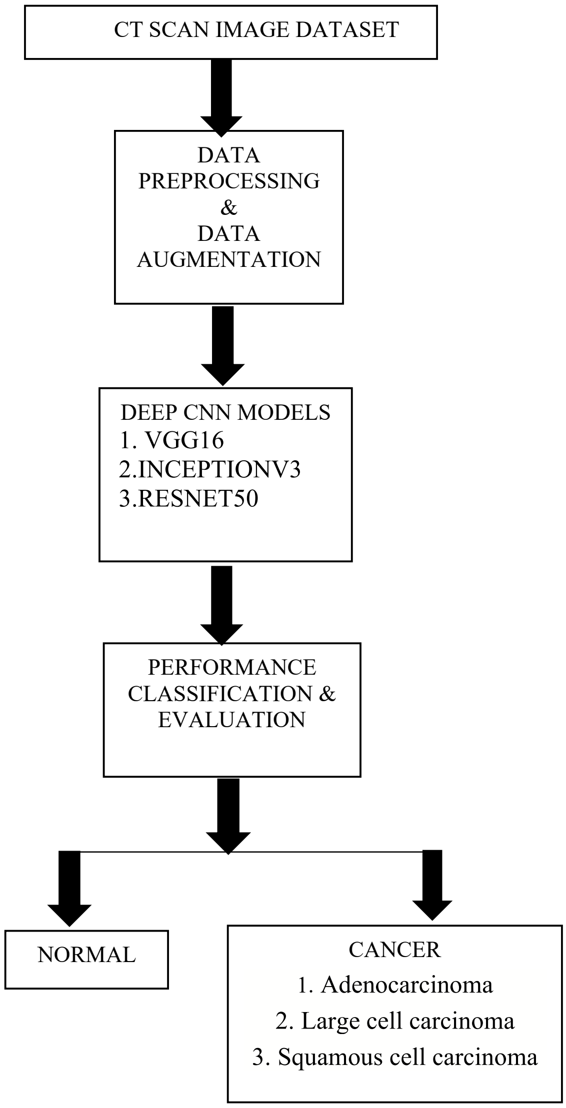

Fig.4. Overview of Proposed Method

During this work, three differing types of deep learning algorithms: ResNet50, InceptionV3 and Vgg16 are accustomed classify the output. Hence, the output part is identified as either normal or Cancer category i.e., Adenocarcinoma, Large cell carcinoma, and Squamous cell carcinoma. During this study, four evaluation metrics Accuracy, Recall, precision, and F1Score were assigned to the bottom CNN model. In final we compare the all-deep neural network VGG16, INCEPTIONV3, RESNET50, and also predict the normal as well as three cancerous diseases such as Adenocarcinoma, Large cell carcinoma and Squamous cell carcinoma.

A. Preprocessing & Augmentation

One of the important steps during this methodology is data pre-processing [9]. It is resized the image input for various algorithms. All images are normalized in line with the pre-trained model. The module that allows you to work with raw CT scan pictures. Data reading, candidate patch extraction, area saving, augmentation, train-test split, and others are among them. As we all know CNN works with an outsized dataset. As a result, data augmentation techniques are frequently used to construct alternative versions of an actual dataset in order to increase its size or to build a whole new training dataset. Deep learning algorithms can benefit from data augmentation to improve their accuracy. Various augmentation techniques such as gray scales, horizontal and vertical flips, random crops, colour jitter, translations, rotations, resizing, scaling, and many more are available. Using these tactics on our data, we may easily double or quadruple the amount of training data, resulting in a very strong model. We used the following augmentation techniques to improve the visualization: rescale=1.0/255.0, horizontal_flip=True, fill mode= nearest, zoom range=0.2, shear range=0.2, height shift range=0.2, width shift range=0.2.

V. RESULTS & DISCUSSION

The evaluation findings of the suggested model are discussed in this section. This model's dataset was also discussed.

A. Datasets

Dataset include CT scans from Chest CT-Scan images Dataset https://www.kaggle.com/mohamedhanyyy/chest-ctscan-images. The images are in jpg or png format to fit the model. The data folder contains the train, test, and validation folders. Three different kinds of chest cancer (adenocarcinoma, large cell carcinoma, and squamous cell carcinoma) are represented in each folder, as well as one folder with normal CT-Scan images (Normal) [10, 11, 12]. In this database the testing set is represented by Test, the training set is represented by Train, and the validation set is represented by Valid: Training: Testing: Valid :: 70 : 20 : 10 . Total 10000 files are used in this work. The details of database are formatted in a TABLE I

TABLE I. Overview of Dataset

DIRECTORY	***DISEASE***	***NUMBER OF IMAGES***
TRAIN	Adenocarcinoma Large cell carcinoma Squamous cell carcinoma Normal	195 115 155 148
TEST	Adenocarcinoma Large cell carcinoma Squamous cell carcinoma Normal	120 51 90 54
VALID	Adenocarcinoma Large cell carcinoma Squamous cell carcinoma Normal	23 21 15 13

The Python programming language is used to train, test, and evaluate many algorithms in this research. A machine running 64-bit Windows 8 with a 2.40GHz Intel i3-core processor and 4GB of RAM is used to train different models

B. Simulation Results and Graph

In this part the results are stored in a tabular form. The bellow table shows the results of three deep neural networks such as VGG16, INCEPTIONV3, and RESNET50. The uneven nature of the Real dataset is significantly worse. We found that networks learnt to categories nodules after training, but that they still made mistakes, resulting in false positives.

TABLE II. Performance Results of Deep Neural Network

Model Name	**Accuracy**	***Val_Accuracy***	***Precision***	***Recall***	***F-1 Score***
VGG16	0.82	0.84	0.75	0.90	0.89
INCEPTION V3	0.87	0.77	0.79	0.88	0.90
RSNET50	0.95	0.87	0.88	0.93	0.91

The above TABLE II shows that ResNet50 gives the better accuracy i.e.,95% as compared to other three deep neural networks. So, we assume that ResNet50 is the best model for this study on Chest CT Scan image datasets. Here we discuss different graph for different algorithm such as ResNet50 and Vgg16, InceptionV3.

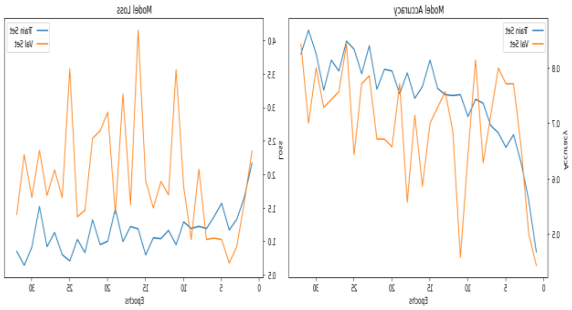

Fig.5. Model_VGG16

The above figure 5 shows the graph of model VGG16. In this model we compare the training set and validation set. The training set is high as compare to valid set in mode accuracy. But the train set is decreases in model loss. Here we take 32 epochs for update the accuracy.

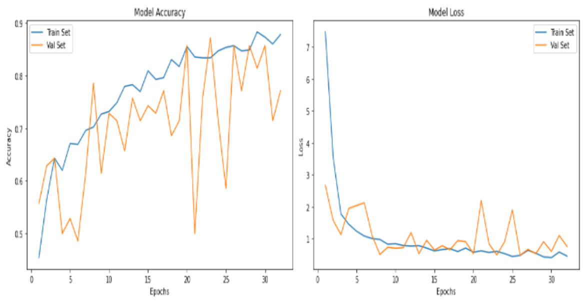

Fig.6. Model_ InceptionV3

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In this graph the model accuracy in the training set is high and validation set is low means the model has generalized fine. But in opposite part the training set and validation set difference is quite small because of overfitting. Here after 32 epochs accuracy is better.

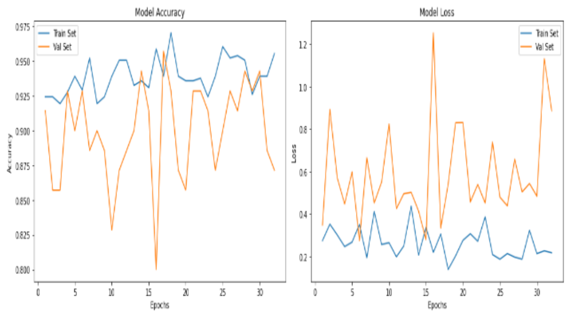

Fig.7. Model_ResNet50

Above model shows the better training accuracy than valid set-in model accuracy as well as validation loss is greater than training set. After 32 epochs this graph gives the better accuracy as compare to other two. The accuracy is 0.95

VI. CONCLUSION & FUTURE WORKS

This paper demonstrates how deep CNN-based transfer learning may be used to identify cancer automatically. Three different pre-trained CNN algorithms are trained and assessed using CT-Scan to distinguish between normal and cancer patients. Early identification of cancer is critical for deciding the best course of therapy and preventing the disease from posing a life-threatening hazard to the patient. The most common method for diagnosing cancer is to take a CT-Scan. It has been discovered that ResNet50 has a better level of accuracy than the others. In 2015, over 221,200 new instances of lung cancer were reported, accounting for nearly 13% of all cancer diagnoses. Many lives can be saved by a speedy recovery combined with efficient therapy based on an accurate identification of the ailment. Deep convolutional neural networks have a distinct style that provides high accuracy and superior results. The CNN algorithm determines if the input lung image is normal or cancerous, and the result is displayed. As a result, a Deep CNN network is utilized to classify lung images in order to detect cancer. Training the network with a larger database as well as other deep pre-trained networks and focusing on alternative feature extraction could improve detection accuracy, which could be time-consuming in the future.

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