DETECTING STAGE OF LUNG CANCER BASED ON TUMOR SIZE - BY USING SEGMENTATION AND FEATURE EXTRACTION IN MEDICAL IMAGE PROCESSING

A Project report submitted in partial fulfillment of the requirements for the award of the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES

(UGC AUTONOMOUS)

(*Permanently Affiliated to AU, Approved by AICTE and Accredited by NBA & NAAC with 'A' Grade*)
Sangivalasa, Bheemili mandal, Visakhapatnam dist. (A.P) 2020-2021

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CERTIFICATE

This is to certify that the project report entitled **"DETECTING STAGE OF LUNG CANCER ON THE BASIS ON TUMOR SIZE – BY USING SEGMENTATION AND FEATURE EXTRACTION IN MEDICAL IMAGE PROCESSING"** submitted by ***Sura Divya (317126512172), Ruqaiyya (31712612165), Gandem Sravya (316126512199) and Sodadasi Mani Swaroop(317126512170)*** in partial fulfilment of the requirements for the award of the degree of ***Bachelor of Technology in Electronics & Communication Engineering*** of Andhra University, Visakhapatnam is a record of Bonafide work carried out under my guidance and supervision.

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1. p16 tumor
2. TP53 tumor
3. K-RAS oncogene
4. R G B
5. 1D
6. 2D
7. med(g(s,t))
8. f by a structuring element s (denoted $f \oplus s$)
9. Opening of an image f by a structuring element s (denoted by $f \circ s$)
10. Erosion of a binary image f by a structuring element s (denoted $f \ominus s$)
11. STATS
12. MATLAB
13. X_width
14. Y_width
15. $f \oplus s = f^c \ominus s_{rot}$, where s_{rot} is the structuring element s rotated by f
16. strel
17. Srot
18. f^c (complement of image f)
19. SE (single structuring element)
20. AoB (opening)
21. A.B (closing)
22. |z| (set of pixel locations of z)
23. imdilate (grayscale dilation)
24. (x,y) (pixel coordinates)
25. imerode (binary erosion)
26. mxn (size of structuring element)
27. XOR
28. 0-255 (PIXEL VALUES)
29. Ismember
30. +1,+2,+3 (Different staining intensities)

ABBREVIATIONS

CT	:	Computed Tomography
MRI	:	Magnetic Resonance Imaging
SCLC	:	Small cell lung cancer
NSCLC	:	Non-small cell lung cancer
DNA	:	Deoxyribonucleic acid
EGFR	:	Estimated Glomerular Filtration rate
PET	:	Positron emission tomography
DEXA	:	Dual energy X-ray absorption
ROI	:	Region of interest
BOW	:	Bag of words
GLCM	:	Gray level co-occurrence matrix
LBP	:	Local Binary pattern
SIFT	:	Scale invariant feature transform
OCR	:	Optical character recognition
CIA	:	Cancer imaging archive
RGB	:	Red green blue
CADS	:	Computer aided design
RCM	:	Robinson Compass Maks
KCM	:	Krisch compass masks
CE	:	Canny edge
ZM	:	Zernike moments
ML	:	Machine learning
LM	:	Labelled matrix
CH	:	Convex hull
CI	:	Convex image
CA	:	Convex area
FI	:	Filled image

ABSTRACT

Cancer is an extensive global and universal disease now days which pretend to be an utmost cause for large impermanence rate among men and women every era. Approximately 80-85% of the people who get affected by cancer are being succumbed to death. Recognition of cancer at the first stage is an only aspect in front of us to give proper treatment. Among numerous types of cancers, lung cancer is a very fearful and complicated one. Lung cancer means growing of tumor cells briskly and having chances of spreading those cancer cells to other organs which in turn damaging other normal tissue cells of the body. Noticing tumor prematurely can be helpful in curing disease completely and it becomes pivotal to find out whether the tumor has been changed to cancer or not, if the prognostication is made at an initial stage, then countless lives that are at risk could be rescued and moreover accurate prediction can help the doctors to start their treatment at the earliest. In this paper, we have proposed a simple, easy and precise method for accurate prediction of stage of cancer using CT image of the lungs in Image processing. For this process, a CT image will be considered, and then the image will be pre-processed for noise removal. Further segmentation is done to identify and separate desired tumor nodule and extraction of morphological features such as area, perimeter, eccentricity and diameter is carried out under feature extraction. Finally, the classification of lung cancer into different stages based on the size of tumor results have been proposed using MATLAB which are more accurate and less time consuming when compared to other lung cancer prediction systems. The method proposed in this paper to detect tumor in lungs is simpler when compared to applying other difficult algorithms.

Keywords: ***Lung cancer, Impermanence, pivotal, briskly, prognostication.***

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OBJECTIVE:

The primary objective in this project is to identify the stage of cancer based on the size of tumor. Lung cancer is leading disease in present days. The identification of lung cancer at initial stages is of extreme importance because earlier detection is the only method to improve the survival rate. The presence of lung cancer can be diagnosed with the help of a CT image of the lungs. The manual detection by doctor may result in false reports. So, the objective in this project is need of computerized method for cancer detection. This project analyzes CT images using different image processing operations on them to get accurate detections. Here a CT image will be considered, and then the image will be pre-processed for noise removal and image enhancement. Further extraction of morphological features is carried out from the pre-processed image and determination of lung cancer takes place.

1.2 MOTIVATION:

With today's technology, doctors can replace every part of the human body, from bones to organs, hands and face except brain and lungs. Hence early detection of damage in the lungs or brain should be recognized to improve the survival rate of human beings. This is the main motivation of this project. There are many techniques to diagnose lung cancer such as Chest Radiograph (X-Ray), Computed Tomography (CT), Magnetic Resonance Imaging (MRI) etc. But even after analyzing these reports, doctors may not accurately predict the stage of cancer or size of tumor. Therefore, there is a great need for a new technology i.e., Image Processing Techniques which is a good tool to improve manual analysis and to predict more accurately the size of tumor cells.

1.3 <u>LUNG CANCER DESCRIPTION</u>:

Lung cancer is the uncontrolled growth of abnormal cells in the lung. Normal lung tissue is made up of cells that are programmed by genes to create lung tissue in a certain shape and to perform certain functions. Lung cancer develops when the genetic material responsible for production of lung cells is damaged (genetic mutations). Repeated exposure to carcinogens such as tobacco smoke may cause damage in lung cells. While tobacco is the leading cause of lung cancer, some other carcinogens linked to lung cancer include radon and asbestos. These mutations in the genetic material of the lung cells cause the instructions for those cells to go askew. Consequently, those cells and their offspring reproduce wildly, without regard for the normal shape and function of a lung. That wild reproduction causes the formation of tumours that block air passages in the lung and make it stop functioning as it should.

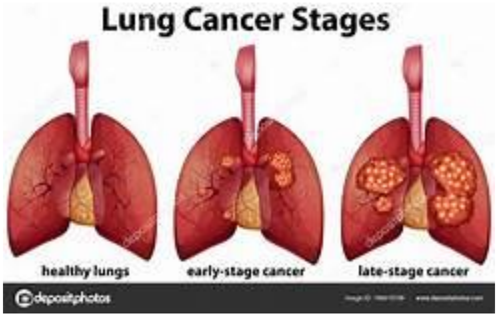


Fig. 1.3) Lung cancer stages

Lung cancer is usually divided into two major types. The first type is small cell lung cancer (SCLC). The second type is non-small cell lung cancer NSCLC. Sometimes a lung cancer may have characteristics of both types. This is called mixed small cell/large cell carcinoma. About 20% of all lung cancers are is small cell lung cancer (SCLC). It is named for the size of the cancer cells. Although each of the cells is small, they can multiply quickly and form large tumours, and can spread to lymph nodes and other organs such as the bones, brain, adrenal glands, and liver. This type of cancer often starts in the bronchi and toward the centre of the lungs. Smoking almost always causes small cell lung cancer. It is very rare for someone who has never smoked to have small cell lung cancer. Other names for SCLC are oat cell carcinoma and small cell undifferentiated carcinoma. Non-small cell (NSCLC) represents 75% to 80% of all cases of lung cancer and includes three distinct types of lung cancer: squamous cell carcinoma, adenocarcinoma, and large cell carcinoma. These subtypes are grouped together and called "non-small cell lung cancer" because their pattern of spread and their treatment differ from small cell lung cancer, and when diagnosed at an early stage, may have the potential to be cured by surgery. In addition to the two main types of lung cancer, other tumours can occur in the lungs.

1.3.1 <u>Types of Lung cancer</u>:

Lung cancer is one of the malignant tumours with the fastest increase in incidence and mortality, and it is one of the greatest threats to the health and life of the population. In recent decades, the incidence and mortality of lung cancer in many countries have increased significantly. According to the histologic size and appearance of cancer cells, lung cancer is divided into

1. Small Cell Lung Cancer and Non-small Cell Lung Cancer
2. The Non-small Cell Lung Cancer is mainly divided into

Small Cell Carcinoma,

Lung Aden carcinoma and

Large Cell Carcinoma.

E lab science has developed a series of lung cancer research related antibodies, such as CK-7 (one of the tumour markers of lung cancer, which is expressed in almost all the lung adenocarcinoma). Those high quality antibodies can help you detect the expression of related proteins more accurately.

1.4 <u>WHAT CAUSES LUNG CANCER</u>:

What Causes Lung Cancer?

We don't know what causes each case of lung cancer. But we do know many of the risk factors for these cancers and how some of them cause cells to become cancer.

Smoking:

Smoking tobacco is by far the leading cause of lung cancer. About 80% of lung cancer deaths are Caused by smoking and many others are caused by exposure to second-hand smoke.

Smoking is clearly the strongest risk factor for lung cancer, but it often interacts with other factors. Smokers exposed to other known risk factors such as <u>radon</u> and <u>asbestos</u> are at an even higher risk. Not everyone who smokes gets lung cancer, so other factors like genetics probably play a role as well (see below).

Causes in non-smokers:

Not all people who get lung cancer are smokers. Many people with lung cancer are former smokers, but many others never smoked at all. And it is rare for someone who has never smoked to be diagnosed with small cell lung cancer (SCLC), but it can happen.

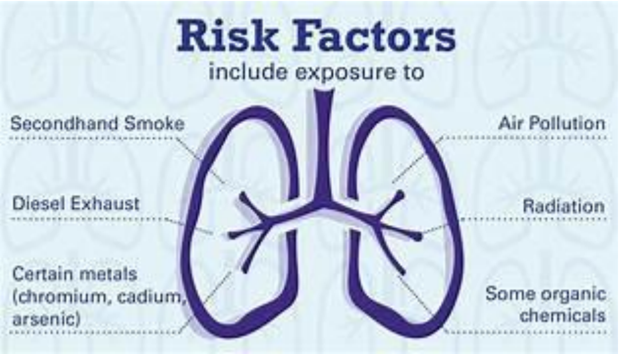


Fig 1.4.1) Risk factors for cause of lung cancer

Lung cancer in non-smokers can be caused by exposure to radon, second-hand smoke, air pollution, or other factors. Workplace exposures to asbestos, diesel exhaust or certain other chemicals can also cause lung cancers in some people who don't smoke.

A small portion of lung cancers occur in people with no known risk factors for the disease. Some of these might just be random events that don't have an outside cause, but others might be due to factors that we don't yet know about.

Lung cancers in non-smokers are often different from those that occur in smokers. They tend to occur in younger people and often have certain gene changes that are different from those in tumours found in smokers. In some cases, these gene changes can be used to guide treatment.

Gene changes that may lead to lung cancer:

Scientists know how some of the risk factors for lung cancer can cause certain changes in the DNA of lung cells. These changes can lead to abnormal cell growth and, sometimes, cancer. DNA is the chemical in our cells that makes up our genes, which control how our cells function. DNA, which comes from both our parents, affects more than just how we look. It also can influence our risk for developing certain diseases, including some kinds of cancer.

Some genes help control when cells grow, divide to make new cells, and die:

- Genes that help cells grow, divide, or stay alive are called **oncogenes**.
- Genes that help control cell division or cause cells to die at the right time are called **tumour suppressor genes**.

Cancers can be caused by DNA changes that turn on oncogenes or turn off tumour suppressor genes. Changes in many different genes are usually needed to cause lung cancer.

Inherited gene changes:

Some people inherit DNA mutations (changes) from their parents that greatly increase their risk for developing certain cancers. But inherited mutations alone are not thought to cause very many lung cancers.

Still, genes do seem to play a role in some families with a history of lung cancer. For example, people who inherit certain DNA changes in a particular chromosome (chromosome 6) are more likely to develop lung cancer, even if they don't smoke or only smoke a little.

Some people seem to inherit a reduced ability to break down or get rid of certain types of cancer-causing chemicals in the body, such as those found in tobacco smoke. This could put them at higher risk for lung cancer.

Other people inherit faulty DNA repair mechanisms that make it more likely they will end up with DNA changes. People with DNA repair enzymes that don't work normally might be especially vulnerable to cancer-causing chemicals and radiation.

Some non-small cell lung cancers (NSCLCs) make too much of the EGFR protein (which comes from an abnormal *EGFR* gene). This specific gene change is seen more often with adenocarcinoma of the lung in young, non-smoking, Asian women, but the excess EGFR protein has also been seen in more than 60% of metastatic NSCLCs.

Researchers are developing tests that may help identify such people, but these tests are not yet used routinely. For now, doctors recommend that all people avoid tobacco smoke and other exposures that might increase their cancer risk.

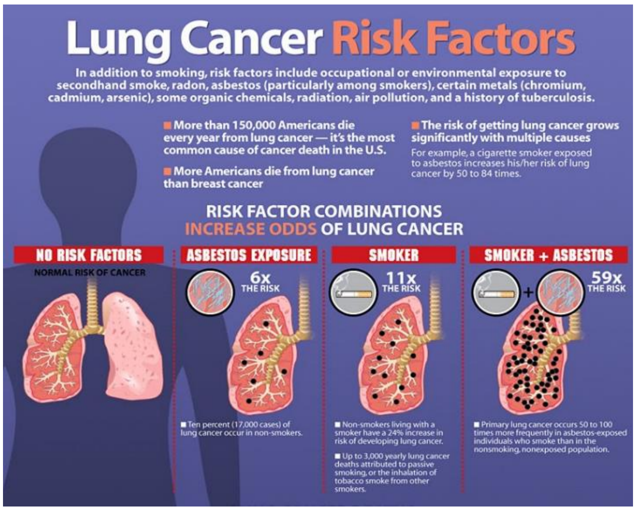


Fig 1.4.2) Lung cancer risk factors

Acquired gene changes:

Gene changes related to lung cancer are usually acquired during life rather than inherited. Acquired mutations in lung cells often result from exposure to factors in the environment, such as cancer-causing chemicals in tobacco smoke. But some gene changes may just be random events that sometimes happen inside a cell, without having an outside cause.

Acquired changes in certain genes, such as the *RB1* tumor suppressor gene, are thought to be important in the development of SCLC. Acquired changes in genes such as the *p16* tumor suppressor gene and the *K-RAS* oncogene, are thought to be important in the development of NSCLC. Changes in the *TP53* tumor suppression gene and to chromosome 3 can be seen in both NSCLC and SCLC. Not all lung cancers share the same gene changes, so there are undoubtedly changes in other genes that have not yet been found.

1.5 <u>BRIEF IDEA OF THE PROJECT</u>:

Cancer is defined as group of cells in the human body growing uncontrollably in a massive number leading to development of tumor. There is a myth that cigarette is the main cause to evolve lung cancer. But the truth is all smokers may not have lung cancer and not all the people having lung cancer smoke. Lung cancer may cause due to air pollution, inheritance where family background may have lung cancer, exposure to any harmful radiation gases, carcinogens and of course smoking also. Cancer cells from the breast, kidney or any other organs can be carried away in the blood or the lymph fluid to the lungs. Suppose if cancer cells from breast spreads to the lungs, it is metastatic breast cancer, not complete lung cancer, but the lungs also get effected here. In this way, lung cancer can be caused due to numerous reasons. Lung cancer varies differently from person to person, depending on the size of the tumor and the stage it is in. Stage I is considered as when the cancer is restricted to the lung. Stage II is when the cancer is limited to the chest. Stage III is when the tumor grows larger and appears in the CT scan. Stage IV is confined to spreading cancer cells to other parts of the body and growth of tumors in other parts as well.

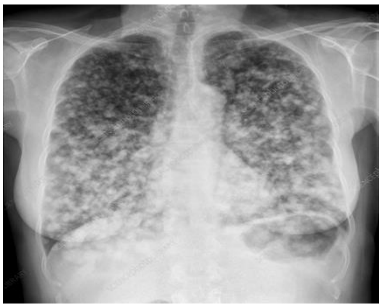


Fig 1.5.1) Lung cancer chest CT scan image

Analyzing CT scan image of lungs and predicting stage of cancer based on tumor requires a high level of skill and concentration, and is possible only by the expert doctors or radiologists. CT stands for computerized tomography where passing of X-rays inside the human body takes place. There are many other image processing methods and techniques such as MRI, Ultrasound, DEXA, X-ray and PET, but CT scan is best recommended because of three main reasons. One is due to CT scans can completely examine not only bones as like X-ray does, but also soft organs like lung tissues. Second one is CT scanning is painless, cost effective, accurate, fast, simple, less sensitive to patient movement and moreover X-rays used in standard CT scans have no immediate side effects. Third reason is Computed tomography (CT) images have better clarity, low noise and distortion. Thus, CT scan images are preferred in this project and taken as input. CT scan images are downloaded from the Internet from the Cancer Imaging Archive database. Here one CT image having tumor regions is taken in this project. In the same way, any CT image can be taken and can be tested.

Fig 1.5.2) Human Tracheal and lungs system having impact on left lung

As medical images may have noise, the CT image is passed to the second step, i.e., pre-processing where median filter is used in this paper for elimination of noise. Then conversion of image into binary followed by segmentation is done where CT image is partitioned into some sets of pixels and obtaining of tumor (white) region pixels i.e., extraction of required and interested region (which are the white regional pixels in different places present in the lungs, eliminating the other part of the lung which is not affected takes place). By the end of this step, just some white pixel areas/regions grouped together will be separated out which particularly means that final declaration of whether it is tumor or still few cancer cells grouped together in less number which not yet developed into tumor (that means the cancer cells size still less than tumor size) cannot be predicted. But, after segmentation, for analyzing CT scan image, it became simpler and complexity was reduced. Various simple segmentation techniques such as morphological operations like dilation, erosion, opening to apply big mask were used in this paper. Last step is feature extraction to decide whether those white regional pixels were still initial cancer cells or tumor is decided here and area, perimeter, eccentricity and diameter of those white regional pixels are extracted and based on the eccentricity value of the white grouped pixels, exact tumors are separated out and based on radius value of tumor, classification of lung cancer into various stages is decided in this project. On the basis of a fixed eccentric value as prescribed by the medical standards, only regions having greater eccentric value than the standard value will be considered as tumors and it becomes easier for the radiologists/doctors to easily find the stage of cancer instantly.. Proper medication like radiotherapy or surgery can be done if the tumor's size (eccentric value is much higher than the standard medical value) is large.

CHAPTER 2

IMAGE PRE-PROCESSING

2.1 INTRODUCTION TO IMAGE PREPROCESSING :

Preprocessing is a typical name for procedures applied to both input and output intensity images. These images are indistinguishable from the original data taken by the sensors. Basically, image pre processing is a method to transform raw image data into a clean image data, as most of the raw image data contain noise and contain some missing values or incomplete values, inconsistent values, and false values. Missing information means lacking of certain attributes of interest or lacking of attribute values. Inconsistent information means there are some discrepancies in the image. False value means error in the image value. The purpose of preprocessing is an enhancement of the image data to reduce reluctant falsifications or to improve some image features vital for additional processing. Some will contend that image preprocessing is not a smart idea, as it alters or modifies the true nature of the raw data. Nevertheless, smart application of image preprocessing can offer benefits and take care of issues that finally produce improved global and local feature detection.

Image preprocessing may have beneficial effects on the excellence of feature extraction and the outcomes of image analysis. Image preprocessing is similar to the scientific standardization of a data set, which is a general step in many feature descriptor techniques. Image preprocessing is used to correct the degradation of an image. In that case, some prior data or information is important such as information about the nature of the degradation, information about the features of the image capturing device, and the conditions under which the image was obtained.

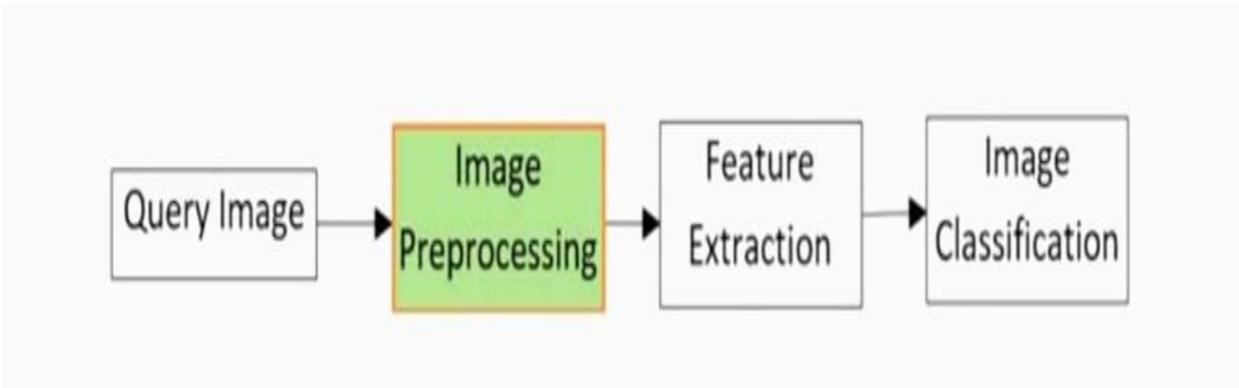


Fig 2.1.1 Image pre processing step in digital image processing

2.2 GRAY SCALE IMAGE:

In the digitized world a gray scale image is a computerized/digital image in which the estimation of every pixel is an individual example, i.e., it conveys just power or intensity i.e. white or black in terms of display Pictures of this kind, otherwise called white (maximum amplitude) and dark (minimum amplitude) pictures, comprise selective shades of dim. Gray scale pictures are the after effect of measuring the amplitude of light at every pixel in a single band of the light spectrum. They can likewise be obtained from a full coloured picture. The explanation for picking gray scale picture is even least pixel power is additionally useful in recognizing changes in the cells. In fact, a dim shading is one in which the R, G, B planes have equal intensity, the intensity level represented as a number from decimal 0 to 255. For each pixel in a RGB gray scale picture, G = B = R. The amplitude differs in extent with the number speaking to the brightness levels of the RGB hues. Dark is spoken to by R=G=B=0 and white is spoken to by R=G=B=255.

Fig 2.2.1 RGB Image

Fig 2.2.2 Gray scale Image

2.3 HISTOGRAM EQUALISATION:

Histogram equalization is a technique used to enhance the contrast of an image by increasing the intensity histogram uniformity of an image. This is usually performed using the normalized cumulative histogram function to remap the histogram intensities into more equalized distribution along the intensities of gray scale. The normalized cumulative histogram function can be defined as

$Cpf(pi) = \sum P(j)$; j=0

Where P is an image histogram and is a certain intensity level within the histogram In this chapter, the histogram equalization method was used to improve the contrast of the nuclei image with different staining intensities (+1, +2 and +3) by stretching out the intensities of a nuclei image into more equalized arrangements over the intensity scale.

The aim of this step is to be able to extract more identifying and discriminative features for the equalized image histogram, which will then be used to classify the three different staining intensities of positively stained nuclei. This will be performed using a number of steps first; the intensities of the segmented nuclei image histogram are adjusted by limiting the range to a certain maxima and minima. The minima and maxima are adjusted to include what is thought to be a pixel intensity belonging to a positive nuclei object. This is used to eliminate noise which could accrue from pixels on the border of the nuclei object that could belong to the background. This can be achieved by adjusting the minima certain intensity level which is thought to be the lowest intensity level of positive nuclei. In this study, the lowest intensity level is thought to be 180. The maximum is set to the highest intensity level of positive nuclei objects and are believed to be 80. The aim of performing this step is to limit the intensity range to only those pixels that identify a positive nuclei object. The maxima and minima in this case were selected based on the analysis of 1000 positive nuclei objects. The second step of the histogram equalization is to normalize the adjusted cumulative histogram from 0 to 255 using the normalize histogram cumulative remapping function. This will stretch the range of the selected intensities over the total intensity scale.

With growing application in science and engineering digital image processing is treated as a rapidly evolving field. In the real world signals do not exist without noise, which arises during image acquisition (digitization) and/or transmission. When images are acquired using a camera, light levels and sensor temperature are major factors affecting the amount of noise.

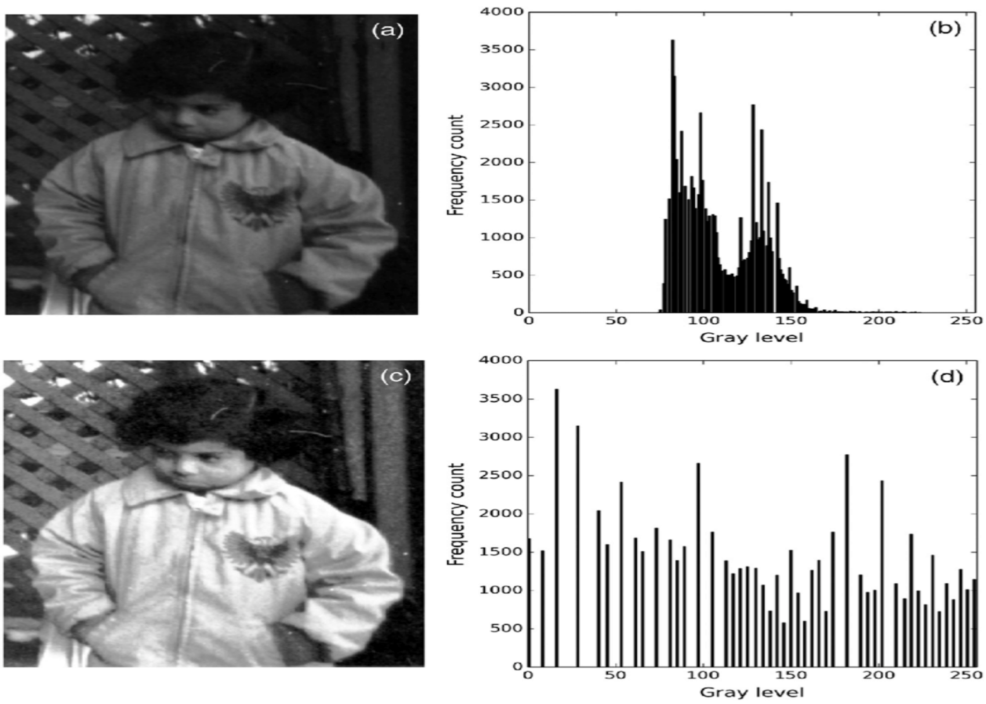


Fig 2.3.1 Histogram Equalization

During transmission, images are corrupted mainly due to interference in the channel used for transmission. Removing noise from images is an important problem in image pr sing. In the early development of image processing, linear filters were the primary tools for image enhancement and restoration. Their mathematical simplicity and the existence of some desirable properties made them easy to design and implement. Moreover, linear filters offered satisfactory performance in many applications. However, they have poor performance in the presence of non additive noise and in situations where system nonlinearities or Gaussian statistics are encountered. In image processing applications, linear filters tend to blur the edges and do not remove Gaussian and mixed Gaussian impulse noise effectively.

Linear noise removal methods are not so effective when transient to stationary wideband components are involved since their spectrum is similar to the spectrum of noise, the basic idea that the energy of a signal will often be concentrated in a few coefficients in transform domain while the energy of noise is spread among all coefficients in transform domain. Therefore, the nonlinear methods will tend to keep a few larger coefficients representing the signal while the noise coefficients will tend to reduce to zero.

Noise removal methods based on multiresolution transforms involves three steps:

A linear forward transform, nonlinear thresholding step and a linear inverse transform.

Wavelets are successful in representing point discontinuities in one dimension, but less successful in two dimensions. As a new multiscale representation suited for edges and other singularity curves, the curve let transform has emerged as a powerful tool. The developing theory of curve lets predict that, in recovering images which are smooth away from edges, curve lets obtain smaller asymptotic mean square error of reconstruction than wavelet methods. In this comparative study, various filtering algorithms are used to fully remove noise from aerial images and to preserve the quality of them. These filtering algorithms have various advantages and disadvantages. Among the different filters, none of them overcome others in respect to computation cost, noise removing and quality of resultant image. As a result, noise removal method can be improved and still is an open research area.

2.4 NOISE:

Noise represents unwanted information which collapses image quality. In the image noise removal process, information about the type of noise present in the original image plays a significant role. Typical images are corrupted with noise modelled with either a Gaussian, uniform, or salt or pepper distribution. Another typical noise is a speckle noise, which is multiplicative in nature. The behaviour of each of these noises is described below.

Gaussian Noise:

Gaussian noise statistical noise that has a probability density function of the normal distribution noise that is also known as Gaussian-distribution. In other words, the values that the noise can take on are Gaussian-distributed. Gaussian noise is properly defined as the noise with a Gaussian amplitude distribution. Noise is modelled as additive white Gaussian noise (AWGN), where all the image pixels deviate from their original values following the Gaussian curve. That is, for each image pixel with intensity value, the corresponding pixel of the noisy image is given by the equation where, each noise value n is drawn from a zero-mean Gaussian distribution.

Salt and Pepper Noise:

Salt and pepper noise is caused by sharp, sudden disturbances in the image signal and its appearance is randomly scattered white or black (or both) pixels over the image. As image containing salt and pepper noise will have dark pixels in bright regions and bright pixels in dark regions. This noise type can be caused by dead pixels, analog to digital verter errors and bit errors in transmission.

Speckle Noise:

Speckle noise affects all inherent characteristics of coherent imaging, including medical ultra sound imaging. It is caused by coherent processing of backscattered signals from multiple distributed targets. Speckle noise is caused by signals from elementary scatters. In medical literature, speckle noise is referred to as texture and may possibly contain useful diagnostic information. For visual interpretation, smoothing the texture may be less desirable. Physicians generally have a preference for the original noisy images, more willingly, than the smoothed versions because the filter, even if they are more sophisticated, can destroy some relevant image details. Thus it is essential to develop noise filters which can preserve the features that are of interest to the physician. Several different methods are to eliminate speckle noise, based upon different mathematical models of the phenomenon. In our work, we recommend hybrid filtering techniques for removing speckle noise in the ultrasound images. Each noise value n is drawn from uniform distribution with mean 0 and variance sigma square.

2.4.1 **<u>Noise Reduction of CT images:</u>**

Noise reduction is a very essential step in digital image processing for getting better quality images. Medical imaging is a valuable tool in the field of medicine .Computer Tomography (CT), Magnetic Resonance Imaging (MRI), Ultra Sound imaging (USI) and other imaging techniques provide more effective information about the anatomy of the human body during the diagnosis process. In the medical field the Surgeons always desired the enhanced medical images for the diagnosis because most of the time the images are not perfect and are deteriorated by many internal and external factors. The low quality of medical images causes difficulty for the Surgeons at the time of diagnosis or interpretation. A quality images is needed by Biometric Identification and Authentication Systems to aim at consistent and exact outcomes which are more useful and they prove to be helpful for to examine the symptoms of the patients. The quality of the MRI and brain image is obtained by the noise free images to get the better result and increased accuracy of the result. Many filters are applied to get the best possible result for the noises present in the image. Weiner filter and Median filter gives the best results compared to the other filters for the Speckle Noise, Gaussian Noise and Poisson noise as well which are present in an image. Some filters work best for specific noises like Salt Pepper, Gaussian, Speckle, Blurred Noise etc.

2.5 **<u>FILTERING:</u>**

Filtering is a method for enhancing or altering an image. There are mainly two types of filtering:

• Spatial Filtering

• Frequency Filtering

In spatial filtering, the processed pixel value for the existing pixel is dependent on both itself and neighbouring pixel.

Smoothing filters are mainly used to reduce noise of an image and for blurring. Blurring is used to remove unimportant information from an image prior to feature extraction, and is used to connect small breaks in curves or lines. Blurring is also used to reduce noise from an image. A smoothing filters also useful for highlighting gross details,

Two types of smoothing spatial filters exist:

• Smoothing Linear Filters

• Order-Statistics Filters

A smoothing linear filter is basically the mean of the neighbourhood pixels of the filter mask. Therefore, this filter is sometimes called “mean filter” or “averaging filter.” The concept entails substituting the value of every single pixel in an image with the mean of the neighbourhood pixels defined by the filter mask. Figure 2.5.1 shows a 3 × 3 standard mean and weight smoothing linear filter:

$$\frac{1}{9}\times\begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix}\qquad\frac{1}{16}\times\begin{bmatrix}1&2&1\\2&4&2\\1&2&1\end{bmatrix}$$

(A) (B)

Fig 2.5.1

(A) Standard mean smoothing linear filter (B) Weighted mean smoothing linear filter.

2.5.1 <u>Median Filtering</u> :

Median filtering a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection of an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise, also having applications in signal processing. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighbouring entries. The pattern of neighbours is called the "window", which slides, entry by entry, over the entire signal. For ID signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median.

To demonstrate, using a window size of three with one entry immediately preceding and following each entry, a median filter will be applied to the following simple ID signal

x = (2, 80, 6, 3)

So, the median filtered output signal will be:

y1 =med(2, 2, 80) = 2.

y2=med(2, 80, 6) = med(2, 6, 80) = 6,

y3=med(80, 6, 3) = med(3, 6, 80) = 6,

y=med(6, 3, 3) = med(3, 3, 6) = 3.

i.e. y= (2, 6, 6, 3).

Median filtering is one kind of smoothing technique, as is linear Gaussian filtering. All smoothing techniques are effective at removing noise in smooth patches or smooth regions of a signal, but adversely affect edges. Often though, at the same time as reducing the noise in a signal, it is important to preserve the edges. Edges are of critical importance to the visual appearance of images, for example. For small to moderate levels of (Gaussian) noise, the median filter is demonstrably better than Gaussian blur at removing noise whilst preserving edges for a given, fixed window size. However, its performance is not that much better than Gaussian blur for high levels of noise, whereas, for speckle noise and salt and pepper noise (impulsive noise), it is particularly effective, Because of this, median filtering is very widely used in digital image processing

Reason for using median filtering:

f (x, y)=median(g(s, t))

Effective for both uni-polar and bipolar impulse noise

CT scan images mainly contain a mixture of salt and pepper noise and Gaussian noise. As the filter efficiently removes salt and pepper noise it is effectively used for our experiment. The advantage of Median filter is to remove outlier without reducing the quality of the image while smoothing compared to other filters.

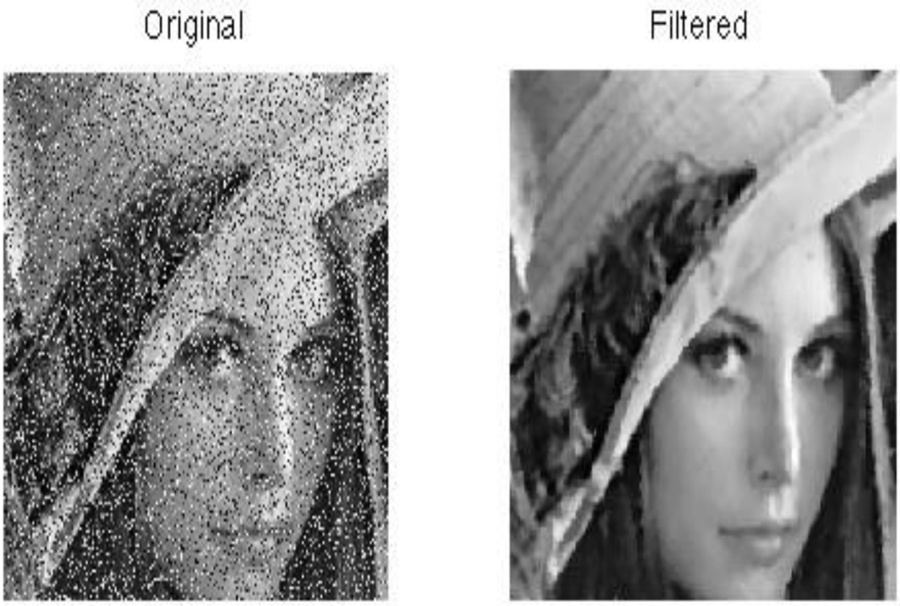


Fig 2.5.1.1 Median Filtered Image

2.6 <u>THRESHOLDING:</u>

Thresholding is a procedure of transforming an input grayscale image into a binarized image, or image with a new range of gray level, by using a particular threshold value. The goal of thresholding is to extract some pixels from the image while removing others. The purpose of thresholding is to mark pixels that belong to foreground pixels with the same intensity and background pixels with different intensities. Threshold is not only related to the image processing field. Rather threshold has the same meaning in any arena. A threshold is basically a value having two set of regions on its either side, that is, above the threshold or below the threshold. Any function can have a threshold value. The function has different expressions for below the threshold value and for above the threshold value. For an image, if the pixel value of the original image is less than or below a particular threshold value it will follow a specific transformation or conversion function, if not, it will follow another.

Threshold can be global or local. Global threshold means the threshold is selected from the whole image. Local or adaptive threshold is used when the image has uneven illumination, which makes it difficult to segment using a single threshold. In that case, the original image is divided into sub-images, and for each sub-image a particular threshold is used for segmentation.

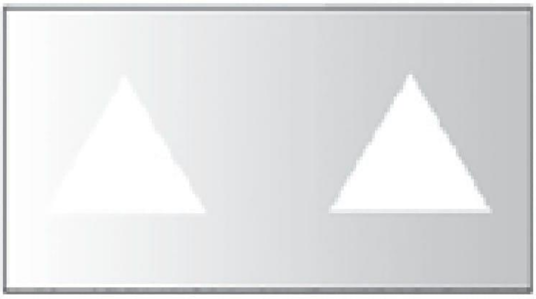


Fig 2.6.1 Input Gray Image

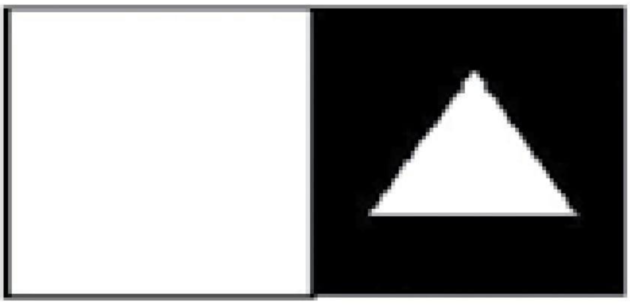


Fig 2.6.2 Global Thresholding

Fig 2.6.3 Global Thresholding

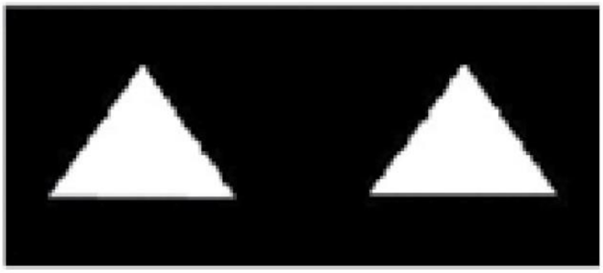


Fig 2.6.4 Local Thresholding

2.6.1 Conversion of Gray Scale Image to Binary Image:

A gray scale (or gray level) image is simply one in which the only colours are shades of gray. The reason for differentiating such images from any other sort of colour image is that less information needs to be provided for each pixel. A gray scale image has a certain number (probably 8) bits of information per pixel, hence, 256 possible grey values. A binary image has only two values for each pixel, 0 and 1 corresponding to black and white (or vice versa).

This conversion is done due to the following advantages

- Easy to acquire: simple digital cameras can be used together with very simple framestores, or low-cost scanners, or thresholding may be applied to grey-level images.
- Low storage: no more than 1 bit/pixel, often this can be reduced as such images are very amenable to compression (e.g. run-length coding).
- Simple processing: the algorithms are in most cases much simpler than those applied to grey-level images.

Fig 2.6.5 Grayscale Image to Binary Image

CHAPTER 3

IMAGE SEGMENTATION

3.1 <u>INTRODUCTION OF SEGMENTATION:</u> Segmentation is defined as the process of dividing an image into regions with similar properties such as gray level, color, texture, brightness, and contrast. In case of medical image segmentation, the aim of segmentation is to study anatomical structure and has an essential role in computer - aided diagnosis systems in different applications. The vast investment and development of medical imaging modalities such as microscopy, Dermos copy, X-ray, ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography attract researchers to implement new medical image - processing algorithms. Image segmentation is considered the most essential medical imaging process as it extracts the region of interest (ROI) through a semiautomatic or automatic process. It divides an image into areas based on a specified description, such as segmenting body organs/tissues in the medical applications for border detection, tumor detection/segmentation, and mass detection.

Because segmentation partitions the image into coherent regions, clustering procedures can be applied for segmentation by extracting the global characteristics of the image to professionally separate the ROI from the background. Clustering has several techniques such as K - means clustering, hierarchical clustering, divisive clustering, and mean shift clustering. Moreover , due to the irregular and fuzzy borders in most of the medical images, fuzzy set and neutrosophic set theories become important in the segmentation process to handle uncertainty in the medical images.

Additionally, for image segmentation, the gradient and intensity information is used. Various segmentation approaches can be used, including those based on boundaries such as the deformable model, while other approaches are region - based methods such as region merging, region growing, and active contour. However, most of the medical images have noise, intensity inhomogeneity, and weak boundaries, which require complex procedures.

Developing intelligent/advanced methods for medical image segmentation has become a hotspot, leading to hybrid approaches for efficient segmentation based on the boundary and ROI by using the information of both boundaries and regions for image segmentation. Such approaches include graph - based methods such as graph cut segmentation, which is iterated to separate the object and background in the image using explicit segmentation’s constraints by choosing seed points representing some pixels from the background.

Segmentation assists doctors to diagnose and make decisions. After segmentation, the defected features have to be extracted through a feature extraction process.

For our project we use morphological operations like erosion, dilation, opening. The flowchart of segmentation used for our project is shown below:

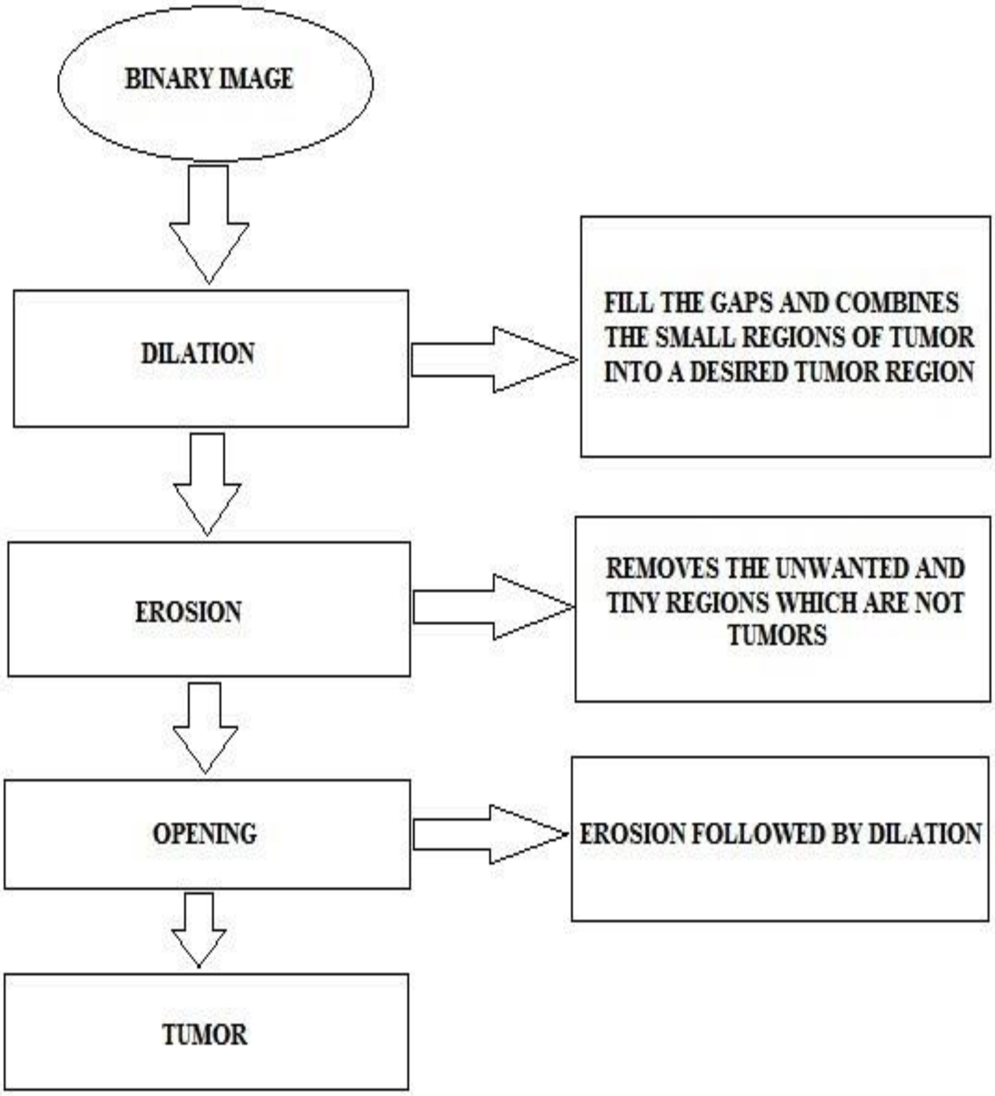


Fig 3.1.1) Flow chart of segmentation proposed in this project

Binary images may contain numerous imperfections. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the image. Morphological image processing is a collection of non - linear operations related to the shape or morphology of features in an image. Morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images.

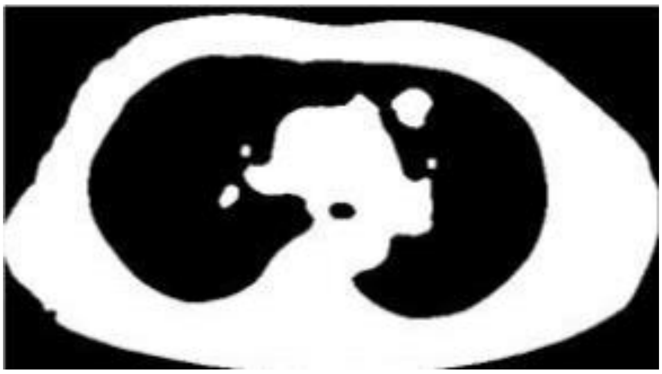


Fig 3.1.2) Binary image

Morphological techniques probe an image with a small shape or template called a **structuring element**. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels. Some operations test whether the element "fits" within the neighborhood, while others test whether it "hits" or intersects the neighborhood:

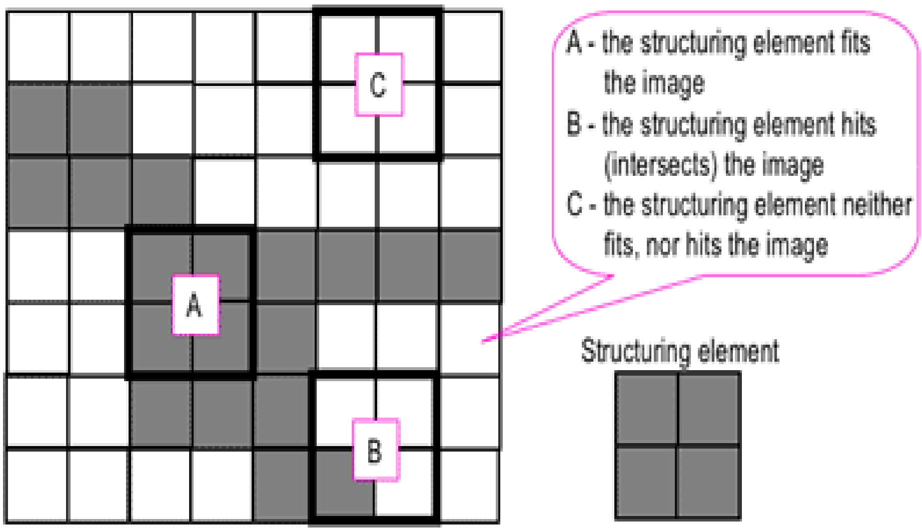


Figure 3.1.3) Structuring element

A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image. The **structuring element** is a small binary image, i.e. a small matrix of pixels, each with a value of zero or one:

- The matrix dimensions specify the *size* of the structuring element.
- The pattern of ones and zeros specifies the *shape* of the structuring element.
- An *origin* of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.

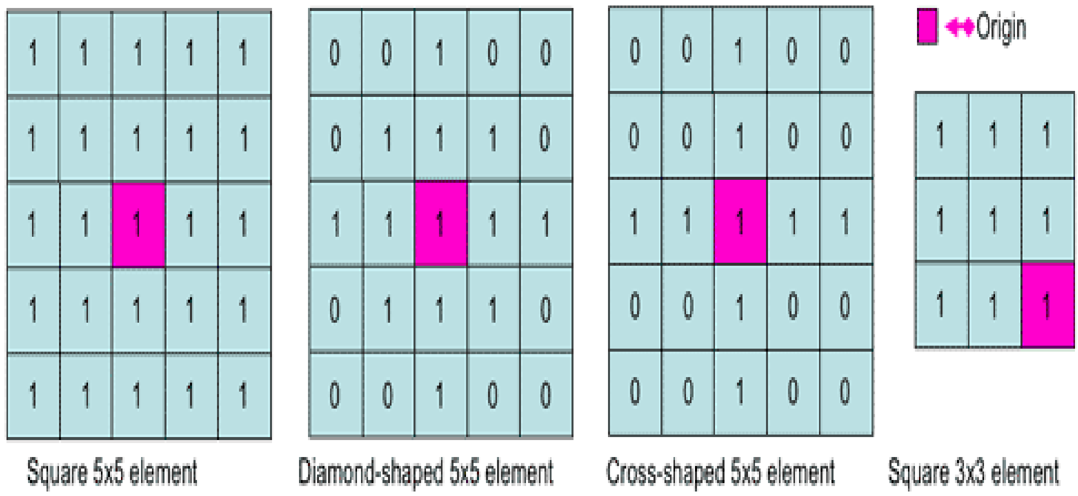
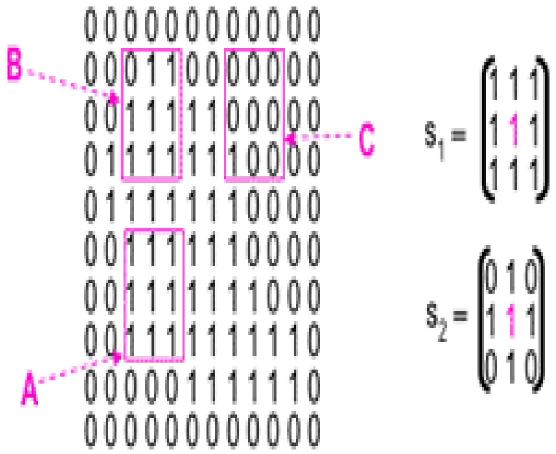


Fig 3.1.4) Types of structuring element

When a structuring element is placed in a binary image, each of its pixels is associated with the corresponding pixel of the neighborhood under the structuring element. The structuring element is said to **fit** the image if, for each of its pixels set to 1, the corresponding image pixel is also 1. Similarly, a structuring element is said to **hit**, or intersect, an image if, at least for one of its pixels set to 1 the corresponding image pixel is also 1.



		A	B	C
fit	s_1	yes	no	no
	s_2	yes	yes	no
hit	s_1	yes	yes	yes
	s_2	yes	yes	no

Fig 3.1.5) Fitting and hitting of a binary image with structuring elements s_1 and s_2.

The fundamental morphological image processing operations are:

- Erosion
- Dilation
- Opening
- Closing

3.2 EROSION AND DILATION:

Dilation	Erosion
It increases the size of the objects.	It decreases the size of the objects.
It fills the holes and broken areas.	It removes the small anomalies.
It connects the areas that are separated by space smaller than structuring element.	It reduces the brightness of the bright objects.
It increases the brightness of the objects.	It removes the objects smaller than the structuring element.
Distributive, duality, translation and decomposition properties are followed.	It also follows the different properties like duality etc.
It is XOR of A and B.	It is dual of dilation.
It is used prior in Closing operation.	It is used later in Closing operation.
It is used later in Opening operation.	It is used prior in Opening operation.

Erosion:

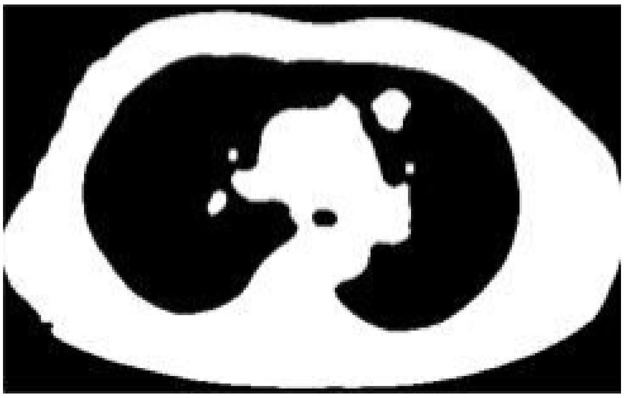


Fig 3.2.1) Erosion image

The erosion of a binary image *f* by a structuring element *s* (denoted $f \ominus s$) produces a new binary image $g = f \ominus s$ with ones in all locations (x,y) of a structuring element's origin at which that structuring element *s* fits the input image *f*, i.e. $g(x,y) = 1$ is *s* fits *f* and 0 otherwise, repeating for all pixel coordinates (x,y).

Erosion with small (e.g. 2×2 - 5×5) square structuring elements shrinks an image by stripping away a layer of pixels from both the inner and outer boundaries of regions. The holes and gaps between different regions become larger, and small details are eliminated:

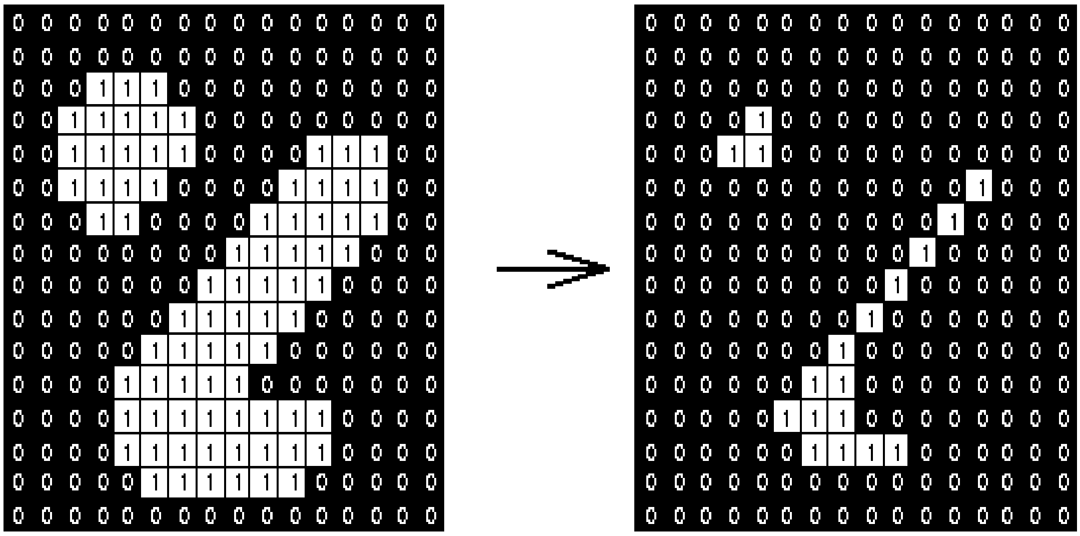


Fig 3.2.2) Erosion: a 3×3 square structuring element

Larger structuring elements have a more pronounced effect, the result of erosion with a large structuring element being similar to the result obtained by iterated erosion using a smaller structuring element of the same shape. If s_1 and s_2 are a pair of structuring elements identical in shape, with s_2 twice the size of s_1, then

$$f \ominus s_2 \approx (f \ominus s_1) \ominus s_1.$$

Erosion removes small-scale details from a binary image but simultaneously reduces the size of regions of interest, too. By subtracting the eroded image from the original image, boundaries of each region can be found:

$$b = f - (f \ominus s)$$

Where *f* is an image of the regions, *s* is a 3×3 structuring element, and *b* is an image of the region boundaries.

The binary erosion of *A* by *B*, denoted $A \ominus B$, is defined as the set operation $A \ominus B = \{z \mid (B_z \subseteq A\}$. In other words, it is the set of pixel locations *z*, where the structuring element translated to location *z* overlaps only with foreground pixels in *A*. imerode automatically takes advantage of the decomposition of a structuring element object. Also, when performing binary erosion with a structuring element object that has a decomposition, imerode automatically uses binary image packing to speed up the erosion.

Dilation:

The dilation of an image *f* by a structuring element *s* (denoted $f \oplus s$) produces a new binary image $g = f \oplus s$ with ones in all locations (*x*,*y*) of a structuring element's origin at which that structuring element *s* hits the the input image *f*, i.e. $g(x,y) = 1$ if *s* hits *f* and 0 otherwise, repeating for all pixel coordinates (*x*,*y*). Dilation has the opposite effect to erosion -- it adds a layer of pixels to both the inner and outer boundaries of regions. The holes enclosed by a single region and gaps between different regions become smaller, and small intrusions into boundaries of a region are filled in:

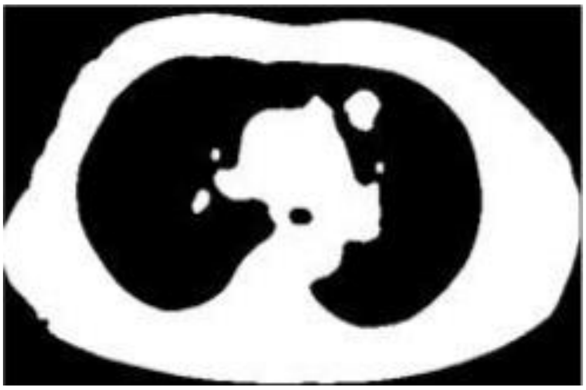


Fig 3.2.3) Dilated image

imdilate performs grayscale dilation for all images except images of data type logical. In this case, the structuring element must be flat and imdilate performs binary dilation. The binary dilation of A by B, denoted A ⊕ B, is defined as the set operation:

$$A \oplus B = \{z \mid (\text{[Equation]})_z \cap A \neq \emptyset\}$$

where *B* is the reflection of the structuring element B. In other words, it is the set of pixel locations z, where the reflected structuring element overlaps with foreground pixels in A when translated to z. Note that some applications use a definition of dilation in which the structuring element is not reflected.

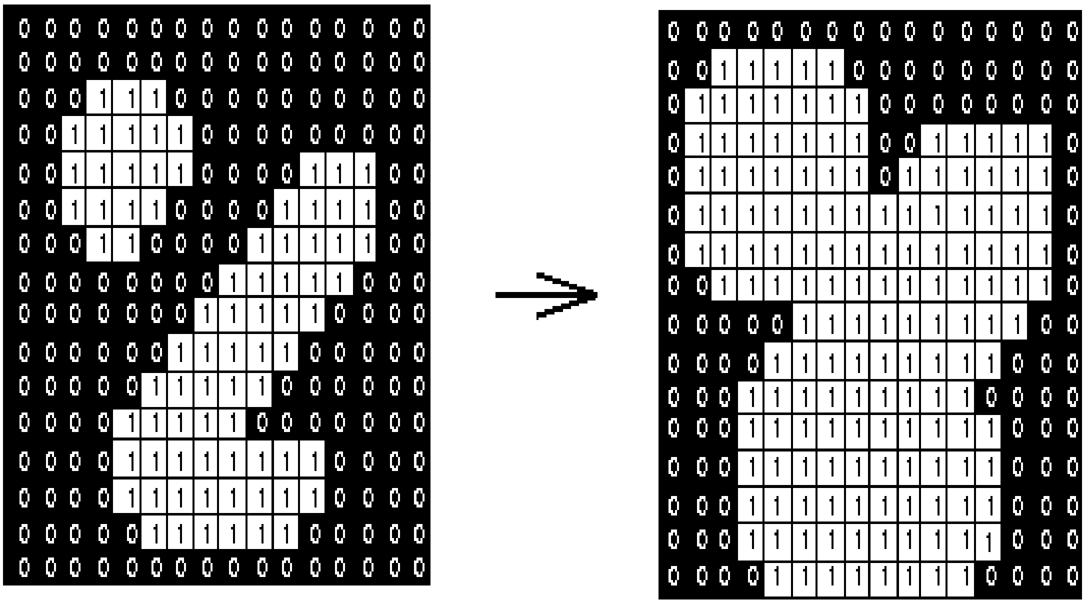


Fig 3.2.4) Dilation: a 3×3 square structuring element

Results of dilation or erosion are influenced both by the size and shape of a structuring element. Dilation and erosion are *dual* operations in that they have opposite effects. Let f^c denote the complement of an image *f*, i.e., the image produced by replacing 1 with 0 and vice versa. Formally, the duality is written as

$$f \oplus s = f^c \ominus s_{rot}$$

Where s_{rot} is the structuring element *s* rotated by [Equation].

If a structuring element is symmetrical with respect to rotation, then s_{rot} does not differ from *s*. If a binary image is considered to be a collection of connected regions of pixels set to 1 on a background of pixels set to 0, then erosion is the fitting of a structuring element to these regions and dilation is the fitting of a structuring element (rotated if necessary) into the background, followed by inversion of the result.

3.3 OPENING AND CLOSING:

Opening	Closing
Opening is a process in which first erosion operation is performed and then dilation operation is performed.	Closing is a process in which first dilation operation is performed and then erosion operation is performed.
Opening operation performed on X & Y is the union of all translations of Y that fit entirely within X.	Closing operation performed on X & Y is the complement of the union of all translations of Y that do not fit entirely within X.

It eliminates the thin protrusions of the obtained image.	It eliminates the small holes from the obtained image.
Opening operation performed on X & Y is represented by (AoB).	Closing operation performed on X & Y is represented by (A.B)
Opening is used for removing internal noise of the obtained image.	Closing is used for smoothening of contour and fusing of narrow breaks.

Opening:

The **opening** of an image *f* by a structuring element *s* (denoted by $f \circ s$) is an erosion followed by a dilation:

$$f \circ s = (f \ominus s) \oplus s$$

Opening is so called because it can open up a gap between objects connected by a thin bridge of pixels. Any regions that have survived the erosion are restored to their original size by the dilation. Opening is an **idempotent** operation: once an image has been opened, subsequent openings with the same structuring element have no further effect on that image:

$$(f \circ s) \circ s) = f \circ s$$

J = imopen(I,SE) performs morphological opening on the grayscale or binary image I, returning the opened image, J. SE is a single structuring element object returned by the strel or offsetstrel functions. The morphological open operation is erosion followed by dilation, using the same structuring element for both operations. The opening operation erodes an image and then dilates the eroded image, using the same structuring element for both operations. Morphological opening is **useful for removing small objects** from an image while preserving the shape and size of larger objects in the image.

Together with closing, the opening serves in computer vision and image processing as a basic workhorse of morphological noise removal. Opening removes small objects from the foreground (usually taken as the bright pixels) of an image, placing them in the background, while closing removes small holes in the foreground, changing small islands of background into foreground. These techniques can also be used to find specific shapes in an image. Opening can be used to find things into which a specific structuring element can fit (edges, corners, ...).

3.4 MASKING:

A mask is a binary image consisting of zero- and non-zero values. If a mask is applied to another binary or to a grayscale image of the same size, all pixels which are zero in the mask are set to zero in the output image. All others remain unchanged.

Masking can be implemented either using pixel multiplication or logical AND, the latter in general being faster.

Masking is often used to restrict a point or arithmetic operator to an area defined by the mask. We can, for example, accomplish this by first masking the desired area in the input image and processing it with the operator, then masking the original input image with the inverted mask to obtain the unprocessed area of the image and finally recombining the two partial images using image addition. An example can be seen in the worksheet on the logical AND operator. In some image processing packages, a mask can directly be defined as an optional input to a point operator, so that automatically the operator is only applied to the pixels defined by the mask .

The binary mask defines a region of interest (ROI) of the original image. Mask pixel values of 1 indicate the image pixel belongs to the ROI. Mask pixel values of 0 indicate the image pixel is part of the background.

Any binary image can be used as a mask, provided that the binary image is the same size as the image being filtered.

3.4.1 Create a Binary Mask from a Grayscale Image:

You can create a mask from a grayscale image by classifying each pixel as belonging to either the region of interest or the background. For example, suppose you want to filter the grayscale image I, filtering only those pixels whose values are greater than 0.5. You can create the appropriate mask with this command:

BW = (I > 0.5)

A mask is a filter. Concept of masking is also known as spatial filtering. Masking is also known as filtering. The process of filtering is also known as convolving a mask with an image. As this process is same of convolution so filter masks are also known as convolution masks.

How it is done

The general process of filtering and applying masks is consists of moving the filter mask from point to point in an image. At each point (x,y) of the original image, the response of a filter is calculated by a pre - defined relationship. All the filters values are pre - defined and are a standard.

Types of filters

Generally there are two types of filters. One is called as linear filters or smoothing filters and others are called as frequency domain filters.

Why filters are used?

Filters are applied on image for multiple purposes. The two most common uses are as following:

- Filters are used for Blurring and noise reduction

- Filters are used or edge detection and sharpness

Blurring and noise reduction

Filters are most commonly used for blurring and for noise reduction. Blurring is used in pre - processing steps, such as removal of small details from an image prior to large object extraction.

Masks for blurring

The common masks for blurring are.

- Box filter
- Weighted average filter

In the process of blurring we reduce the edge content in an image and try to make the transitions between different pixel intensities as smooth as possible. Noise reduction is also possible with the help of blurring.

Edge Detection and sharpness

Masks or filters can also be used for edge detection in an image and to increase sharpness of an image.

Blurring

In blurring, we simple blur an image. An image looks sharper or more detailed if we are able to perceive all the objects and their shapes correctly in it. For example. An image with a face looks clear when we are able to identify eyes, ears, nose, lips, and forehead e.t.c very clear. This shape of an object is due to its edges. So in blurring, we simply reduce the edge content and make the transition form one color to the other very smooth.

Blurring vs zooming

You might have seen a blurred image when you zoom an image. When you zoom an image using pixel replication, and zooming factor is increased, you saw a blurred image.

Because in zooming, you add new pixels to an image, that increase the overall number of pixels in an image, whereas in blurring, the number of pixels of a normal image and a blurred image remains the same.

3.5 <u>TYPES OF FILTERS</u>:

Blurring can be achieved by many ways. The common type of filters that are used to perform blurring are:

Mean filter

Weighted average filter

Gaussian filter

Mean filter

Mean filter is also known as Box filter and average filter. A mean filter has the following properties:

- It must be odd ordered
- The sum of all the elements should be 1
- All the elements should be same

The blurring can be increased by increasing the size of the mask. The more is the size of the mask, the more is the blurring. Because with greater mask , greater number of pixels are catered and one smooth transition is defined.

Weighted average filter

In weighted average filter, we gave more weight to the center value. Due to which the contribution of center becomes more than the rest of the values. Due to weighted average filtering, we can actually control the blurring.

Properties of the weighted average filter are.

- It must be odd ordered
- The sum of all the elements should be 1
- The weight of center element should be more then all of the other elements

What are edges

The sudden changes of discontinuities in an image are called as edges. Significant transitions in an image are called as edges.

3.6 TYPES OF EDGES:

Generally edges are of three types:

- Horizontal edges
- Vertical Edges
- Diagonal Edges

Why detect edges

Most of the shape information of an image is enclosed in edges. So first we detect these edges in an image and by using these filters and then by enhancing those areas of image which contains edges, sharpness of the image will increase and image will become clearer.

3.6.1 <u>Masks for edges detection:</u>

Here are some of the masks for edge detection that we will discuss in the upcoming tutorials.

- Prewitt Operator
- Sobel Operator
- Robinson Compass Masks
- Krisch Compass Masks
- Laplacian Operator.

Above mentioned all, the filters are Linear filters or smoothing filters.

Prewitt Operator

Prewitt operator is used for detecting edges horizontally and vertically.

Sobel Operator

The sobel operator is very similar to Prewitt operator. It is also a derivate mask and is used for edge detection. It also calculates edges in both horizontal and vertical direction.

Robinson Compass Masks

This operator is also known as direction mask. In this operator we take one mask and rotate it in all the 8 compass major directions to calculate edges of each direction.

Kirsch Compass Masks

Kirsch Compass Mask is also a derivative mask which is used for finding edges. Kirsch mask is also used for calculating edges in all the directions.

Laplacian Operator

Laplacian Operator is also a derivative operator which is used to find edges in an image. Laplacian is a second order derivative mask. It can be further divided into positive laplacian and negative laplacian.

All these masks find edges. Some find horizontally and vertically, some find in one direction only and some find in all the directions. The next concept that comes after this is sharpening which can be done once the edges are extracted from the image

Sharpening

Sharpening is opposite to the blurring. In blurring, we reduce the edge content and in Sharpening, we increase the edge content. So in order to increase the edge content in an image, we have to find edges first.

Edges can be finding by one of the any method described above by using any operator. After finding edges, we will add those edges on an image and thus the image would have more edges, and it would look sharpen. This is one way of sharpening an image.

CHAPTER 4
FEATURE EXTRACTION

4.1 WHAT IS FEATURE EXTRACTION :

Feature extraction is a part of the dimensionality reduction process, in which, an initial set of the raw data is divided and reduced to more manageable groups. So when you want to process it will be easier. The most important characteristic of these large data sets is that they have a large number of variables. These variables require a lot of computing resources to process them. So Feature extraction helps to get the best feature from those big data sets by select and combine variables into features, thus, effectively reducing the amount of data. These features are easy to process, but still able to describe the actual data set with the accuracy and originality.

The ultimate objective of feature extraction is to take out required features from the target image. In this boundary tracing followed by labeling the number of tumors and then using region props, extracting regional properties or parameters like area, perimeter, centroid, eccentricity and diameter results are obtained and based on a single parameter value i.e., the radius of the tumor, the stage of the cancer is decided. Table I shows the parameters that were deduced from the extraction step. Table II shows the principle which was determined by the medical field radiologists and doctors for differentiating cancer stages based on the radius value (R) of the tumor.

Feature extraction increases the accuracy of learned models by extracting features from the input data. This phase of the general framework reduces the dimensionality of data by removing the redundant data. Of course, it increases training and inference speed. The methods of feature extraction obtain new generated features by doing the combinations and transformations of the original feature set . The type of features that can be extracted from the medical images is color, shape, texture or due to the pixel value. Some of the medical images, such as X-ray images, do not contain any color information and have few objects. However, the texture and shape feature extraction techniques are very suitable. The examples of the texture feature extraction techniques are gray level co occurrence matrices and LBP. On the other hand, the examples of the shape feature extraction techniques are the canny edge and Laplacian operators.

Detecting the interesting key points and areas in the medical image by a bag of words technique is very important in feature extraction phase. This technique uses the difference of Gaussians and SIFT detector. The former is constant to translation, scale, rotation, and lightness changes. It samples images at different locations and scales. The second detects the regions around each key point.

Principal component analysis and linear discriminant analysis are two famous for feature extraction. They are single-label automatic methods for classification of data. They can be used as dimensionality reduction. It is very important to concentrate on the methods that work efficiently with multi label datasets. In multi label datasets, linear discriminate analysis is designed based on the label correlations. On the other hand, hierarchy of multi label classifiers is a multi label method. It is specifically designed for extracting features in large datasets

Feature extraction describes the relevant shape information contained in a pattern so that the task of classifying the pattern is made easy by a formal procedure. In pattern recognition and in image processing, feature extraction is a special form of dimensionality reduction. The main goal of feature extraction is to obtain the most relevant information from the original data and represent that information in a lower dimensionality space. When the input data to an algorithm is too large to be processed and it is suspected to be redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input Pattern recognition is an emerging field of research in the area of image processing.

It has been used in many applications such as character recognition, document verification, reading bank deposit slips, extracting information from cheques, applications for credit cards, health insurance, loan, tax forms, data entry, postal address reading, check sorting, tax reading, script recognition etc. Character recognition is also applicable in newly emerging areas, such as development of electronic libraries, multimedia database, and systems which require handwriting data entry. In the late 60's, these systems were still very expensive, and therefore could only be used by large companies and government agencies. Today, pattern recognition systems are less expensive. Several research works have been done to evolve newer techniques and methods that would reduce the processing time while providing higher recognition accuracy. The widely used feature extraction methods are Template matching, Deformable templates, Unitary Image transforms, Graph description, Projection Histograms, Contour profiles, Zoning, Geometric moment invariants, Zernike Moments, Spline curve approximation, Fourier descriptors, Gradient feature and Gabor features. As an example, OCR is the process of converting scanned images of machine printed or handwritten text into a computer process able format. The process of optical character recognition has following three stages: Preprocessing, Feature extraction, Classification.

Feature extraction is done after the preprocessing phase in character recognition system. The primary task of pattern recognition is to take an input pattern and correctly assign it as one of the possible output classes.

This process can be divided into two general stages: Feature selection and Classification. Feature selection is critical to the whole process since the classifier will not be able to recognize from poorly selected features. Criteria to choose features given by Lippmann are: "Features should contain information required to distinguish between classes, be insensitive to irrelevant variability in the input, and also be limited in number, to permit, efficient computation of discriminant functions and to limit the amount of training data required" Feature extraction is an important step in the construction of any pattern classification and aims at the extraction of the relevant information that characterizes each class. In this process relevant features are extracted from objects/ alphabets to form feature vectors. These feature vectors are then used by classifiers to recognize the input unit with target output unit. It becomes easier for the classifier to classify between different classes by looking at these features as it allows fairly easy to distinguish. Feature extraction is the process to retrieve the most important data from the raw data. Feature extraction is finding the set of parameter that define the shape of a character precisely and uniquely. In feature extraction phase, each character is represented by a feature vector, which becomes its identity. The major goal of feature extraction is to extract a set of features, which maximizes the recognition rate with the least amount of elements and to generate similar feature set for variety of instance of the same symbol. The widely used feature extraction methods are Template matching, Deformable templates , Unitary Image transforms, Graph description, Projection

Histograms, Contour profiles, Zoning, Geometric moment invariants, Zernike Moments, Spline curve approximation, Fourier descriptors, Gradient feature and Gabor features.

4.2 WHY FEATURE EXTRACTION IS USEFUL?

The technique of extracting the features is useful when you have a large data set and need to reduce the number of resources without losing any important or relevant information. Feature extraction helps to reduce the amount of redundant data from the data set.

In the end, the reduction of the data helps to build the model with less machine's efforts and also increase the speed of learning and generalization steps in the machine learning process.

The process of feature extraction is useful when you need to reduce the number of resources needed for processing without losing important or relevant information. Feature extraction can also reduce the amount of redundant data for a given analysis.

Also, the reduction of the data and the machine's efforts in building variable combinations (features) facilitate the speed of learning and generalization steps in the machine learning process.

When the pre-processing and the desired level of segmentation (line, word, character or symbol) has been achieved, some feature extraction technique is applied to the segments to obtain features, which is followed by application of classification and post processing techniques. It is essential to focus on the feature extraction phase as it has an observable impact on the efficiency of the recognition system. Feature selection of a feature extraction method is the single most important factor in achieving high recognition performance. Feature extraction has been given as "extracting from the raw data information that is most suitable for classification purposes, while minimizing the within class pattern variability and enhancing the between class pattern variability". Thus, selection of a suitable feature extraction technique according to the input to be applied needs to be done with utmost care. Taking into consideration all these factors, it becomes essential to look at the various available techniques for feature extraction in a given domain, covering vast possibilities of cases.

4.3 APPLICATIONS OF FEATURE EXTRACTION :

Bag of Words- Bag-of-Words is the most used technique for natural language processing. In this process they extract the words or the features from a sentence, document, website, etc. and then they classify them into the frequency of use. So in this whole process feature extraction is one of the most important parts.

Image Processing –Image processing is one of the best and most interesting domains. In this domain basically you will start playing with your images in order to understand them. So here we use many many techniques which includes feature extraction as well and algorithms to detect features such as shaped, edges, or motion in a digital image or video to process them.

Auto-encoders: The main purpose of the auto-encoders is efficient data coding which is unsupervised in nature. This process comes under unsupervised learning. So Feature extraction procedure is applicable here to identify the key features from the data to code by learning from the coding of the original data set to derive new ones.

How to Store Images in the Machine?

So in this section, we will start with from scratch. For the first thing, we need to understand how a machine can read and store images. Loading the image, read them and then process them through the machine is difficult because the machine does not have eyes like us. Let's have a look at how a machine understands an image.

Machines see any images in the form of a matrix of numbers. The size of this matrix actually depends on the number of pixels of the input image.

4.4 WHAT IS PIXEL?

The Pixel Values for each of the pixels stands for or describe how bright that pixel is, and what color it should be. So In the simplest case of the binary images, the pixel value is a 1-bit number indicating either foreground or background.

So pixels are the numbers, or the pixel values which denote the intensity or brightness of the pixel.

Smaller numbers which is closer to zero helps to represent black, and the larger numbers which are closer to 255 denote white.

So this is the concept of pixels and how machine sees the images without eyes through the numbers.

The dimensions of the image 28 x 28. And if you want to check then by counting the number of pixels you can verify.

But, for the case of a colored image, we have three Matrices or the channels

Red,

Green

And Blue.

So in these three matrices, each of the matrix has values between 0-255 which represents the intensity of the color of that pixel.

If you have a colored image like the dog image we have in the above image on the left. so being a human you have eyes so you can see and can say it is a dog colored image. But how computer can understand it is colored or black and white image?

So you can see we also have a three matrices which represents the channel of RGB – (for the three color channels – Red, Green, and Blue) On the right, we have three matrices. These three channels are superimposed and used to form a colored image.

So this is how a computer can differentiate between the images.

4.5 REGIONPROPS:

Measure properties of image regions

Syntax: STATS = regionprops(L,properties)

Description:

STATS = regionprops(L,properties) measures a set of properties for each labeled region in the label matrix L. Positive integer elements of L correspond to different regions. For example, the set of elements of L equal to 1 corresponds to region 1; the set of elements of L equal to 2 corresponds to region 2; and so on. The return value STATS is a structure array of length max(L(:)). The fields of the structure array denote different measurements for each region, as specified by properties.

Properties can be a comma-separated list of strings, a cell array containing strings, the single string 'all', or the string 'basic'. This table lists the set of valid property strings. Property strings are case insensitive and can be abbreviated.

If properties are the string 'all', then all the preceding measurements are computed. If properties is not specified or if it is the string 'basic', then these measurements are computed: 'Area', 'Centroid', and 'BoundingBox'.

4.5.1 Definitions related to region props:

'**Area**' -- Scalar; the actual number of pixels in the region. (This value might differ slightly from the value returned by bwarea, which weights different patterns of pixels differently.)

'**BoundingBox**'-- 1-by-ndims(L)*2 vector; the smallest rectangle containing the region. BoundingBox is [ul_corner width], where ul_corner is in the form [x y z ...] and specifies the upper left corner of the bounding box width is in the form [x_width y_width ...] and specifies the width of the bounding box along each dimension

'**Centroid**'-- 1-by-ndims(L) vector; the center of mass of the region. Note that the first element of Centroid is the horizontal coordinate (or x-coordinate) of the center of mass, and the second element is the vertical coordinate (or y-coordinate). All other elements of Centroid are in order of dimension.

This figure illustrates the centroid and bounding box. The region consists of the white pixels; the green box is the bounding box, and the red dot is the centroid.

'**ConvexHull**' -- p-by-2 matrix; the smallest convex polygon that can contain the region. Each row of the matrix contains the x- and y-coordinates of one vertex of the polygon. This property is supported only for 2-D input label matrices.

'**ConvexImage**' -- Binary image (logical); the convex hull, with all pixels within the hull filled in (i.e., set to on). (For pixels that the boundary of the hull passes through, regionprops uses the same logic as roipoly to determine whether the pixel is inside or outside the hull.) The image is the size of the bounding box of the region. This property is supported only for 2-D input label matrices.

'**ConvexArea**' -- Scalar; the number of pixels in 'ConvexImage'. This property is supported only for 2-D input label matrices.

'**Eccentricity**' -- Scalar; the eccentricity of the ellipse that has the same second-moments as the region. The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. The value is between 0 and 1. (0 and 1 are degenerate cases; an ellipse whose eccentricity is 0 is actually a circle, while an ellipse whose eccentricity is 1 is a line segment.) This property is supported only for 2-D input label matrices.

'**EquivDimeter**' -- Scalar; the diameter of a circle with the same area as the region. Computed as sqrt(4*Area/pi). This property is supported only for 2-D input label matrices.

'**EulerNumber**' - Scalar; equal to the number of objects in the region minus the number of holes in those objects. This property is supported only for 2-D input label matrices.

'**Extent**' -- Scalar; the proportion of the pixels in the bounding box that are also in the region. Computed as the area divided by the area of the bounding box. This property is supported only for 2-D input label matrices.

'**Extrema**' -- 8-by-2 matrix; the extrema points in the region. Each row of the matrix contains the x- and y-coordinates of one of the points. The format of the vector is [top-left top-right right-top right-bottom bottom-right bottom-left left-bottom left-top]. This property is supported only for 2-D input label matrices.This figure illustrates the extrema of two different regions. In the region on the left, each extrema point is distinct; in the region on the right, certain extrema points (e.g., top-left and left-top) are identical.

'**FilledArea**' -- Scalar; the number of on pixels in FilledImage.

'**FilledImage**' -- Binary image (logical) of the same size as the bounding box of the region. The on pixels correspond to the region, with all holes filled in.

'**Image**' -- Binary image (logical) of the same size as the bounding box of the region; the on pixels correspond to the region, and all other pixels are off.

'**MajorAxisLength**'-- Scalar; the length (in pixels) of the major axis of the ellipse that has the same normalized second central moments as the region. This property is supported only for 2-D input label matrices.

'**MinorAxisLength**' -- Scalar; the length (in pixels) of the minor axis of the ellipse that has the same normalized second central moments as the region. This property is supported only for 2-D input label matrices.

'**Orientation**' -- Scalar; the angle (in degrees) between the x-axis and the major axis of the ellipse that has the same second-moments as the region. This property is supported only for 2-D input label matrices.

This figure illustrates the axes and orientation of the ellipse. The left side of the figure shows an image region and its corresponding ellipse. The right side shows the same ellipse, with features indicated graphically; the solid blue lines are the axes, the red dots are the foci, and the orientation is the angle between the horizontal dotted line and the major axis.

'**perimeter**' -- p-element vector containing the total number of pixels around the boundary of each region in the image, where p is the number of regions. The following figure shows the pixels included in the perimeter calculation for this object. The regions must be contiguous. If the image contains discontiguous regions, perimeter returns unexpected results.

'**PixelIdxList**' -- p-element vector containing the linear indices of the pixels in the region.

'**PixelList**' -- p-by-ndims(L) matrix; the actual pixels in the region. Each row of the matrix has the form [x y z ...] and specifies the coordinates of one pixel in the region.

'**Solidity**' -- Scalar; the proportion of the pixels in the convex hull that are also in the region. Computed as Area/ConvexArea. This property is supported only for 2-D input label matrices.

The comma-separated list syntax for structure arrays is very useful when working with the output of regionprops. For example, for a field that contains a scalar, you can use a this syntax to create a vector containing the value of this field for each region in the image.

For instance, if stats is a structure array with field Area, then the following two expressions are equivalent stats(1).Area, stats(2).Area, ..., stats(end).Area and stats.Area

Therefore, you can use these calls to create a vector containing the area of each region in the image.

stats = regionprops(L,'Area');

allArea = [stats.Area];

allArea is a vector of the same length as the structure array stats.The function ismember is useful in conjunction with regionprops for selecting regions based on certain criteria. For example, these commands create a binary image containing only the regions in text.tif whose area is greater than 80.

idx = find([stats.Area] > 80);

BW2 = ismember(L,idx);

4.6 NUMBER OF REGIONS IN L:

Most of the measurements take very little time to compute. The exceptions are these, which may take significantly longer, depending on the number of regions in L:

4 regions:

'ConvexHull'

'ConvexImage'

'ConvexArea'

'FilledImage'

Note that computing certain groups of measurements takes about the same amount of time as computing just one of them because regionprops takes advantage of intermediate computations used in both computations. Therefore, it is fastest to compute all of the desired measurements in a single call to regionprops.

CHAPTER 5
CLASSIFICATION

5.1 TUMOR DESCRIPTION:

Tumour can be benign, pre-malignant, or malignant, and caused by several different factors. Malignant ones are cancerous, while benign are not.

Fig 5.1.1) Smoking increases the chance of developing a tumour.

When cells are formed, they have the ability to differentiate. When cells begin splitting in a mother's womb, they program themselves for specific jobs. Some become heart cells; some become the **brain**, and so forth, until the body is fully formed. Cells also have the ability to self-regulate. When new cells are needed, they know how to produce more and to stop when no more cells are needed.

When cells continue to be created, this can cause tumours. Tumour cells cannot differentiate or self-regulate, but continue to grow until they are discovered. Tumours begin to apply pressure to surrounding body parts and nerves, causing health problems. This is especially true of those in the brain.

Fig 5.1.2) Inheritance may also cause Lung cancer

No one is sure exactly what causes tumours to begin growing. There are, however, several things that can increase a person’s risk of developing one. Some of these risk factors are environmental. Exposure to radiation or toxic substances can increase the risk, as can sun damage. There are several behavioural risk factors for tumours’. Smoking, alcohol, and drug are all risky behaviours that increase the chance of developing them. An inactive lifestyle and obesity are also risk factors. There are also several foods that may cause tumours. These include artificial sweeteners, grilled foods, sugar (in large quantities), hydrogenated oils, and processed foods. Some causes are inherited. A strong family history of tumours increases the chance that a person from that family will develop a tumour. The location where they develop is also thought to have a genetic basis in some people. For example, if your mother, grandmother, and sister all had **breast cancer**, there is a very good chance that you will develop breast cancer as well. There are no definite ways to prevent all types of tumours. However, a little prevention can reduce the risk in drastic ways. Exercising and eating a well-balanced diet are two of the best ways to reduce the risk. Avoiding tanning booths and sun damage can also help to prevent their formation. Eating a lot of fruits and vegetables, which contain **antioxidants**, are another great way to prevent tumours.

The rate of people killed by cancer increases each year. By being aware of what can increase a persons risk for developing tumours, it may be possible to reverse this trend. While the reason they form is not known, knowing how to decrease the chances of developing one is one of the best health moves a person can make.

5.2 RADIUS OF TUMOR:

RADIUS DEFINITION (In general)

A straight line extending from the centre of a circle or sphere to the circumference or surface: **The radius of a circle is half the diameter.**

In particular to the image processing, in this project, we used region props command which measures a variety of image quantities and features in a black and white image. In the same way, we computed diameter of the detected tumours and from that extracted radius of tumour which is half of the diameter value.

Apart from using region props, we can use formulas also for extracting the features and classifying the stage of cancer, but as per the medical standard table is based on radius, we used radius value of the tumour for classifying the stage of cancer.

5.3 STAGES OF CANCER CLASSIFICATION:

Table I shows the parameters that were deduced from the extraction step. Table II shows the principle which was determined by the medical field radiologists and doctors for differentiating cancer stages based on the radius value (R) of the tumor .

Table 1.) Parameters obtained

REGION	AREA	PERIMETER	CENTROID	DIAMETER	ECCENTRICITY
1	144.0	42.9	137.6 143.5	13.5	0.8
2	521.0	81.8	249.2 76.6	25.8	0.6

Table 2.) Cancer stages classification based on radius value (R).

STAGE OF CANCER	REQUIREMENT
I	R < 3 cm
II	3cm < R < 7cm
III	R > 7cm
IV	R > 10 and above

CHAPTER 6
RESULTS AND CONCLUSIONS

6.1 <u>EXPERIMENTAL RESULTS:</u>

As stated in the preceding section, based on the stages of cancer data, various stages are determined for the tumor according to the radius value of the tumor. “Fig. 6.1” shows cancerous lungs CT scan image which was collected from Cancer Imaging Archive (CIA) database. The various experiments/processes proposed in the above sections for the lung cancer detection were implemented using MATLAB, which is necessary and suitable for better classification of the stage of cancer and accuracy in the process of prediction using segmentation and feature extraction. “Fig. 6.2 and 6.3” illustrates the preprocessing output results and “Fig. 6.4,6.5,6.6,6.7” shows the segmentation results and extraction of desired regions. “Fig. 6.8” exhibits numbering for the tumors detected and “Fig. 6.9” reveals the classification for the exact tumors detected.

The accuracy of the proposed model to detect the lung cancer stage is highlighted based on these results shown under.

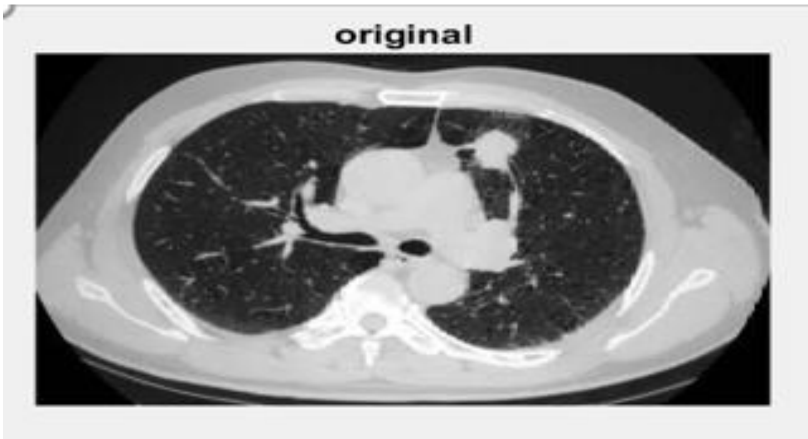


Fig 6.1) Lung cancerous CT scan image

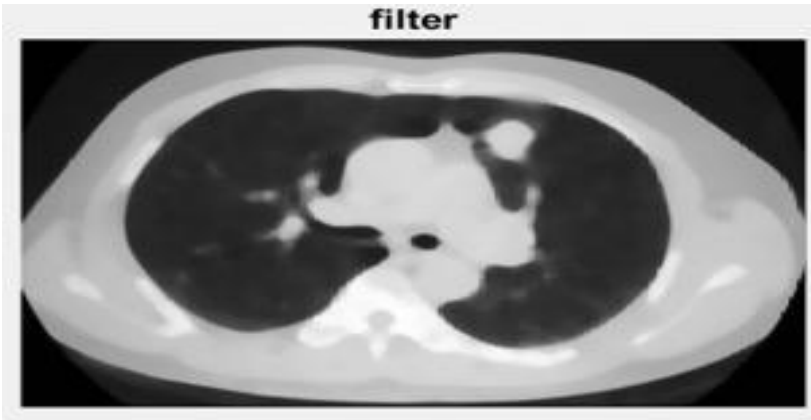


Fig 6.2) Noise removal using the median filter

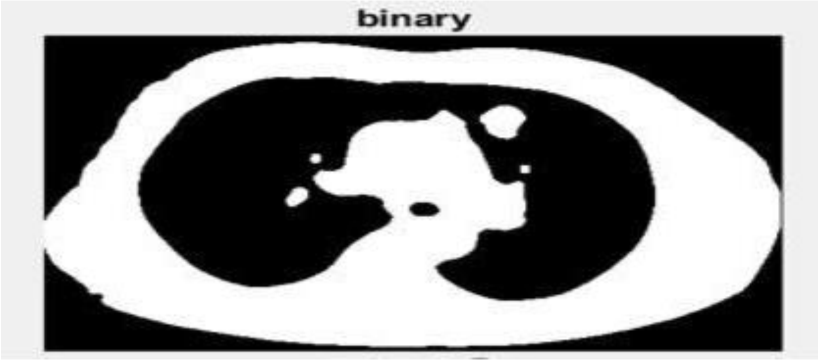


Fig 6.3) Gray to binary converted image

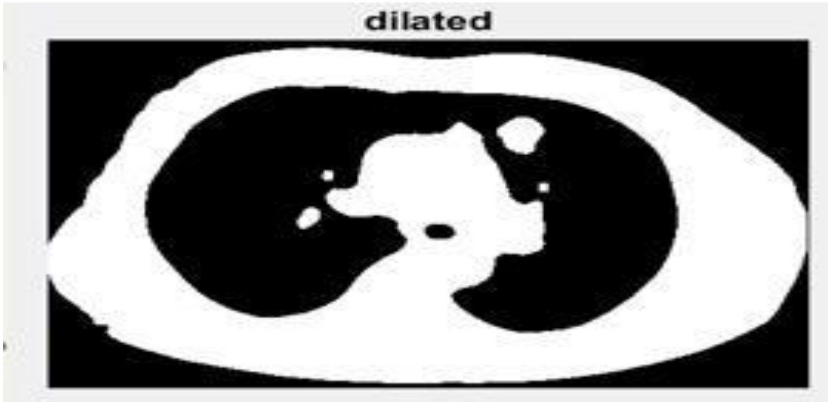


Fig 6.4) Dilated image

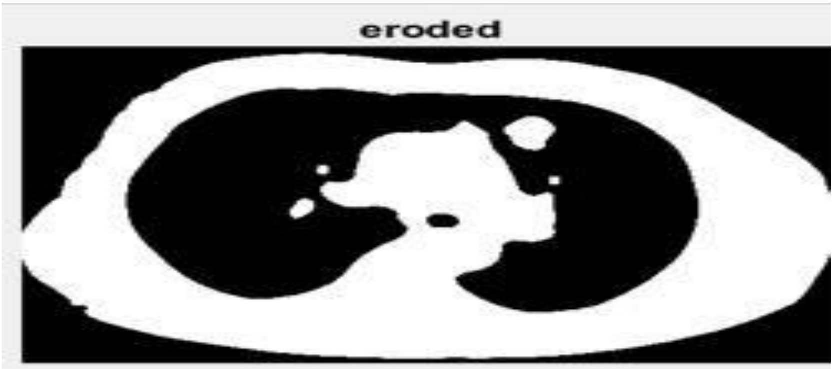


Fig 6.5) Eroded image

Fig 6.6) Big mask image

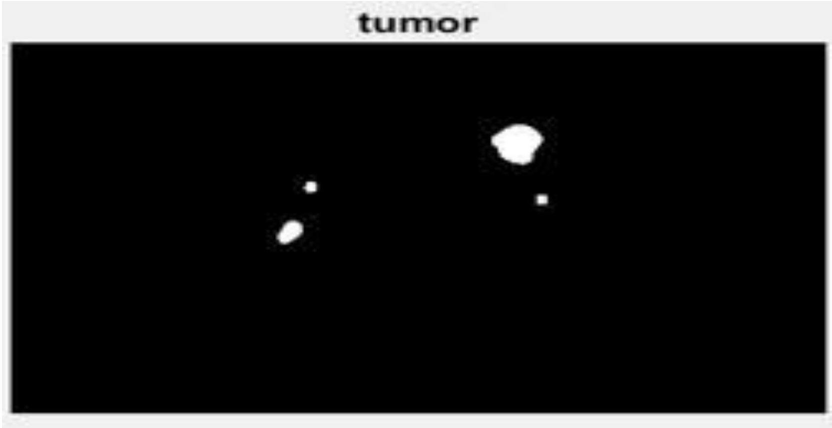


Fig 6.7) Tumors or small lump of less sized cancer cells

Fig 6.8) Outlines and numbering of tumors

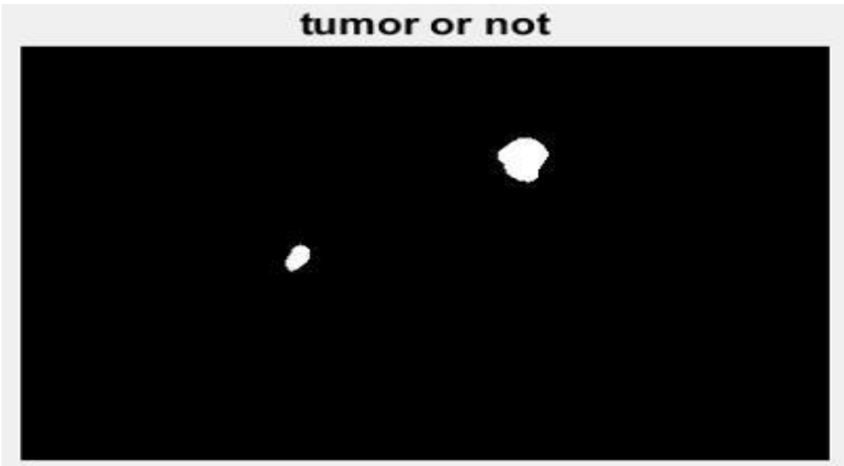


Fig 6.9) Showing exact tumors

6.2 CONCLUSION:

The study carried out in this project entirely is about predicting the stage of cancer-based on any one of the four features extracted. From the results obtained it is observed that using the eccentricity value of the tumor part, the exact tumors are separated. The stages of cancer are classified based on the radius value of the tumor (radius value extracted from the diameter). According to the cancer stages classification table prescribed by the medical standards as mentioned above. A total of five features were extracted in this paper like area, perimeter, diameter, eccentricity, and centroid. Based on these outcomes, the result is an exact finding of cancer stage with accuracy. The motivation behind lung cancer identification is to help the radiologist and doctors to take an exact decision regarding the cancer stage instantly and this methodology can be used to prevent wrong predictions. The future scope could be to work on improving efficiency in diagnosis and prediction of the stage of cancer by any person simply by seeing CT scan report or without any assistance of doctors or radiologists.

6.3 FUTURE SCOPE:

We are aiming to get the more accurate results by using various enhancement and segmentation technique, different segmentation strategies and calculations are the root idea of digital image processing the more accurate result will be more helpful and good for the diagnosis solution and the person can have more chances of survival from this dangerous disease. Future scope could be we can also develop the system as a real time system which means the system will work at the time of diagnosis as well as with the time when we take the computed tomography (CT) images, the advantage of the real time system will be that it helps the person to cure the disease as soon as possible and provides a help for early treatment so the survival chance can be increase. In future by parameter and area calculation of the tumour at the time of detection we can also find that tumour has been in which stage much more accurately.

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Detecting stage of lung cancer based on tumor size - By using segmentation and feature extraction in medical image processing

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Abstract

Cancer is an extensive global and universal disease nowadays which pretends to be the utmost cause for a large impermanence rate among men and women every era. Approximately 80-85% of the people who get affected by cancer are being succumbed to death. Recognition of cancer at the first stage is the only aspect in front of us to give proper treatment. Among numerous types of cancers, lung cancer is a very fearful and complicated one. Lung cancer means the growth of tumor cells briskly and having chances of spreading those cancer cells to other organs which in turn damaging other normal tissue cells of the body. Noticing tumor prematurely can help to cure the disease completely and it becomes pivotal to find out whether the tumor has been changed to cancer or not, if the prognostication is made at an initial stage, then countless lives that are at risk could be rescued and accurate prediction can help the doctors to start their treatment at the earliest. In this paper, we have proposed a simple, easy, and precise method for accurate prediction of the stage of cancer using CT images of the lungs in Image processing. For this process, a CT image will be considered, and then the image will be pre-processed for noise removal. Further segmentation is done to identify and separate desired tumor nodule and extraction of morphological features such as area, perimeter, eccentricity, and diameter is carried out under feature extraction. Finally, the classification of lung cancer into different stages based on the size of tumor results has been proposed using MATLAB which is more accurate and less time-consuming when compared to other lung cancer prediction systems. The method proposed in this paper to detect a tumor in the lungs is simpler when compared to applying other difficult algorithms.

Keywords **- Lung cancer, Impermanence, pivotal, briskly, prognostication.**

I. INTRODUCTION

Cancer is defined as a group of cells in the human body growing uncontrollably in a massive number leading to the development of tumors. There is a myth that cigarette is the main cause to evolve lung cancer. But the truth is all smokers may not have lung cancer and not all people having lung cancer smoke. Lung cancer may cause due to air pollution, inheritance where family background may have lung cancer, exposure to any harmful radiation gases, carcinogens, and of course smoking also[8]. Cancer cells from the breast, kidney, or any other organs can be carried away in the blood or the lymph fluid to the lungs. Suppose if cancer cells from the breast spread to the lungs, it is metastatic breast cancer, not complete lung cancer, but the lungs also get affected here. In this way, lung cancer can be caused due to numerous reasons.

Lung cancer varies differently from person to person, depending on the size of the tumor and the stage it is in. Stage I is considered as when the cancer is restricted to the lung[1]. Stage II is when the cancer is limited to the chest[1]. Stage III is when the tumor grows larger and appears in the CT scan. Stage IV is confined to spreading cancer cells to other parts of the body and growth of tumors in other parts as well[1]. Analyzing CT scan images of lungs and predicting the stage of cancer based on tumor requires a high level of skill and concentration, and is possible only by expert doctors or radiologists. CT stands for computerized tomography where the passing of X-rays inside the human body takes place. There are many other image processing methods and techniques such as MRI, Ultrasound, DEXA, X-ray, and PET, but CT scan is best recommended because of three main reasons[9]. One is due to CT scans can completely examine not only bones as like X-ray does but also soft organs like lung tissues. The second one is CT scanning is painless, cost-effective, accurate, fast, simple, less sensitive to patient movement, and X-rays used in standard CT scans have no immediate side effects. The third reason is Computed tomography (CT) images have better clarity, low noise, and distortion[1]. Thus, CT scan images are preferred in this paper and taken as input. CT scan images are downloaded from the Internet from the Cancer Imaging Archive database[1]. Here one CT image having tumor regions is taken in this paper. In the same way, any CT image can be taken and can be tested. As medical images may have noise, the CT image is passed to the second step, i.e., pre-processing where the median filter is used in this paper for the elimination of noise [8]. Then conversion of an image into binary followed by segmentation is done where CT image is partitioned into some sets of pixels and obtaining of tumor (white) region pixels i.e., extraction of the required and interested region (which are the white regional pixels in different places present in the lungs, eliminating the other part of the lung which is not affected takes place). By the end of this step, just some white pixel areas/regions grouped will be separated which particularly means that final declaration of whether it is a tumor or still few cancer cells grouped in less number which not yet developed into the tumor (that means the cancer cells size still less than tumor size) cannot be predicted. But, after segmentation, for analyzing CT scan images, it became simpler and complexity was reduced. Various simple segmentation techniques such as morphological operations like dilation, erosion, opening to apply big mask were used in this paper[2]. The last step is feature extraction to decide whether those white regional pixels were still initial cancer cells or tumor is decided here and area, perimeter, centroid, eccentricity, and diameter of those white regional pixels are extracted and based on the radius value of the white grouped pixels, classification of lung cancer into various stages is decided in this paper. Based on a fixed eccentric value as prescribed by the medical standards, only regions having a greater eccentric value than the standard value will be considered as exact tumors and based on radius value of tumor, stages of cancer are determined and it becomes easier for the radiologists/doctors to easily find the stage of cancer instantly. Proper medication like radiotherapy or surgery can be done if the tumor's size (radius value is much higher than the standard medical value) is large.

II.PROPOSED METHODOLOGY

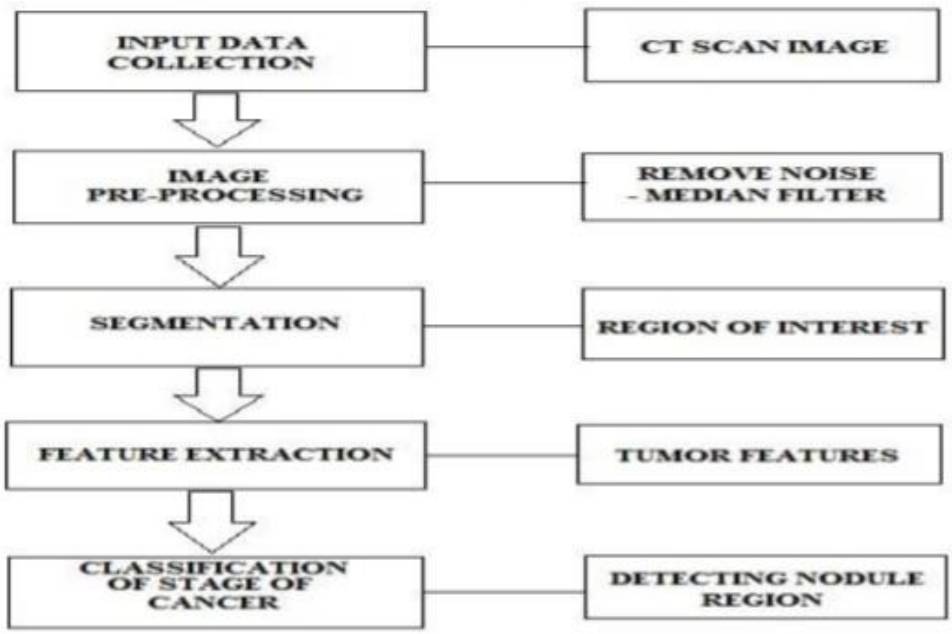

fig 1.) implemented methodology

III. PRE-PROCESSING

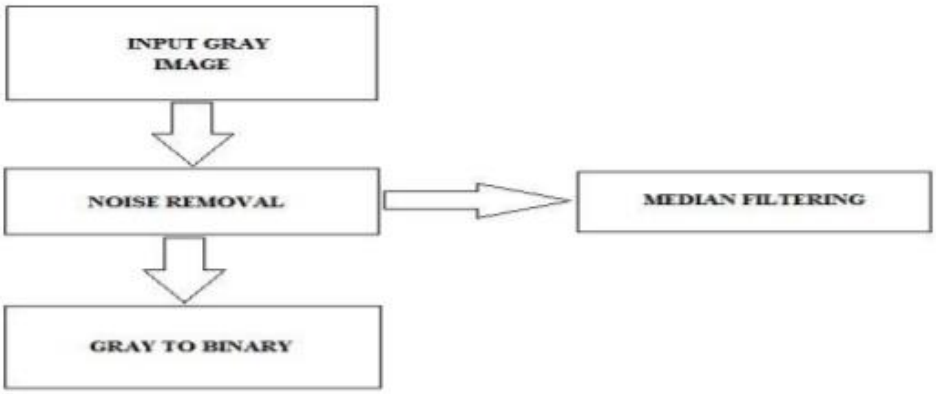

fig 2.) flow chart for pre-processing

Pre-processing is the second step to enhance image quality by suppressing the noise where the median filter is used in this paper. Generally, CT scan images have salt pepper noises(impulse noise) which can be effectively eliminated using the median filtering approach. As the median gives the mid-value of the pixels, no new extra pixels will be created and sharp edges of the CT scan image are preserved.[1] Then conversion of an image into binary using certain threshold took place because CT scan image contains different intensities of colors like gray, black, white and therefore to simplify the next steps, converting into two intensities i.e., into black and white took place here. Moreover, color, RGB, gray images may use more processing power, huge memory, and time to process. For this reason, images are transformed into binary for processing, which needs less computing power and takes less time for processing.

IV. SEGMENTATION

The primary purpose of segmentation is to remove or eliminate the irrelevant parts of the images and to extract required white regional grouped pixel parts (which may be a tumor or less than tumor size i.e., initial small cancer cells lump formation). The first dilation is performed here to add pixels of sufficiently small size to bridge gaps in the binary image, because due to noise if present, some white regional large size tumors may appear as individual different small size cancer cells which may be mistreated as not a tumor. Hence by dilation, the pixels in the object are thickened and if there are any separated pixels of the tumor region due to noise can be combined and will be appeared as a tumor. In the same way, dilation is also done to remove small pixels present if any, so at end of this erosion step, the noise regions will not appear anymore and only tumor region pixels or group of few cancer cells pixels are visible.

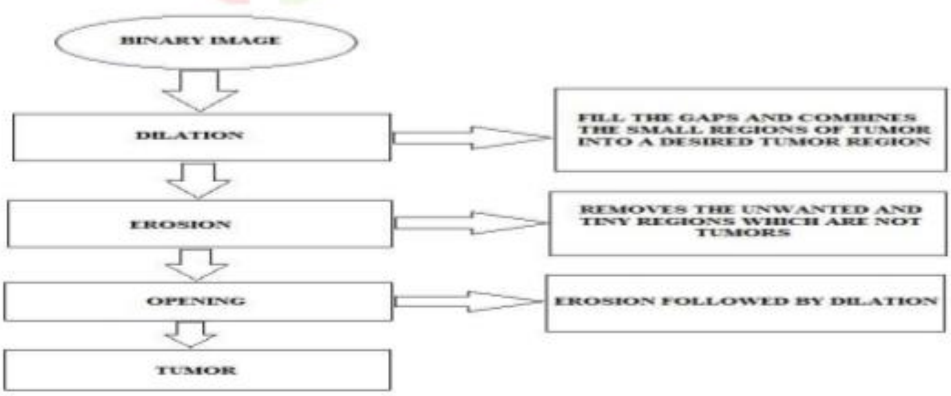

fig 3.) steps implemented in segmentation process

The next big mask is applied using the opening operation to fill the complete image and now subtracting or removing the eroded image from the big mask image, we got the exact tumors separated. But by the end of segmentation, we still cannot exactly tell whether those tumors are small(i.e., less gathering of cancer cells) or big (huge tumor). Hence feature extraction stage is necessary to classify cancer.

MAIN TASK OF CREATING MASK: To separate the tumor regions or group of small cancer cells still not yet developed into the tumor from the remaining area/region of lungs.

Binarisation: It is the process of converting a pixelated image into binary and the foremost thing is to select the threshold for binarisation. Based on formulas, the threshold is determined in this paper.

Filling holes: Also called dilation is done to gradually enlarge the boundaries of regions of foreground pixels (i.e. white pixels, typically) in a binary image.[6]

Erosion: It is done to erode the boundaries of regions of foreground pixels (i.e. white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger. This step is important because it separates the lung nodules from the blood vessels. [6]

Opening: The next operation is an opening operation which is an erosion followed by a dilation. This step is done to keep the blobs connected to the walls of the lungs.

Big mask: Subtracting the eroded image from the big mask image gives the tumor region areas. Again by applying another opening operation, if the tumors detected having a size less than 55, then only those tumors are considered as exact tumors.

V. FEATURE EXTRACTION

The ultimate objective of feature extraction is to take out required features from the target image. In this boundary tracing followed by labeling the number of tumors and then using region props, extracting regional properties or parameters like area, perimeter, centroid,eccentricity and diameter results are obtained and based on a single parameter value i.e., the radius of the tumor, the stage of the cancer is decided. Table I shows the parameters that were deduced from the extraction step. Table II shows the principle which was determined by the medical field radiologists and doctors for differentiating cancer stages based on the radius value (R) of the tumor [7].

table 1. parameters obtained

REGION	AREA	PERIMETER	CENTROID	DIAMETER	ECCENTRICITY
1	144.0	42.9	137.6 143.5	13.5	0.8
2	521.0	81.8	249.2 76.6	25.8	0.6

table 2. cancer stages classification based on radius value (R)[7].

STAGE OF CANCER	REQUIREMENT
I	R < 3 cm
II	3cm < R < 7cm
III	R > 7cm
IV	R > 10 and above

VI. RESULTS

As stated in the preceding section, based on the stages of cancer data, various stages are determined for the tumor according to the radius value of the tumor. "Fig. 4" shows cancerous lungs CT scan image which was collected from Cancer Imaging Archive (CIA) database. The various experiments/processes proposed in the above sections for the lung cancer detection were implemented using matlab, which is necessary and suitable for better classification of the stage of cancer and accuracy in the process of prediction using segmentation and feature extraction. "Fig. 5 and 6" illustrates the preprocessing output results and "Fig. 7,8,9,10" shows the segmentation results and extraction of desired regions. "Fig. 11" exhibits numbering for the tumors detected and "Fig. 12" reveals the classification for the exact tumors detected.

The accuracy of the proposed model to detect the lung cancer stage is highlighted based on these results shown under.

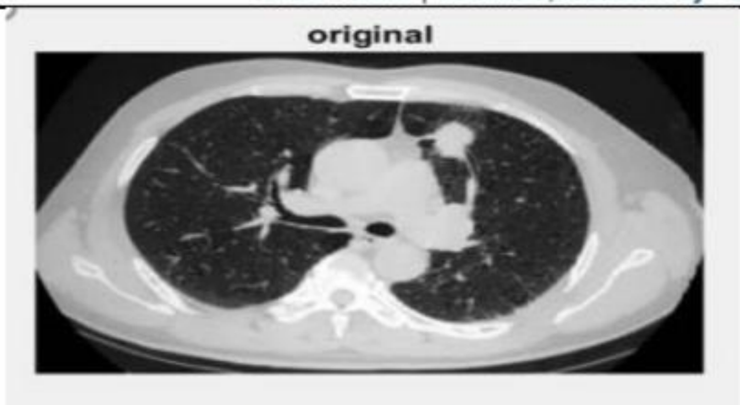

fig 4.) lung cancerous CT scan image

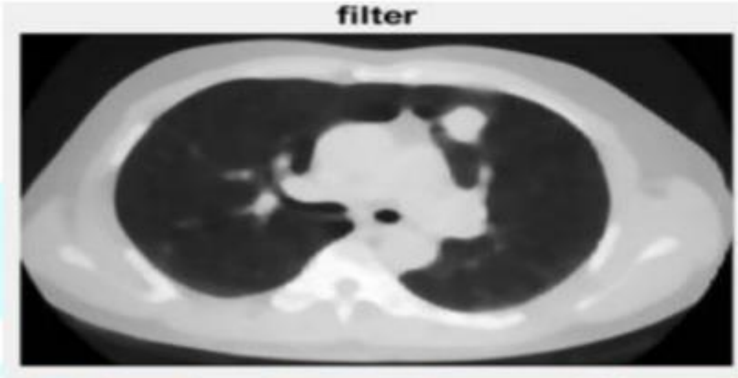

fig 5.) noise removal using the median filter

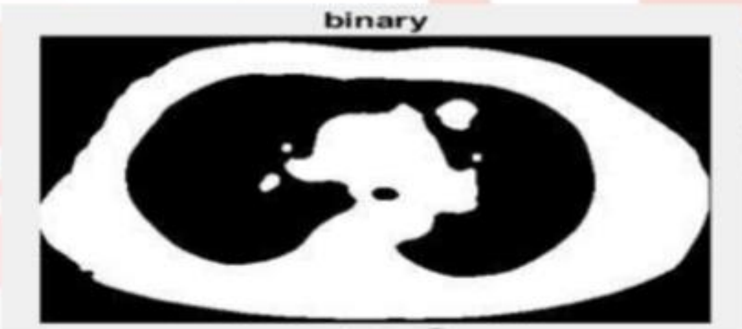

fig 6.) gray to binary converted image

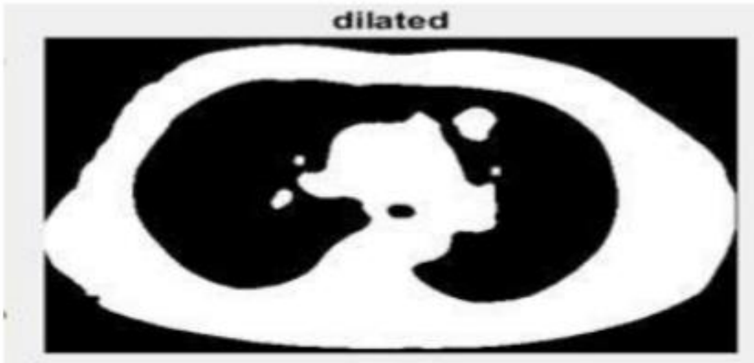

fig 7.) dilated image

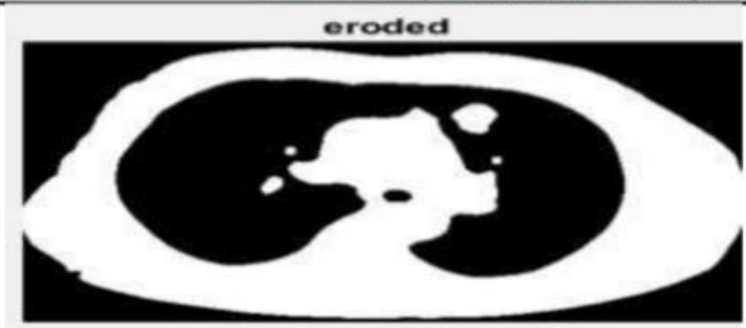

fig 8.) eroded image

Fig 9.) Big mask image

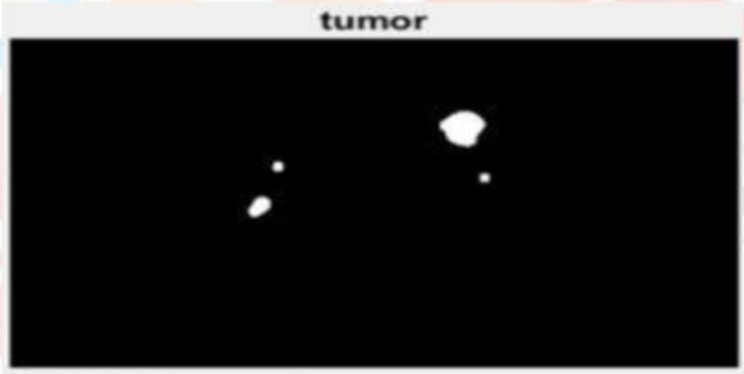

fig 10.) tumors or small lump of less sized cancer cells

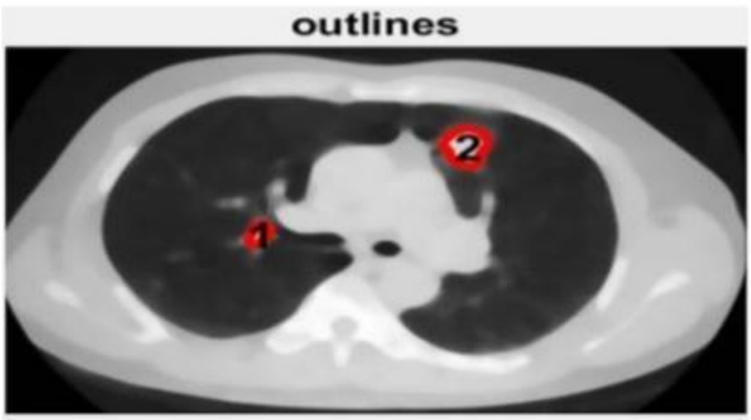

fig. 11.) outlines and numbering of tumors

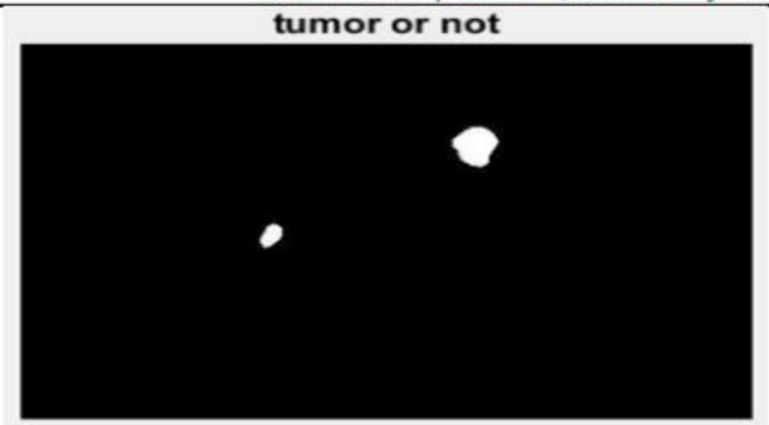

fig 12.) showing exact tumors

VII. CONCLUSION

The study carried out in this paper entirely is about predicting the stage of cancer-based on any one of the four features extracted. From the results obtained it is observed that using the eccentricity value of the tumor part, the exact tumors are separated. The stages of cancer are classified based on the radius value of the tumor(radius value extracted from the diameter).According to the cancer stages classification table prescribed by the medical standards as mentioned above. A total of five features were extracted in this paper like area, perimeter, diameter, eccentricity, and centroid. Based on these outcomes, the result is an exact finding of cancer stage with accuracy. The motivation behind lung cancer identification is to help the radiologist and doctors to take an exact decision regarding the cancer stage instantly and this methodology can be used to prevent wrong predictions. The future scope could be to work on improving efficiency in diagnosis and prediction of the stage of cancer by any person simply by seeing CT scan report or without any assistance of doctors or radiologists.

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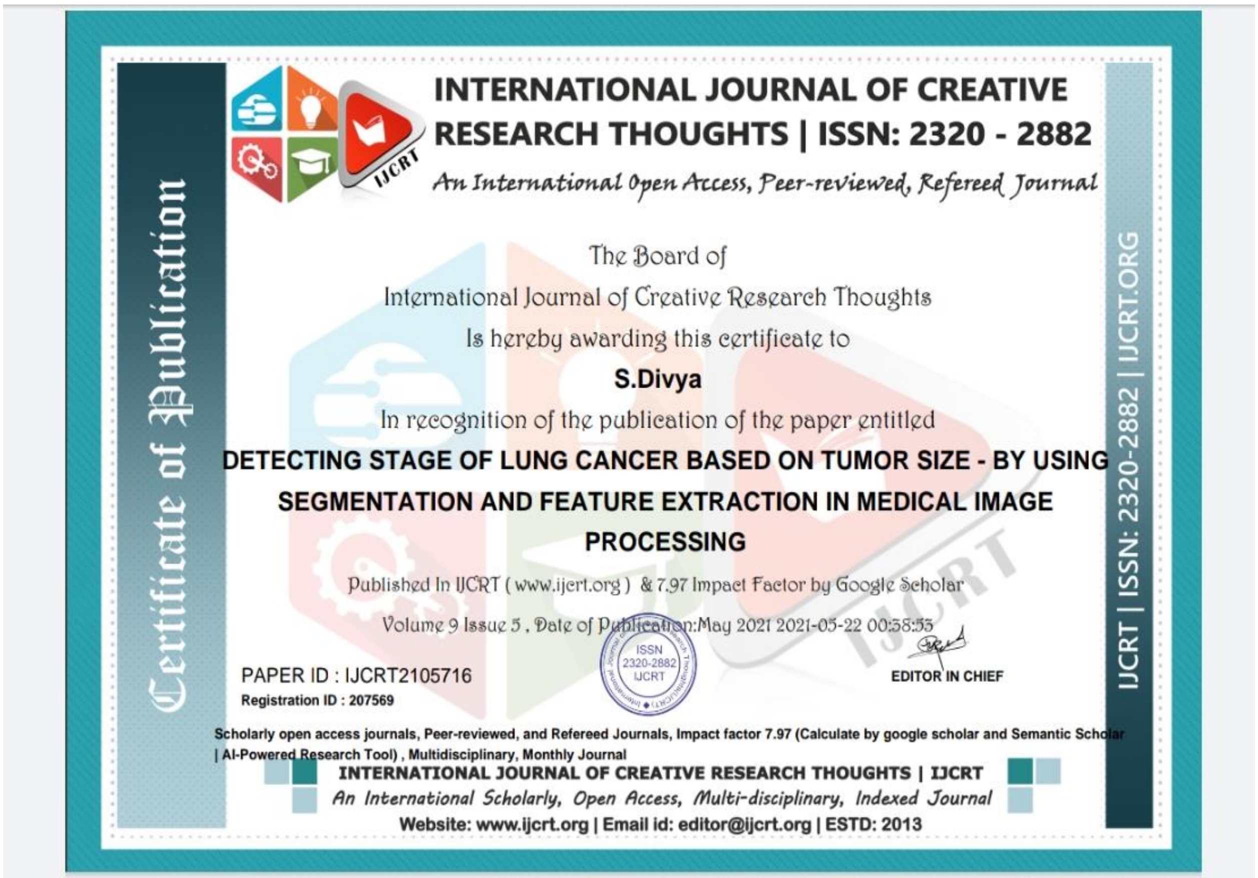

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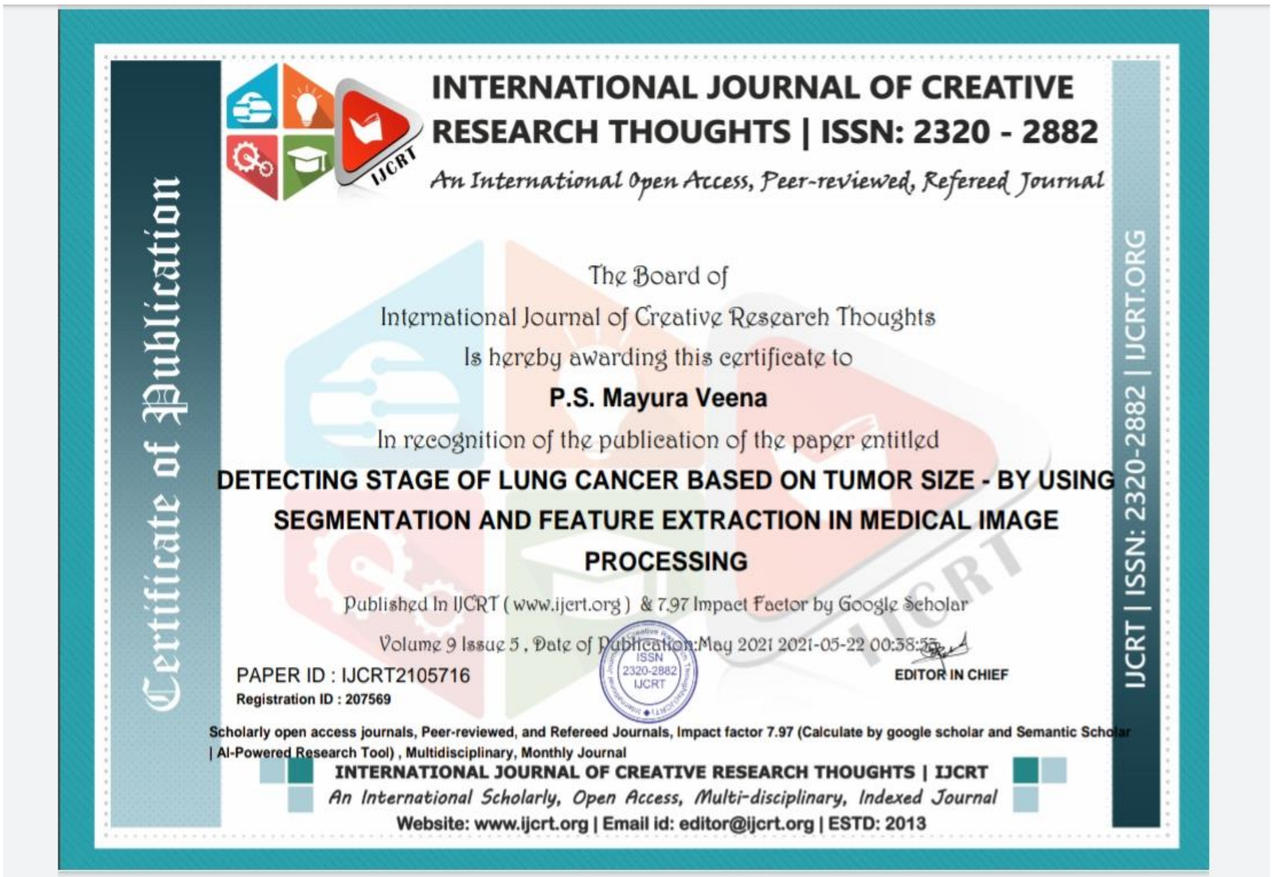

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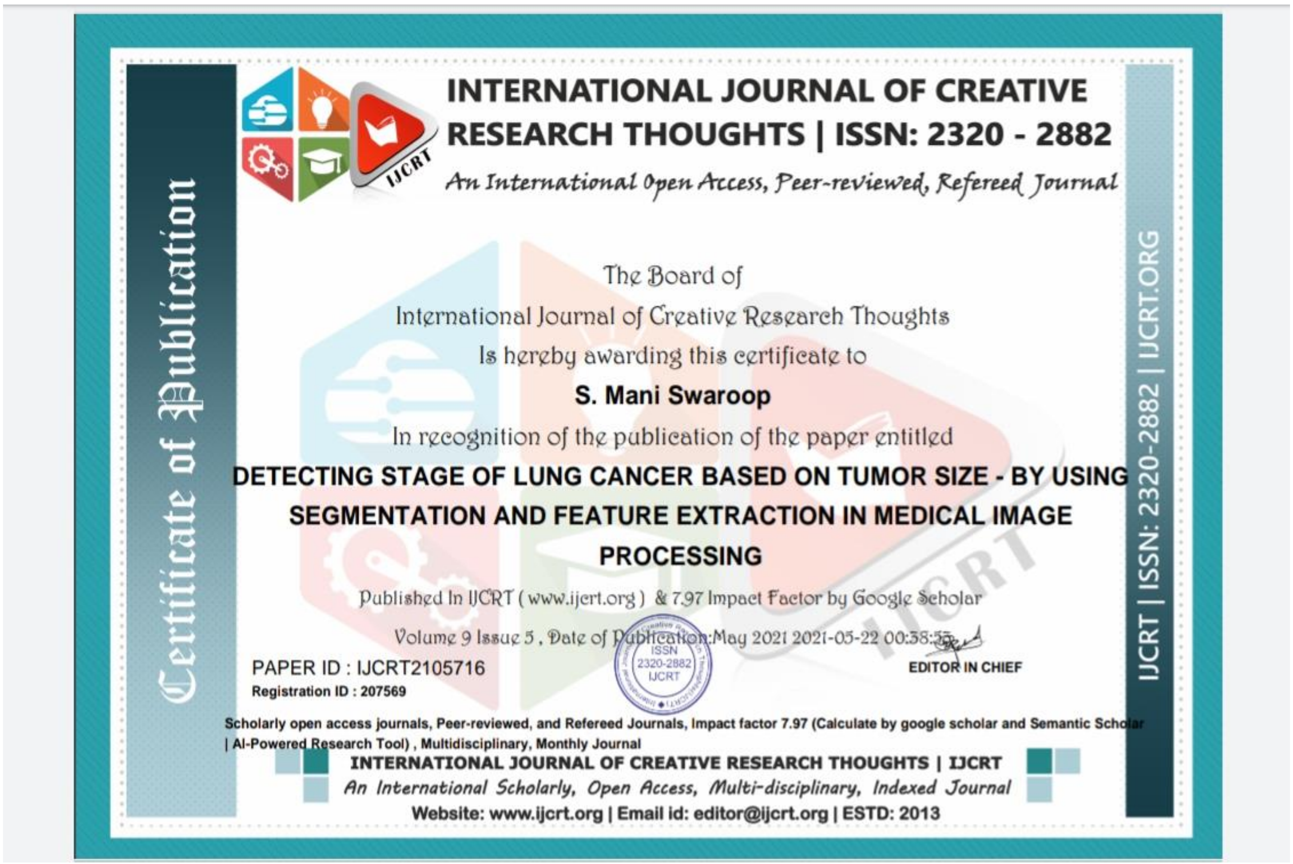
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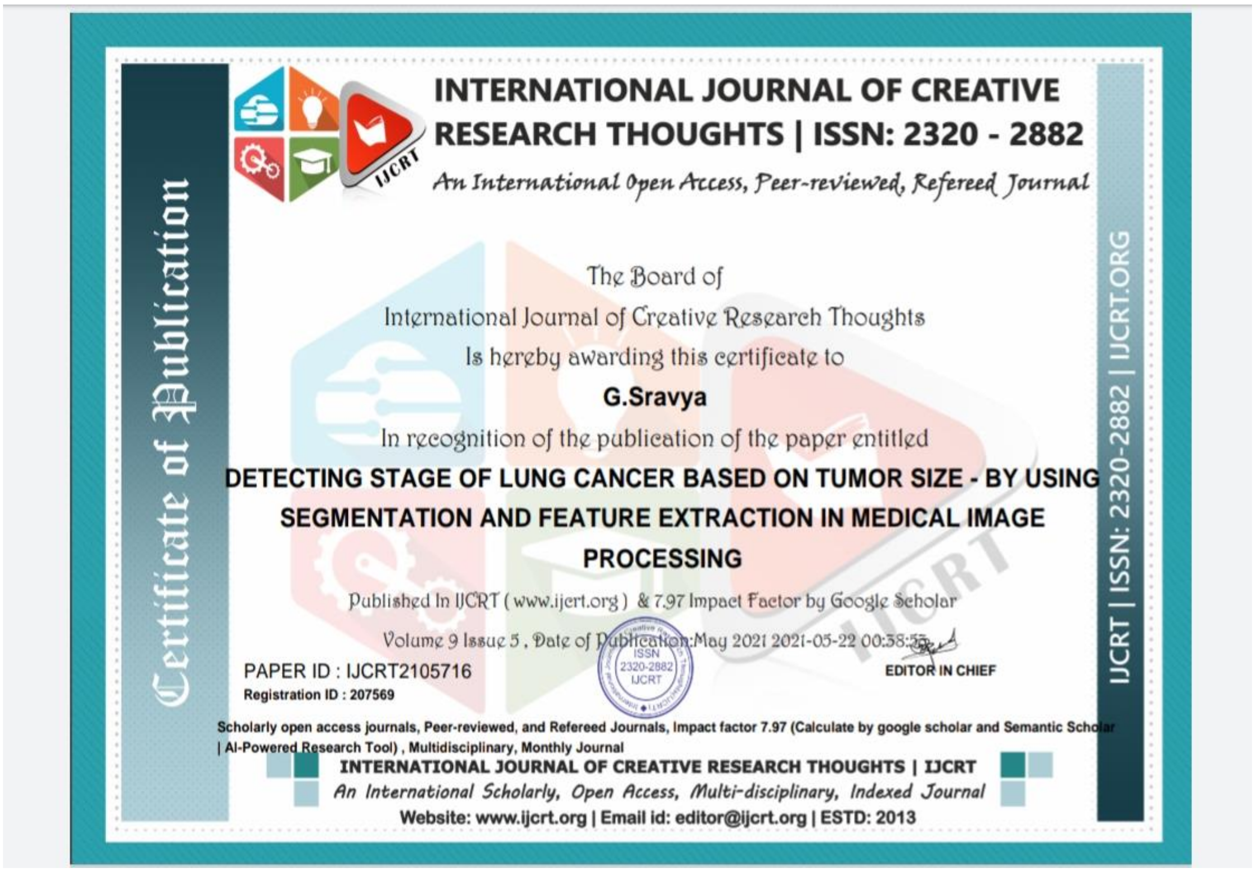

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