## A Project Report on

# LUNG CANCER DETECTION USING CNN

*Submitted in partial fulfillment of the requirement for the award of the degree of*

**BACHELOR OF ENGINEERING**

**IN**

**INFORMATION SCIENCE AND ENGINEERING**

**By**

**Chhavi Verma**

**DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING**

(Accredited by NBA Tier-1)

2022-23

# CERTIFICATE

Certified that the project work entitled **"Lung Cancer Detection using CNN"** carried out by **Ms. Chhavi Verma, TB. , S K J**, USN **Information Science Department** in partial fulfillment for the award of Bachelor of Engineering in **Information Science and Engineering** of the Visvesraya Technological University, Belgaum during the year **2022 – 23**. It is certified that all corrections/suggestions indicated for Internal Assessment for progess-I have been incorporated in the Report deposited in the departmental library.

Signature of the Guide    Signature of Group Head    Signature of the HOD

## External Viva

Name of the examiners    Signature with date

1.

# ABSTRACT

This project aims to detect Lung Cancer by using Machine Learning technique ie. CNN (Convolutional Neural Network).The dataset contains Positron emission tomography (PET). It will use different libraries to build and evaluate CNN models with the primary objective of achieving an accuracy of 90% or higher. Also, it will evaluate the performance of different CNN architectures to validate the accuracy of the models.

WORKING DOMAIN The working domain is Deep Learning using CNN, a scope of Machine Learning. Therefore, we propose a solution that utilizes CNNs to automate the detection process & to improve accuracy in medical imaging.

EXISTING SOLUTION To provide a solution to existing solution that rely on manual interpretation of medical images by radiologists which can be subjective & time – consuming. The traditional image analysis technique may not fully leverage potential of advanced technologies to automate the task & accurately detect & classify the lung cancer.

LAGGING IN EXISTING SOLUTION The main drawback is potential for human error. Any mistakes in human analysis can impact patients outcome.

CONTRIBUTION OF PRESENTED SOLUTION By training CNN models on a dataset of pet scan images this solution aims to provide efficient results. This way the model can can significantly expedite the diagnosis process & enable timely intervention. We can refine existing algorithms & explore new possibilities for utilizing artificial intelligence in medical diagnosis.

SOLUTION The project's expected outcome is to provide a more effective and efficient way of detecting Lung Cancer, which can lead to early diagnosis that can potentially save lives.

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# Chapter 1

# Introduction

Cancer of lungs is a significant global health concern, which accounts for a substantial deaths worldwide, India's share due to cancer related deaths was recorder around 84,000 in the year 2020 according to global cancer observatory. Anyone infected with a serious disease like lung cancer needs to get a timely diagnosis & detection. As early detection definitely helps in improving patients outcome & may increase his/her survival rates. And that is the basic aim of this project. With advancements in technology there is a growing interest in leveraging innovative approaches to enhance the accuracy & efficiency of lung cancer detection using CNN trained on PET scan images.

Traditional method of detecting cancers mostly rely on manual interpretation by doctors(radiologists), it is effective but can be time consuming a lot of times, reason being sometimes doctors take a little more time to analyze intricate & minor tumors to treat their patients effectively. This approach is effective & no doubt in that as we've been relying on doctors for almost every medical problem. But there are valid proofs & evidences that yes doctors too can go wrong in detecting and complex & minor symptoms of cancers. They may overlook it to be something normal and might declare it negative but later that one ignorance towards something minor turns out to be a high stage lung cancer later on.

That is why the way doctors are trained & gain experience by doing their practicals & by treating patients in their internships, the same way we are going to train Lung Cancer detection model using CNN. The more training we give to our models, the more minor, major or complex 'Yes' Cancer folders & 'No' Cancer folders we feed to the model the more accurate & precise it becomes in detecting Lung Cancer of all stages.

The moment we train Machine Learning Models to an extremely higher degree, the more ability it'll showcase in detecting PET Scan images,  resulting in Doctors trusting the competence of these models. This in turn will help doctors in giving faster diagnosis which further results in effective treatment. Will add more satisfaction to their methods of dealing and working. Will add a pace in their day-to-day task of analyzing the results from PET-scan images.

CNNs have proven itself to be highly proficient in learning complex patterns & structures from even massive datasets. By training CNNs on a comprehensive collection of PET scan images, we aim to develop a model that can accurately detect lung cancer & distinguish it from benign abnormalities. The use of CNNs makes automated analysis possible, which further helps in reducing human subjectivity and potentially enhancing accuracy in detecting lung cancer lesions.

The integration of CNNs & Pet-scan images for lung cancer holds great promise. By combining the power of Deep Learning with functional information provided by PET scans we can unlock new avenues for early detection & intervention. The best thing about timely identification of lung cancer can lead to personalized treatment strategies, improved patient prognosis & ultimately higher chances of successful outcomes.

In this project our objective is to assess the effectiveness & precision of a CNN based lung cancer detection using PET scan images. We will explore various architectures & techniques within CNN framework, keeping in mind to achieve the highest level of accuracy & reliability. By undergoing a very extreme & challenging evaluation & analysis of lung cancer images our aim is to demonstrate the potential of this novel approach in revolutionizing lung cancer detection.

We aim to make the model work better & give much finer outputs also by implementing few algorithms which may work better than CNN. Some examples we are looking forward to try could be algorithms like Random Forest & Support Vector Machine. Implementing these models along with CNN will definitely give a clear idea on which all techniques are better than CNN. And definitely this adds more clarity on the precision & accuracy of different techniques.

By venturing into the realm of lung cancer detection using CNNs & Pet-scan images, we contribute to the ongoing efforts to combat this formidable disease. We are aiming to produce outcomes & findings that has the potential to pave the way for advancements in diagnostics techniques. Totally, we’re trying to add better approaches to this single field.

Navigating through this captivating field we will try our best to fuse the faster evolving technologies and medical imaging to transform the landscape of lung cancer detection.

# Chapter 2

# Literature Survey

## 2.1 Existing Literature

There is existing literature on lung cancer detection using CNN with PET and CT scan images. Here are a few notable studies and papers in this field:

"Deep Convolutional Neural Networks for Lung Cancer Detection in Computed Tomography Images" by Ardila et al. (2019): This study explores the use of deep convolutional neural networks for detecting lung cancer in CT scan images. The researchers trained a CNN model using a large dataset and achieved high sensitivity and specificity in lung cancer detection.

"A Deep Learning Framework for Lung Cancer Detection in PET-CT Images" by Song et al. (2020): This paper proposes a deep learning framework based on CNN for lung cancer detection using PET-CT images. The authors combined PET and CT scan images and developed a multi-stage network architecture for accurate classification of lung cancer.

"Lung Nodule Classification Using Deep Features in CT Images" by Shen et al. (2017): This research focuses on lung nodule classification using deep learning features extracted from CT scan images. The study demonstrates the effectiveness of CNN-based feature extraction for accurate lung nodule classification and highlights the potential of deep learning in lung cancer detection.

"Classification of Lung Nodule Malignancy Using Deep Convolutional Neural Networks" by Huang et al. (2017): This study explores the use of deep convolutional neural networks for classifying lung nodules as benign or malignant. The researchers trained a CNN model on a large dataset of CT scan images and achieved promising results in differentiating between benign and malignant nodules.

"Automatic Lung Cancer Detection in PET-CT Images Using Deep Learning" by Jauw et al. (2019): This paper presents an automatic lung cancer detection system using deep learning techniques. The authors utilized a CNN model to analyze PET-CT images and achieved high sensitivity in detecting lung cancer.

## 2.2 Research Gaps

While significant progress has been made in lung cancer detection using CNN with PET and CT scan images, there are still several research gaps that exist. Some of the key research gaps in this field include:

Limited availability of annotated datasets: The availability of large-scale, annotated datasets specifically designed for training and validating CNN models for lung cancer detection using PET and CT scan images is still limited. The development of standardized, diverse, and publicly accessible datasets can facilitate research and comparison of different methods.

Generalizability across different populations: Most studies in this field have focused on datasets from specific populations or institutions, which may limit the generalizability of the developed models. Further research is needed to investigate the performance and generalizability of CNN models across different populations, ethnicities, and healthcare systems.

Lack of interpretability and explainability: CNN models often lack interpretability, making it challenging to understand the rationale behind their decisions. Developing methods to interpret and explain the CNN models' predictions can enhance their clinical utility and foster trust among healthcare professionals.

# Chapter 3

# Problem Statement & Objectives

## 3.1 Problem Statement

Lung Cancer is a leading cause of cancer death among men & women worldwide & in entire India. Lung cancer is a prevalent and deadly disease that requires early and accurate detection for effective treatment. While PET (Positron Emission Tomography) scans provide valuable metabolic information, their interpretation can be subjective and prone to human error. Therefore, there is a need to develop a CNN (Convolutional Neural Network) technique that leverages PET scan images to improve the accuracy and efficiency of lung cancer detection.

## 3.2 Objectives

Some points to note before we move on to the objectives is that a project on ‘Lung Cnacer Detection’ should be able to

Accurately detect Lung Cancer in PET/CT scan images.

Identify the features of PET/CT scan images that are most predictive of lung cancer.

Stand when we copare CNN model to other ethods of Lung Cancer Detection.

<u>Main Points Under Objectives</u> :

**Detection of Small and Early-stage Tumors**: The CNN model should be capable of detecting small or early-stage lung tumors that may have subtle metabolic activity in PET scan images. The challenge is to develop a model that can identify these abnormalities, potentially before they become visually apparent to human observers

**Differentiation of Benign and Malignant Lesions**: Accurately distinguishing between benign and malignant lung lesions based on PET scan images is crucial to prevent unnecessary invasive procedures or misdiagnosis. The CNN model should be trained to accurately classify PET scan images, minimizing false positives and false negatives.

**Generalization Across Diverse Populations**: The CNN technique needs to be robust and applicable to a wide range of patient populations. This includes accounting for variations in demographics, disease subtypes, and imaging protocols to ensure the model's generalization and effectiveness across diverse clinical settings.

**Validation and Comparative Evaluation**: Rigorous validation of the CNN technique is necessary to assess its performance against established diagnostic methods and existing PET scan interpretation practices. Comparative evaluation against ground truth data, clinical outcomes, and other imaging modalities like CT scans is crucial to demonstrate the superiority and clinical utility of the CNN-based lung cancer detection.

**One** very Challenging & demanding Objective we're trying to look forward to is to 'Develop a Software Web app' That can be used to automatically detect lung cancer in PET/CT scan images.

Approach

By addressing these challenges, the development of an accurate and reliable CNN technique for lung cancer detection using PET scan images has the potential to significantly improve early detection, enhance diagnostic accuracy, and facilitate personalized treatment decisions for patients with lung cancer

Challenges that comes with objectives

Improved Accuracy: The primary goal is to enhance the accuracy of lung cancer detection using PET scan images. By training a CNN model on a large dataset of PET scans, the objective is to develop a model that can effectively differentiate between cancerous and non-cancerous regions in the lungs with a high level of accuracy.

Integration of Metabolic Information: PET scans provide information about the metabolic activity of tissues, allowing the identification of areas with abnormal metabolic rates, such as cancer cells. The objective is to leverage this metabolic information in combination with CNNs to improve the accuracy of lung cancer detection, as it complements the anatomical details provided by other imaging techniques like CT scans.

Early Detection and Staging: Detecting lung cancer at an early stage significantly improves patient outcomes. By using CNNs with PET scans, the objective is to identify even small cancerous lesions or areas of abnormal metabolic activity that may be indicative of early-stage lung cancer. Additionally, the CNN model can aid in staging the disease by assessing the extent of metabolic abnormality in the lungs.

Differentiating Benign and Malignant Lesions: PET scans can help differentiate between benign and malignant lung lesions based on their metabolic activity. The objective is to train the CNN model to accurately classify PET scan images into cancerous and non-cancerous categories, enabling the identification of malignant lesions and reducing the likelihood of false positives or false negatives.

Development of Quantitative Biomarkers: PET scan images, when combined with CNNs, can provide quantitative biomarkers that help in the diagnosis and monitoring of lung cancer. The objective is to develop robust CNN models that can extract and analyze these biomarkers, allowing for objective and quantitative assessment of the disease.

Clinical Application and Validation: The ultimate objective is to develop a CNN model that can be translated into clinical practice. This involves validating the performance of the CNN model on diverse datasets, including large-scale clinical studies, to demonstrate its reliability, reproducibility, and generalizability. Integration into clinical workflows and comparison against existing diagnostic methods is also crucial

# Chapter 4

# Software Requirement and Specification

## 4.1 Hardware Requirements:

Functional requirements define the specific features, capabilities, and behaviors that a lung cancer detection system using CNN (Convolutional Neural Network) with PET and CT scans should exhibit.
The classification of the functional requirements for lung cancer detection based on hardware and software requirements is as follows:

### 4.1.1 Computer or Server

- A powerful computer or server with sufficient processing capabilities and memory to handle the computational demands of the CNN model and image processing tasks.

### 4.1.2 Graphics Processing Unit (GPU)

- A high-performance GPU capable of parallel processing, as CNN models can benefit significantly from GPU acceleration.

### 4.1.3 Storage

- Sufficient storage capacity to store the large dataset of PET-CT scan images, as well as the trained CNN model and associated files.

### 4.1.4 Display Monitor

- A high-resolution display monitor to visualize the fused images and interact with the user interface.

## 4.2 Software Requirements

### 4.2.1 Deep Learning Framework

- Software frameworks such as TensorFlow, PyTorch, or Keras, which provide the necessary tools and libraries for implementing and training the CNN model.

### 4.2.2 Image Processing Libraries

- Libraries like OpenCV or SimpleITK for image preprocessing tasks, including image normalization, denoising, and image fusion.

### 4.2.3 Programming Languages

- Proficiency in programming languages such as Python, which is commonly used for deep learning applications, is necessary for implementing the CNN model and integrating the system components.

### 4.2.4 Data Management Software

- Software for managing the large dataset of PET-CT scan images, including organizing, indexing, and storing the images efficiently.

### 4.2.5 Operating System

- The system should run on a compatible operating system, such as Windows, macOS, or Linux, depending on the preferred environment for deep learning and image processing software.

### 4.2.6 User Interface Framework

- A user interface framework, such as PyQt or Tkinter, to develop the user-friendly interface for interacting with the system and visualizing the results.

## 4.3 Non Functuinal Requirements

### 4.3.1 Accuracy

- The system should achieve a high level of accuracy in detecting lung cancer from PET scan images. This can be measured by metrics such as sensitivity, specificity, and overall classification accuracy.

### 4.3.2 Speed and Efficiency

- The system should process PET scan images in a timely manner to provide quick results. It should be efficient in terms of computational resources required for training the CNN model and making predictions.

### 4.3.3 Robustness

- The system should be able to handle variations in PET scan images, such as different image qualities, resolutions, and orientations. It should also be resilient to noise and artifacts commonly found in medical imaging.

### 4.3.4 Scalability

- The system should be scalable to handle a large volume of PET scan images, as the dataset may increase over time. It should be capable of processing and analyzing a significant number of images without performance degradation.

### 4.3.5 Security and Privacy

- The system should ensure the confidentiality and privacy of patient data, adhering to relevant regulations and guidelines (such as HIPAA) for handling sensitive medical information.

### 4.3.6 User-Friendly Interface

- The system should have a user-friendly interface that is intuitive and easy to use, allowing medical professionals to interact with the system efficiently. The interface should present results clearly and provide necessary tools for further analysis.

### 4.3.6 Portability

- The system should be compatible with different computing environments, allowing it to be deployed on various hardware configurations, including different operating systems and computing platforms.

### 4.3.7 Maintainability

- The system should be designed in a modular and maintainable manner, enabling easy updates, bug fixes, and integration of new features or improvements. This includes well-documented code, clear architecture, and use of standard practices in software development.

### 4.3.8 Performance

- The system must be able to process images quickly and accurately. The latency for detecting a lung cancer should be no more than 120 seconds.

# Chapter 5

# Methodology

In Methodology we've described the important steps to make a project on 'Lung Cancer Detection' & further we described what we actually did to reach our target, please have a read:

1. <u>Data Collection</u> : The first step is to collect a dataset of PET scan images of lungs. Thsi project specifically has taken its dataset from cancerimagingarchive.net website. The images should have good quality & should have 'Yes' class (Indicating presence of lung cancer) & 'No' class (Indicating absence of lung cancer).

2. <u>Data Preparation</u> : Once the Data Collection has taken place successfully it need to be prepared for cleaning the CNN model. This includes cropping & resizing the images and normalizing pixel values. If the data set is not masive then the best thing to do is to augment the data. This increases the dataset size & training on larger datasets results in a smarter model with more knowledge.

3. <u>Model Training</u> : Next, we will train the model. We here make the model to learn the patterns that can distinguish the images of lugs with & without patterns.

4. <u>Model Evaluation</u> : Once the model training is completed, next, we will evaluate it to assess its performance. Here we make the trained model to predict an image's accuracy on whether the image emits cancer or does not emits cancer. The model's performane can also be evaluated using other metrics such as precision, recall & F1 score.

5. <u>Model Deployment</u> : Once the odel has been evaluated & found to be satisfactory, it can be developed for use in clinica applications. This may involve integrating the model into a software web-app or in an android/ios app. If this is done then it adds more ease of use & functionality to all radiologists & make predicting lung cancer interface user friendly.

6. <u>Feature Extraction</u> : Before training CNN model it becomes necessary to extract features from the images. This can be done using a variety of techniques but here we will be using CNN.

7. <u>Model Selection</u> : There are many different CNN architectures that can be used for lung cancer detection. The suitable architecture fro a particular application depends on a number of factors. Like AlexNet, VGGNet, ResNet, InceptionNet, DenseNet.

The optimal CNN architecture for lung cancer detection will depend on a number of factors, lize size of daatset & complexity of dataset, the accuracy which we are looking for, and the computational resources available. It is important to stay up to date on the latest research in order to choose the best architecture for a particular application.

The above states the proceure to be followed to reach the outcomes desired. And the next few lines will state the procedure that was actually implemented in this 'Lung Cancer Detection' project that made us reach the goal we aimed for.

The dataset for this project is collected from cancerimagingarchive.net website. A renowned website with a massive datasets for for medical images of cancer which has been made accessible for public downloads.Our Pet-Ct scan images are downoaded from here.

We I the next step used an application called 'Radiant DICOM Viewer' to fuse PET with CT scan. And subsequently the images were croped & scaled. Next, we defined our 'Yes' class & 'No' class to seperate the images differently if the images has cancer & also if the images has no cancer. This led us to a total of 600+ images were collected and to increses the dataset size, we applied data augmentation technique.

The dataset was split into training, development & test examples. Additionally the shape of the input featres were also determined ( like x_train, y_train, x_val, y_val, x_test and y_test ).

To evaluate the effectiveness of our model we utilized the epoch method to measure precision, accuracy & F1 score in detecting lung cancer in an image.

Apart from this we also tried experimenting with Macine Learning algorithms such as Support Vector Machine with Histogram of Oriented Gradients (HOG) . We tried defining the `extract_hog_features` function which takes an image as input and performs some important steps like 'Convert the image to grayscale', 'Resize the image to a fixed size of 64x64 pixels', 'Extract HOG features from the resized image using specified parameters', ' Return the extracted features'. Finally we looped through each image file in the specified path for the 'yes' class & here we read "each image file using cv2.imread" then we extracted HOG features from the image using the `extract_hog_features` function. Then append the features to the `X` list and the label (1 for 'yes' class) to the `y` list. Repeat the above steps for the 'no' class (NO_augmented folder). And finally, we returned the lists of features (`X`) and labels (`y`).

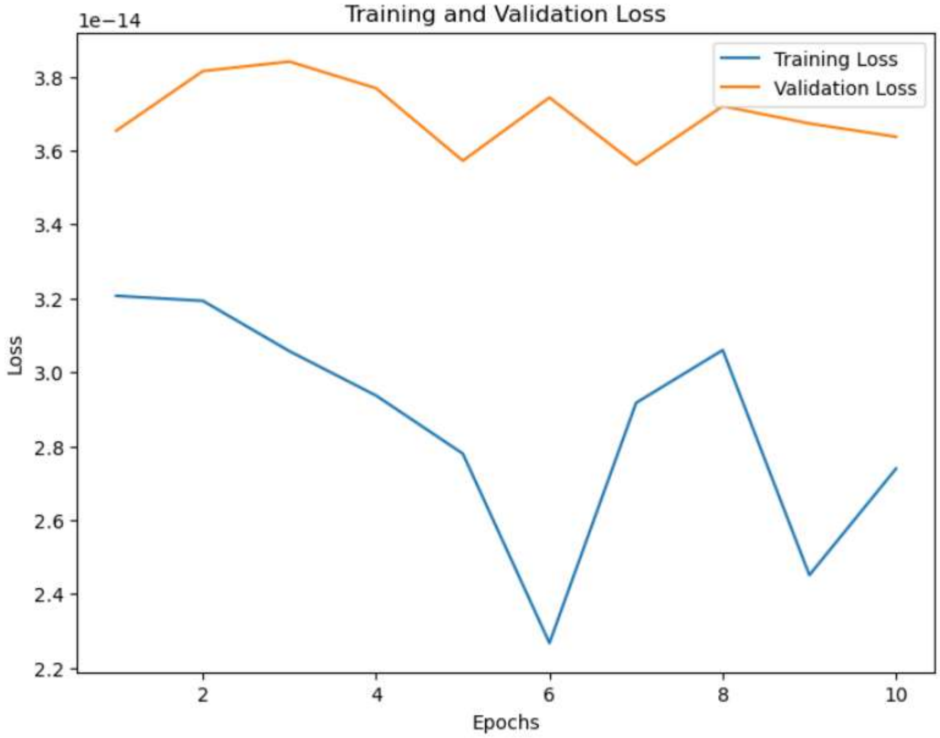
## RESULTS from CNN-based technique applying epoch method

```
Model: "LungDetectionModel"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 240, 240, 3)]     0

 zero_padding2d (ZeroPadding  (None, 244, 244, 3)      0
 2D)

 conv0 (Conv2D)              (None, 238, 238, 32)      4736

 bn0 (BatchNormalization)    (None, 238, 238, 32)      128

 activation (Activation)     (None, 238, 238, 32)      0

 max_pool0 (MaxPooling2D)    (None, 59, 59, 32)        0

 max_pool1 (MaxPooling2D)    (None, 14, 14, 32)        0

 flatten (Flatten)           (None, 6272)              0

 fc (Dense)                  (None, 1)                 6273

=================================================================
Total params: 11,137
Trainable params: 11,073
Non-trainable params: 64
```

## Running the code showed Test Accuracy & Model Validation Accuracy

```
Epoch 1/10
191/191 [==============================] - 104s 523ms/step - loss: 0.0015 - accuracy: 0.9993 - val_loss: 6.5958e-04 - val_accur
acy: 1.0000
Epoch 2/10
191/191 [==============================] - 102s 536ms/step - loss: 2.8820e-14 - accuracy: 1.0000 - val_loss: 1.8639e-07 - val_a
ccuracy: 1.0000
Epoch 3/10
191/191 [==============================] - 104s 546ms/step - loss: 3.0992e-14 - accuracy: 1.0000 - val_loss: 1.9978e-11 - val_a
ccuracy: 1.0000
Epoch 4/10
191/191 [==============================] - 104s 544ms/step - loss: 2.8635e-14 - accuracy: 1.0000 - val_loss: 1.5287e-13 - val_a
ccuracy: 1.0000
Epoch 5/10
191/191 [==============================] - 101s 527ms/step - loss: 2.5202e-14 - accuracy: 1.0000 - val_loss: 4.6955e-14 - val_a
ccuracy: 1.0000
Epoch 6/10
191/191 [==============================] - 110s 576ms/step - loss: 3.0042e-14 - accuracy: 1.0000 - val_loss: 3.9364e-14 - val_a
ccuracy: 1.0000
Epoch 7/10
191/191 [==============================] - 109s 571ms/step - loss: 2.6418e-14 - accuracy: 1.0000 - val_loss: 3.8553e-14 - val_a
ccuracy: 1.0000
Epoch 8/10
191/191 [==============================] - 106s 556ms/step - loss: 2.6316e-14 - accuracy: 1.0000 - val_loss: 3.7031e-14 - val_a
ccuracy: 1.0000
Epoch 9/10
191/191 [==============================] - 102s 534ms/step - loss: 2.8684e-14 - accuracy: 1.0000 - val_loss: 3.7146e-14 - val_a
ccuracy: 1.0000
Epoch 10/10
191/191 [==============================] - 102s 535ms/step - loss: 2.3818e-14 - accuracy: 1.0000 - val_loss: 3.6793e-14 - val_a
ccuracy: 1.0000
Execution time: 0:17:25.7
21/21 [==============================] - 7s 235ms/step - loss: 3.1432e-14 - accuracy: 1.0000
Test Loss: 3.143158002209996e-14
Test Accuracy: 1.0

Best Model Validation Loss: 4.4810379365434194e-13
Best Model Validation Accuracy: 1.0
```

**This is a graph for Training Loss vs Validation Loss**




**Explaining Training Loss & Validation Loss:**

In this case of lung cancer detection using CNN epoch method, a good **Training loss** curve would show a steady decease in the **error** over time. The **Validation Loss** curve should also decrease over time, but I may not decease as quickly as Training Loss curve. Validation Loss is an accurate representation of how the model will perform on new data. Keep in mind that if Validation Loss curve starts to increase then it is a sign that a model is overfitting & you should cahnge your approah.

By leveraging advancements in deep learning & image processing our project offers several positive implications of lung cancer.

Firstly, engineers and researchers can benefi from our work by using CNN model & dataset that we have use, cleaned & pre-proccessed. They can use this dataset for further research & devlopment. The use of PET scan images provides a more comprehensive representation of lung tissue abnormalities, leading to improved accuracy & reliability. We can say that the real world application of our lung cancer detection system holds significant potential for saving lives & enhaning patient outcomes. Early detection plays a crucial role for improving survival rates. It enabes prompt medical intervention & & treatment planning.

Therefore, this AI-driven (deep learning based) medical imaging project will help engineers, researchers and after them the doctors in improving patient outcoes & saving lives through early & accurate detection of lung cancer.

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