STAGE IDENTIFICATION IN LUNG CANCER USING WATERSHED SEGMENTATION AND SVM CLASSIFICATION

A Project report submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by

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ANITS

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*)
Sangivalasa, bheemili mandal, Visakhapatnam
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CERTIFICATE

This is to certify that the project report entitled ***"STAGE IDENTIFICATION IN LUNGCANCER USING WATERSHED SEGMENTATION AND SVM CLASSIFICATION"*** submitted by V. V. Ramalingeswara Rao (319126512063) Ch. Chandra Mouli (320126512L07) Ch. Ganesh Reddy (319126512012) P. Jaya Chandra (319126512043) in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Electronics & Communication Engineering** of Anil Neerukonda Institute of technology and Sciences(A), Visakhapatnam is a record of bonafide work carried out under my guidance and supervision.

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ABBREVIATIONS

CT	:	Computed Topography
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
CAD	:	Computer Aided Design
RCM	:	Robinson Compass Masks
KCM	:	:Krisch Compass Masks
CE	:	Canny Edge
ZM	:	Zemike Moments
ML	:	Machine Learning
LM	:	Labelled Matrix
CH	:	Convex Hull

ABSTRACT

Now a days, stage identification of lung cancer became a challenging issue for pulmonologists form the Computed Tomography (CT) scan directly. An early identification in lung cancer and corresponding medication will save a person from sick. Machine learning algorithms along with image processing techniques help doctors for early identification of cancer .Cancer cells from different organs of the body are carried in blood to the lungs where they get stagnated and develop into a tumour .In this work, we proposed a precise algorithm to identify tumour regions from a CT scan of lungs .Since a CT scan is affected with gaussian and salt – pepper noise a median filter is best suited for removing the noise in the pre-processing step . Gray scale image is converted into binary image for further processing .Watershed algorithm is a new kind of segmentation process where the segmentation is carried out by identifying the catchment basins and segregate the regions accordingly .Tumours are extracted from morphological operations viz., opening and erosion .Under feature extraction, features like area, perimeter, eccentricity and diameter are extracted for the stage identification .Multi class Support Vector Machine (SVM) classifier with a data set containing records of 2574 patients is used which gave us the best possible classification according to stage with less time - consumption .

Keywords—Watershed, median filter, SVM, Morphological operations.

CHAPTER 1

INTRODUCTION

1.1 PROJECT OBJECTIVE:

The primary objective of this project is to identify lung cancer tissues that should be further improved with improved accuracy to reduce the rate of false positives and improve diagnosis accuracy. disease is one of the main reasons of death around the world. causing 1.8 million deaths and 2.1 million new cases annually. Early diagnosis can lower the death rate by allowing clinicians to provide appropriate treatment within the allotted time frame. Cancer occurs when a group of cells grow out of control and lose their balance, resulting in malignant tumours that invade surrounding tissues. The stage of cancer indicates how far the disease has spread. Cancers in later stages are confined to the lungs during stage 1 and 2. spreads to other organs in the vicinity. Imaging techniques like CT scans and biopsies are currently used for diagnosis. by early identification, cellular breakdown in the lungs can then be recognized when it very well may be restored. This task examinations CT pictures and different picture handling procedure on them to get exact location. Here a CT picture will be thought of, and afterward the picture will be pre-handled for clamour expulsion and picture improvement Further picture handled for picture division. The pre-processed image is used for further morphological feature extraction and the diagnosis of lung cancer is made.

1.2 MOTIVATION:

One of the world's most dangerous diseases is lung cancer. consistently a larger number of individuals bite the dust in view of cellular breakdown in the lungs than some other kinds of disease like bosom, cerebrum, and prostate malignant growth. Between the ages of 45 and 70, lung cancer accounts for the majority of cancer deaths. Over 25% of all cancer-related deaths occur annually due to lung cancer, which kills more people than breast, colon, and prostate cancer combined. consequently, early discovery of harm in the lungs or cerebrum ought to be perceived to further develop the endurance pace of people. This is the primary impetus behind this project. Sputum cytology, computed tomography (CT), chest radiography (x-ray), magnetic resonance tomography (MRI), and a number of other methods are currently in use to detect advanced stages of lung cancer. The majority of these methods require a significant amount of time and money to perform. As a result, new technology cannot detect lung cancer in its early stages without it. Lung cancer can be detected with a high-quality tool using the proposed method.

1.3 LUNG CANCER DESCRIPTION:

Cancer is disease in which cells in the body grow out of control. when cancer starts in the lungs is called lung cancer. Lung cancer is also known as lung carcinoma (since about 98%-99% of all lung cancers are carcinomas), is a malignant lung tumour characterized by uncontrolled cell growth in tissues of lung. in time, this uncontrolled growth can metastasize (spreading beyond the lung) either by direct extension, by entering the lymphatic circulation, orb via hematogenous bloodborne spread –into nearby tissue or other, more distantparts of the body. most cancers that originate from within the lungs known as primary lung cancers are carcinomas. The two main types are Small Cell Lung Carcinoma (SCLC) and Non-Small-Cell lung carcinoma (NSCLC). The most common symptoms are coughing (including coughing up blood), weight loss, shortness of breath, and chest pains. Sometimes a lung cancer may have characteristics of both types. this is called mixed cell/largecell carcinoma.

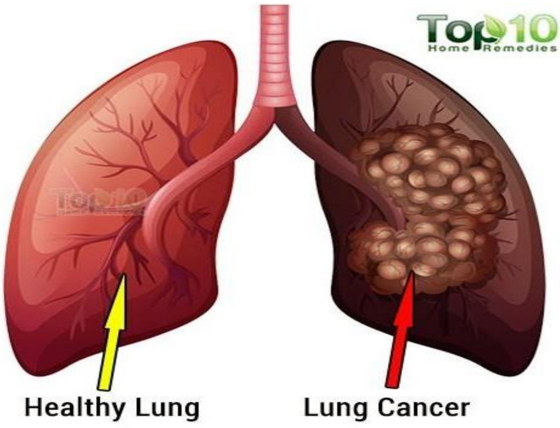


Fig. (1.3). Lung cancer

Even though each cell is small, it can quickly multiply, forming large tumors that can spread to lymph nodes and other organs like the liver, adrenal glands, bones, and brain. This kind of cancer typically begins in the bronchi and spreads to the lungs' center. Small-cell lung cancer is almost always caused by smoking. A person who has never smoked is extremely unlikely to develop small-cell lung cancer. Oat cell carcinoma and small cell undifferentiated carcinoma are two other names for SCLC. There are three distinct types of non-small cell lung cancer, which account for between 75 and 80 percent of all cases: squamous cell carcinoma, adenocarcinoma, and large cell carcinoma; these subtypes are grouped and referred to as "non-small cell lung cancer." Non-small cell lung cancer differs from small cell cancer in its spread pattern and treatment, and if caught early, it may be curable with surgery. In addition to the two main types of lung cancer, another tumour can develop. A type of cancer known as small-cell lung cancer is brought on by smoking and typically begins in the bronchi of the lungs. Even though the cells are small, they can quickly multiply into large tumours that can spread to the brain, adrenal glands, lymph nodes, bones, and liver. Oat cell carcinoma and small cell undifferentiated carcinoma are other names for this kind of cancer. A more prevalent type, non-small cell lung cancer accounts for 75 to 80 percent of all cases. Squamous cell carcinoma, adenocarcinoma, and large cell carcinoma are the three subtypes that fall under this category because they spread in different ways and require different treatments than small cell cancer. Non – small cell lung cancer maybe treated surgically if detected early. In addition to the two primary types of lung cancer, the lungs can also be the site for other cancer cells.

1.4 TYPES OF LUNGS CANCER:

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 health and life of population. In recent decades, the incidence and mortality of lung cancer in many countries have increased significantly.

According to histological size and appearance of size cancer cells, lung cancer is mainly divided into two types.

1. Small Cell Lung Cancer (20-25% of all lung cancers)
2. Non-Small Cell Lung Cancer (most common ~80%).

1.4.1 SMALLCELL LUNG CANCER (SCLC): -

SCLC is the most aggressive form of lung cancer. It is usually starts in the bronchi and then effects whole lung. these cancer cells are small and are considered to be quite aggressive in nature and they have a large growth factor, Because of the reasons at the time of diagnosis, (60% of time), these tumours have often metastasized to other parts of body (brain, liver and bone marrow). SCLS accounts for 20-25% of all lung cancers.

1.4.2 NON-SMALL CELL LUNG CANCER: -

NSCLC is any type of epithelial lung cancer other than small cell lung cancer. It is usually grown and spreads more slowly than SCLC.

Types of NSCL:

Squamous cell: carcinomas usually arise centrally in larger bronchi. Adenocarcinoma: formed from granular structure in epithelial tissues are often found in the periphery of lungs. Large cell carcinomas: can occur in any part of the lung cancer and tend to grow and spread faster than other two types.

1.5 WHAT CAUSES LUNG CANCER:

Anyone can get lung cancer. lung cancer happens when cells in the lung mutate or change. Various factors can cause this mutation to happen, most often, this change in lung cells happen when people breathe in dangerous, toxic substances.

1.5.1 Smoking:

smoking is the number one cause of lung cancer. It causes about 90%of lung cancer cases. Smokers are not only ones effected by cigarette smoke. if your former smoker, your risk is decreased but has not gone away completely-you can still get lungcancer. On-smokers also can be affected by smoking. Breathing in second hand smoke puts you at risk for lung cancer or other illnesses.

1.5.2 Radon:

Radon exposure is the second leading cause of lung cancer. Radon is a colourless, odourless radioactive gas that exists naturally in soil.it comes up through the soil and enters building through small gaps and cracks. One out of every 15 homes in the USA is subject to randon exposure, exposure to randon combined with cigarette smoking seriously increases lung cancer risk.

1.5.3 Hazardous Chemicals:

Exposure to certain Hazardous chemicals poses a lung cancer risk. Working with material such as asbestos, uranium, arsenic, cadmium, chromium, Nickle and some petroleum products is especially dangerous. If you think you may be breathing in Hazardous chemicals at your job, talk to your employer and doctor to find out to protect yourself.

1.5.4 PartialPollution:

Partial pollution refers to a mix of very tiny sold and liquid particles that are in the air we breathe. evidence shows that particle pollution-like that coming from that exhaust smoke-increases the risk of lung cancer.

1.5.5 Genes:

Genetic factors also may play a role in one chance of developing lung cancer. A family History of lung cancer may mean you are at a higher risk of getting the diseases. if others in your family have or ever had lung cancer, it’s important to mention this to your doctor

Fig. (1.5). Risk Factors

1.6 SIGNSAND SYMPTOMS OF LUNG CANCER:

Most lung cancer do not cause any symptoms until they have spread, but some people with early lung cancer do have symptoms. if you go to your doctor when you first notice symptoms, your cancer might be diagnosed at an earlier stage, when treatment is more likely to be effective.

The most common symptoms of lung cancer are: A cough that does not go away or gets worse Coughing up blood or rust- coloured sputum Chest pain that is often worse with deep breathing, coughing or laughing Loss of appetite Unexplained weight loss Shortness of breath Feeling tired or week New onset of wheezing.

1.7 BRIEF IDEA OF THE PROJECT:

Cancer is a noteworthy general health issue worldwide with mortality increase day by day. Lung cancer, among all other cancer types is the most common and deadly that occur both in men and women. Lung cancer, additionally Known carcinoma is the formation of malignant Lung tumours. Due to uncontrolled growth of cells in lung tissues. Eating tobacco and smoking are the leading risk factor for causing cancerous lung nodules. the survival rate of lung cancer patients combining all stages very less roughly 14% with time span of about 5-6years.the main problem with the lung cancer is that most of these cancer cases are diagnosed in later stages of cancer making treatments more problematic and significantly reducing the survival chances. Hence detection of lung cancer in its earlier stages can diagnosed in later stages of cancer in its earlier stages can increases the survival chances up to 60-70% by providing the patients necessary fast treatment thus it curbs the mortality rate. Small cell lung cancer and non-small cell lung cancer are two main types of lung cancer that makes up about 80-85% of all cases where as 15-20% of cancers cases are represented by small cell lung cancer. lung cancer staging depends upon spread of cancer in lungs and tumour size.

Lung cancer is mainly classified into 4 stages in order of seriousness: Stage 1-Cancer is confined to the lung, Stage 2 and Stage 3-cancer is confined within the chest and Stage 4-Lung cancer has spread from the chest tom other parts of the body. Lung cancer diagnosis can be done by using various imaging modalities such positron emission (PET), Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and chest X-ray. CT scan image are mostly preferred over other modalities because they are more reliable, have better clarity and less distortion. Visual interpretation of database is tedious procedure that is time consuming and highly dependent on given individual.

This introduces high possibility of human errors and can lead to misclassification of cancer. Hence an automated system is of most important to guide the radiologist in proper diagnosis of lung cancer. The methodology developed for the system includes dataset collection, pre-processing, Lung segmentation, feature Extraction and classification.

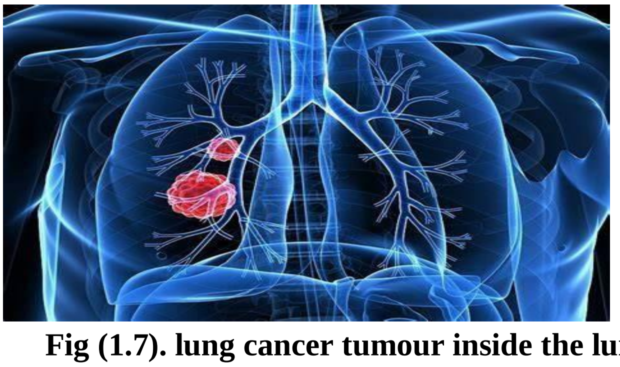


Fig (1.7). lung cancer tumour inside the lung

1.8 WORK FLOW

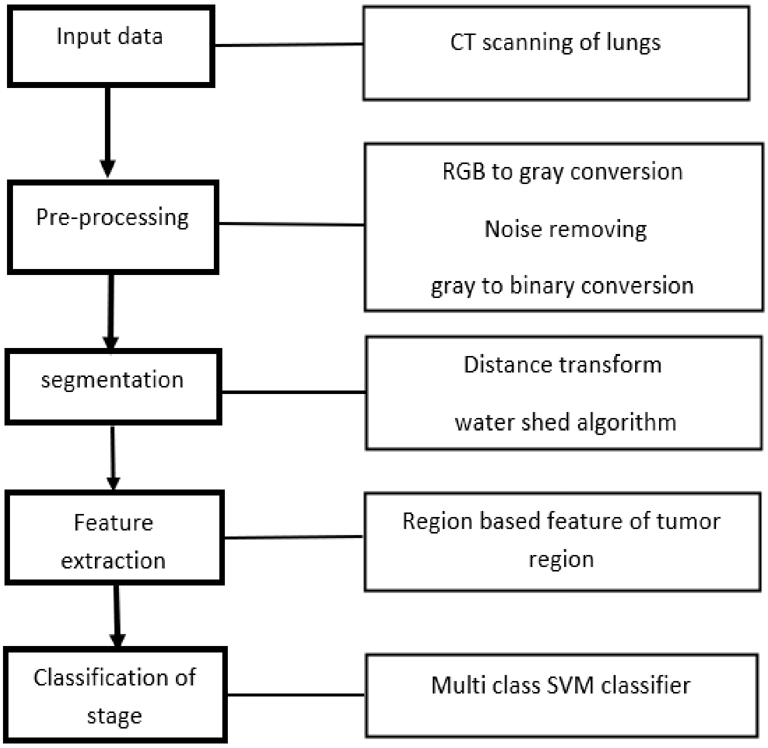


Fig 1.8 Flow chart

CHAPTER2

IMAGEPRE-PROCESSING

2.1 Introduction To Pre-Processing:

The target of the picture pre-handling stage is to stifle undesirable bends present in the picture and to upgrade a few elements helpful for additional handling, It incorporates two principal steps, for example, picture smoothing and picture improvement. Picture smoothing is finished to eliminate undesirable commotion present in the Picture. CT check pictures are inclined to salt and pepper clamours, subsequently, middle sifting is viewed as a very successful procedure in wiping out this motivation commotion while saving the edges middle separating gives the best outcomes for picture smoothing as it eliminates commotion without obscuring the picture.

The picture Upgrade method works on the nature of advanced pictures to produce improved yield for additional handling. Contrast changes are finished to improve the picture since the picture quality is impacted by antiquities caused due contrast varieties in the picture. Contrast changes upgrade the difference of a picture by changing information pixel values with the end goal that default 1% of information gets soaked at the low and extreme focus of info picture information. Picture pre-handling might helpfully affect the greatness of component extraction and results of picture investigation. Picture pre-handling is like the logical normalization of the informational index, which is a general step in many highlights descriptor strategies. Picture pre-handling is utilized to address the debasement of the picture.

2.2 Picture in Gray Scale:

A grayscale picture is one in which every pixel's worth, in computerized photography, PC-produced imaging, and colorimetry, is a solitary example addressing just a little amount of light. At the end of the day, it contains data on the power of grayscale pictures, which are monochrome or high-contrast pictures made up just of various shades of dark. Dark has the least differentiation though white has the most difference. Grayscale pictures are unmistakable from the slightest bit of bi-apparent highly contrasting pictures, which are pictures with just two tones — high contrast — with regards to PC imaging (likewise called bilevel or double pictures). Pictures in grayscale have a few grayscales in the middle between. Grayscale pictures can be delivered by estimating how much light is transmitted by every pixel by When just a single recurrence is recorded, they are monochromatic legitimate because they relate to a particular weighted blend of frequencies. The electromagnetic range is available to hypothetically any area for the frequencies (e.g., infrared, noticeable light, bright, and so on.). A picture with a characterized grayscale variety space known as a colorimetric grayscale deciphers the example values saved as numeric qualities to the colourless channel of a standard variety space, which depends on the noticed qualities of human vision. There is no particular planning from a variety picture to a grayscale picture if the first variety picture doesn't have a characterized variety space or on the other hand if the grayscale picture isn't intended to have a similar human-saw colourless force as the various pictures.

Fig (2.2.1). RGB image

Fig (2.2.2). grayscale image

2.3 Picture Commotion:

Picture commotion is an irregular variety of Brilliance or a variety of data in pictures and is generally a part of electronic clamours. It tends to be created by the picture sensor and hardware of a scanner or computerized camera. Picture commotion can likewise begin in film gain and the undeniable shot clamour of an optimal photon identifier. Picture commotion is an unfortunate result of a picture catch that clouds the ideal data. Ordinarily, the expression "picture clamour" is utilized to allude to the commotion in 2D Pictures, not 3D pictures. The first sign of "Clamour" was "Undesirable transmission"; undesirable electrical variances in signals got by AM radios caused perceptible acoustics commotion (static). By relationship, Undesirable electrical variances are likewise called "commotion".

various sorts of picture clamour:

2.3.1 Gaussian Commotion:

Chief wellsprings of Gaussian commotion in computerized pictures emerge during obtaining. The sensor has innate commotion because of the degree of light and its temperature and the electronic circuits associated with the sensor infuse their portion of electronic circuit clamour. A commonplace model of picture clamour is Gaussian, added substance free at every pixel, and autonomous of the significant force, caused basically by Johnson-Nyquist Commotion (Warm commotion), including what comes from the reset commotion of the capacitor (KTC clamour). Speaker commotion is a significant piece of the "read clamour" of the picture sensor, or at least, of the consistent commotion level in dim areas of the picture. In variety cameras where more enhancement is utilized in the blue variety divert than in the green or red channel, there can be more commotion in the blue channel. At higher openness, in any case, picture sensor commotion is overwhelmed by shot clamour, which isn't Gaussian and not autonomous of sign power

2.3.2 Salt-and-Pepper clamour:

Fat-tail disseminated or "hasty" Clamour is some of the time called Salt-and - Pepper commotion or Spike commotion. A picture containing salt-and-pepper clamour will have dim pixels in brilliant locales and splendid pixels in dim districts. This sort of commotion can be made by simple computerized converter mistakes, bit blunders in transmission, and so on. It very well may be generally wiped out by utilizing dim edge deduction, middle separating, consolidated middle and mean sifting, and inserting around dull/splendid pixels. dead pixels in an LCD screen deliver a comparative, yet non-irregular, show.

Fig 2.3.2). salt and pepper noise

2.3.3 Shot commotion:

The prevailing clamour in the more brilliant pieces of a picture from a picture sensor is regularly that brought about by measurable quantum vacillations, that is to say, Variety in the number of photons detected at a given openness level. this clamour is known as photon shot commotion. Shot commotion follows a toxic substance conveyance, which can be approximated by Gaussian circulation for enormous picture power. The shot commotion has a standard deviation corresponding to the square foundation of the picture power, and the clamour at various pixels is free of another. In options to photons shot commotion, there can be extra shot clamour from the dim spillage current in the picture sensor; this commotion is now and again known as "dim shot clamour" or "dull current clamour". Dull current is most prominent at "hot pixels" inside the picture sensor. The variable dull charge of typical and hot pixels can be deducted, leaving just the shot commotion, or irregular part, of the spillage. On the off chance that spillage dull casing deduction isn't finished, or on the other hand, assuming that the openness times are long sufficient that the hot pixel charge surpasses the direct charge limit, the commotion will be something other than shot clamour, and hot pixels show up as salt-and-pepper clamour.

2.3.4 Quantization clamour:

The clamour brought about by quantizing the pixels of the detected pictures to various discrete levels is known as quantization commotion. It has a roughly uniform conveyance. however, it tends to be signal ward it will be signal autonomously on the off chance that another clamour source is adequately large to cause vacillating, assuming vacillating is expressly applied.

2.3.5 Anisotropic Commotion:

Some commotion sources appear with a huge direction in the picture. For instance, picture sensors are in some cases subject to push clamour or segment commotion.

2.3.6 Intermittent Commotion:

A typical wellspring of occasional commotion in a picture is the structure's electrical connection point during the picture-catching cycle. A picture impacted by occasional commotion will seem to be a rehashing design that has been added on top of the first Picture. In the recurrence space, this kind of commotion should be visible as discrete spikes. A huge decrease in the clamour can be accomplished by applying the score in the recurrence space. the accompanying pictures delineate a picture impacted by the occasional clamour and the aftereffect of lessening the commotion utilizing recurrence area sifting. note that separating pictures has some clamour on the visitors. Further sifting could decrease this line clamour; in any case, it might likewise diminish a portion of the fine subtleties in the application explicitly.

For instance, on the off chance that the fine subtleties on the palace are not viewed as significant, low pass separating could be a suitable choice. If the fine subtleties of the palace are viewed as significant, a practical arrangement might be to completely edit off the boundary of the picture.

Fig. (2.3.6) periodic noise

2.3.7 Glimmer commotion:

Glimmer commotion otherwise called 1/f clamour is a sign or interaction with a recurrence range that tumbles off consistently into the higher frequencies, with a pink range. It happens in practically all
mechanical, bio-clinical, and electronic gadgets and results from different impacts.

2.4 Noise Decrease OF CT Picture:

The sound decrease is an exceptionally fundamental stage in advanced picture handling for getting better-quality pictures. Clinical imaging is an important device in the field of medication. PC tomography (CT). Attractive reverberation pictures (X-ray), ultrasound imaging (USI), and other imaging procedure give more compelling data about the life structures of the human body during the analysis cycle. In the clinical field, specialists generally wanted to upgrade clinical pictures for analysis because more often than not picturesare flawed and are weakened by numerous interior and outside factors. The bad quality of clinical pictures causes
trouble for the specialists at the hour of conclusion or understanding. A quality picture is needed by biometric ID and Validation Framework to focus on steady and careful results which are more valuable and they end up being useful for inspecting the side effects of the patients. The nature of the X-ray and Cerebrum pictures is gotten by the clamour-free pictures to come by the improved outcome and expanded precision of the outcome. Many channels are applied to

come by the most ideal outcome for the commotion present in the picture. The middle channel gives the best outcome contrasted with the other channel for the salt and pepper commotion, gaussian clamour, and Poisson clamour
also which are available in the picture.

2.5 Filtering:

Sifting is the strategy for upgrading or rotating a picture. There are fundamentally two kinds of sifting;
Spatial Separating
Recurrence Separating
In spatial separating, the continued pixel incentive for the current pixel is reliant upon both itself and the adjoining pixel. Smoothing channels are mostly used to lessen the clamour of a picture and for obscuring. Obscuring is utilized to eliminate irrelevant data from a picture earlier to highlight Extraction and is used to associate little breaks in bends or lines. Obscuring is likewise used to lessen commotion from a picture. A smoothing channel is likewise helpful for featuring gross subtleties,
Two kinds of smoothing spatial channels exist:
1. Smoothing straight channels
2. Order-static channels
A smoothing channel is essentially the mean of the local pixels of the channel veil. Thusly, the channel is at times called the "mean channel" or "averaging channel".
The idea involves subbing the worth of every pixel in a picture with the mean of the local pixel characterized by the channel cover.

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

2.6 Median Filter:

Middle sifting is a nonlinear strategy used to eliminate clamour from pictures it is generally utilized as it is extremely viable at eliminating commotion while safeguarding edges. It is especially successful at eliminating 'salt and pepper clamour' type commotion. the middle channel works by traveling through the picture pixel by pixel supplanting each worth with the middle benefit of adjoining pixels. The example of neighbours is known as the 'window', which slides, pixel by pixel, over the whole picture The middle is determined by first arranging all pixel values from the window into numeric request and afterward supplanting the pixel being considered with the middle(median) pixel esteem. To show utilizing a window size of three with one section promptly going before and following every passage, a middle channel will be applied to the accompanying straightforward id signal

X= (2,70,6,7)

In this way, the middle channel yield sign will be:

Y1=med (2,2,70) =2

Y2=med (2,70,6) =med (2,6,70) =6

Y3=med (70,6,7) =med (7,6,70) =6

Y4=med (6,7,7) =med (7,7,6) =7.

i.e., y= (2,6,6,7)

The middle channel is one sort of smoothing procedure, as s direct Gaussian sifting. All smoothing procedures are powerful at eliminating clamour in smooth patches or smooth locales of a sign yet unfavourably influence edges. Frequently however, simultaneously as decreasing the commotion in a sign, protecting the edges is significant. Edges are of basic significance to the visual appearance of pictures.

Justification for utilizing middle sifting:

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

Compelling for both unipolar and bipolar motivation commotion

CT check pictures for the most part contain a combination of salt and pepper commotion and Gaussian clamour. As the channel productively eliminates salt and pepper commotion it is actually utilized for the trials. The upside of a middle channel is to eliminate exceptions without lessening the nature of the picture while smoothing contrasted with another channel.

Fig (2.6.1) original image

Fig (2.6.2). median filter image

2.7 HISTOGRAM Equilization:

This technique is related to dim-level reallocation to acquire uniform, histograms. Every pixel is subbed with a basic histogram of the pixel picture. This license is nearly different from procuring upgraded contrast. Histogram balance is executed by spreading the most happening force values. This strategy is useful in picture-closer views and foundations which are splendid/dim commonly. Histogram is imagined as a chart to address the recurrence of various levels that happens in the given picture. While considering the low differentiation pictures, it is found to have various levels with a higher recurrence of events or with lower recurrence or no events. Histogram Balance is made material for growing the pixel power esteem. Histogram evening out is a broadly adjusted procedure for contrast improvement.

A CDF is made helpful for accomplishing the favored necessary shape for a histogram. To follow the pinnacles and pack the through the power levels are formed. N is the number of pixels and L is the force level. no means the number of pixels having power level as lk. The PDF of lk is the force level in the result. the standardized combined histogram capability can be characterized as

j=o

Where p is a picture histogram and is a sure force level inside the histogram in this section the histogram evening out technique is utilized to work on the difference of the picture of the core inside various staining forces (+1, +2, and +3) by loosening up the powers of a cores picture into additional balanced plans over the power scale.

This step plans to have the option to extricate recognizing and discriminative highlights for balanced picture histograms. Which will then be utilized to order the three different staining powers of decidedly stained cores. This will be performed utilizing a few stages first; the forces of the divided cores picture histogram are changed by restricting the reach to certain maxima and minima. The minima and maxima are changed by restricting the reach to include what is believed to be a pixel force having a place with a positive cores object. This is utilized to dispose of commotion that could accumulate from the pixels on the boundary of the cores. In this review, the most reduced power level is believed to be 180. The greatest is set to the most elevated power level of positive cores protests and is accepted to be 80. the point of playing out this step is to restrict the power reach to just those pixels that recognize a positive cores object. The maxima and minima for this situation were chosen in light of the examination of 1000 positive cores objects. The second step of the histogram leveling is to standardize the changed aggregate histogram from 0 to 255 utilizing the standardized histogram combined remapping capability. This will extend the scope of the chosen powers over the absolute force scale.

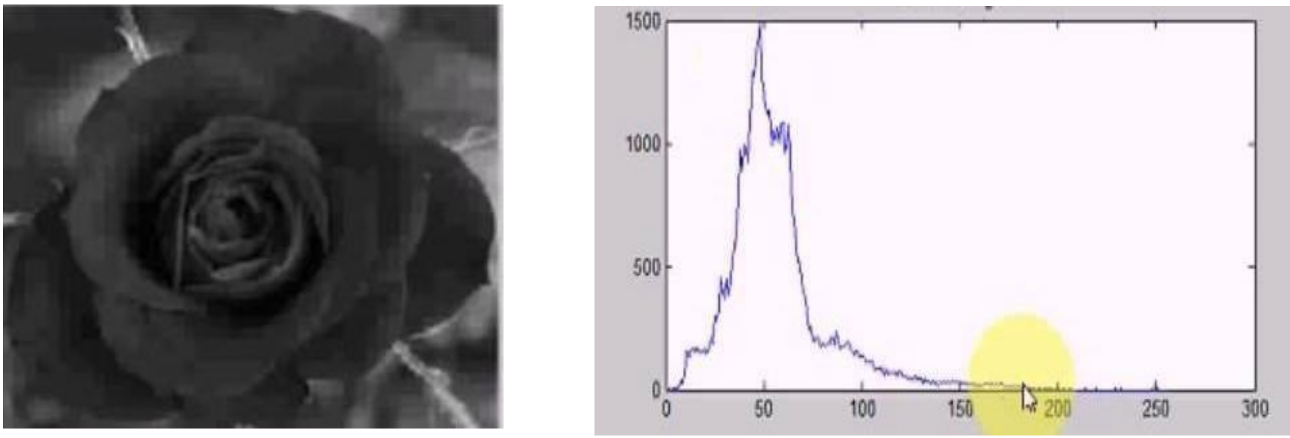


Fig (2.7.1). original image histogram

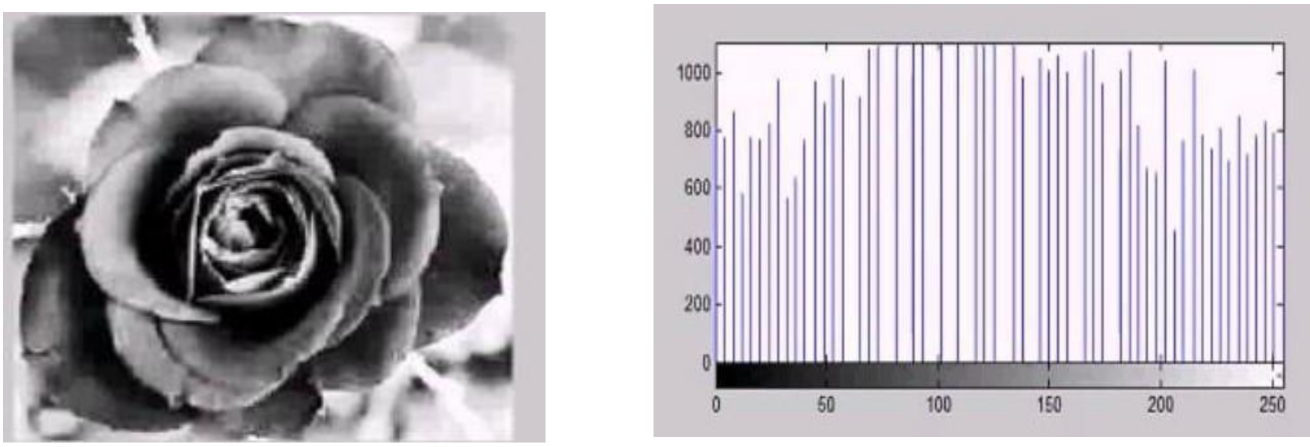


Fig (2.7.2). Histogram equalization of the image

As you can see from the pictures the new picture contrast has been improved and its histogram has additionally been levelled. There is likewise something significant to be noted here during the histogram evening out the general state of the histogram changes, though in histogram extending the general state of the histogram continues as before.

2.8 THRESHOLDING:

Picture thresholding is the least demanding method for isolating the picture foundation and frontal area. Likewise, this picture thresholding can be distinguished as picture division .to apply the thresholding method, we ought to utilize a grayscale picture when thresholding, and that grayscale picture will be switched over completely to a paired picture. In this article, we will talk about various kinds of advanced picture thresholding methods.

Sorts of thresholding:

1. Straightforward thresholding
2. Versatile thresholding
3. Parallel thresholding
4; Otsu thresholding
5. Shorten thresholding

2.8.1 Straightforward thresholding:

In straightforward thresholding, all pixel esteems that are more noteworthy than the particular edge esteem, appoint to the standard worth. After isolating the pixel, we can see the divided pictures as per the thresholding values limit values are characterized into 3 kinds

The worldwide threshold administrator relies upon the dim upsides of the pixel.

The nearby limit administrator relies upon the dark upsides of the pixel and neighbourhood properties.

Dynamic threshold administrator relies upon the dim upsides of the pixel and nearbyproperties and their positions.

2.8.2 Versatile thresholding:

In this method, input pictures will be portioned into little regions. These regions are non-covering regions. Different edge values rely upon the area of pixel values. Since each picture fragment has different light regions.

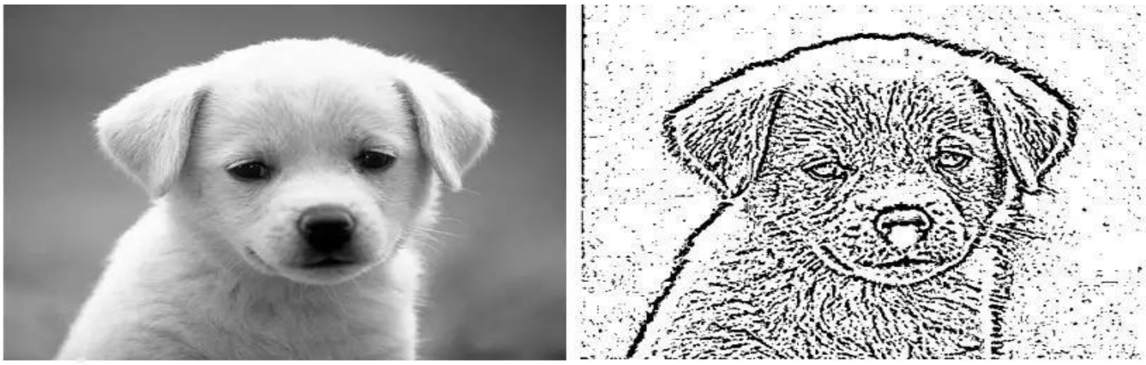


Fig. (2.8.2). adaptive thresholding

2.8.3 Twofold thresholding:

In the twofold thresholding procedure, pixels over the edge worth will be switched off. This is a basic thresholding strategy and the most widely recognized procedure is pixel values contrasted and 255 and 0. As per that edge, pixel tones are dark or white.

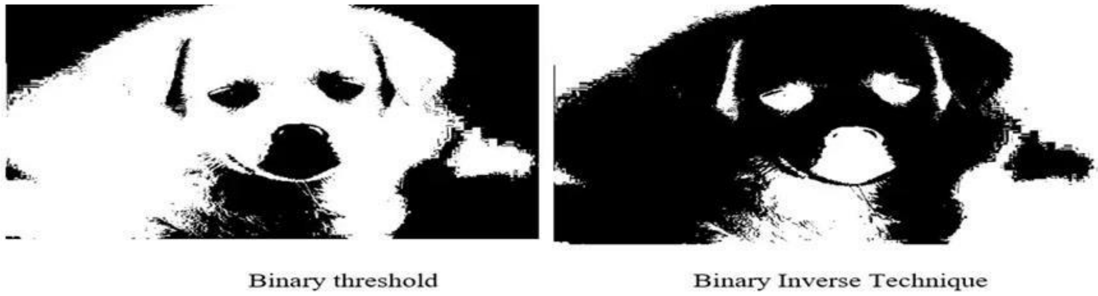


Fig. (2.8.3). binary thresholding

2.8.4 Otsu Thresholding:

This Programmed Ideal Edge Identification strategy finds the ideal worldwide limit esteem from the histogram of the picture. At the point when a picture histogram has 2 pinnacles, the ideal limit worth ought to be in these qualities. Pictures will be isolated into closer view and foundation as indicated by limited esteem. There are 2 classifications in the Otsu technique called 1-D and 2-D. The 2-D strategy is more compelling than the 1-D.

Fig. (2.8.4). Otsu thresholding

In this technique, the objective pixel will be set to the limit esteems. Pixel esteems that are more prominent than the limit worth will be set to an edge esteem. Different qualities continue as before.

2.9 Change OF GRAYSCALE Picture TO Binary Picture:

A grayscale picture is essentially one in which the main tones are shades of dim. The justification for separating such pictures from some other shy of the variety picture is that less data should be accommodated in every pixel. A grayscale picture has a specific number of pieces of data per pixel, hence,256 conceivable dim qualities. A parallel picture has just two qualities for every pixel 0 and 1 compared to high contrast.

The transformation is finished because of the accompanying benefits

- Simple to obtain: straightforward advanced cameras can be utilized along with extremely basic casing stores, or minimal expense scanners or thresholding might be applied to dark-level pictures
- Low capacity: something like 1 digit/pixel, frequently this can be diminished as such pictures are entirely agreeable to pressure.
- Straightforward handling: the calculation is by and large a lot easier than those applied to dim-level pictures.
-

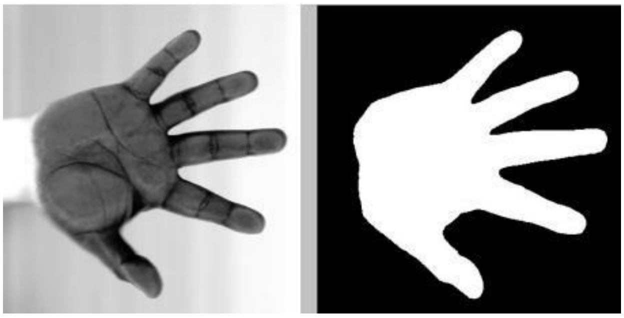


Fig. (2.9.1). conversion from gray scale to Binary image

CHAPTER 3

IMAGE SEGMENTATION

3.1 introduction

Image segmentation, an essential step in digital image processing, involves splitting a picture into various portions according to its characteristics and qualities. This makes the image simpler for easy analysis and enables the use of computer vision. Segmentation is crucial in medical imaging because it allows for the automatic or semi-automatic extraction of the region of interest, allowing for the detection of bodily organs, cancers, and masses. For segmentation, region-based techniques like region merging and active contour are frequently employed, as well as clustering techniques like K-means and hierarchical clustering. Medical images, however, frequently feature erratic borders, noise, and flimsy boundaries, necessitating complicated processes. Image segmentation frequently uses morphological procedures including erosion, dilation, and opening. Segmentation is generally the initial stage of the image. Overall, segmentation is the first step in image analysis, and it plays a crucial role in many applications, including medical imaging. Segmentation is the process of separating the region of interest from an image, which involves dividing the image into different parts based on their attributes and properties. Image segmentation is an important step in image analysis as it simplifies the image for easier analysis. Without segmentation, computer vision implementation would be difficult. Medical imaging modalities such as microscopy, X-ray, CT, MRI, and PET require segmentation for detecting body organs/tissues, tumors, and masses. Clustering techniques like K-means, hierarchical, divisive, and mean-shift clustering can be used to extract the global characteristics of the image for segmentation. Gradient and intensity information can also be used for segmentation, and approaches based on boundaries and regions can be used. Morphological operations such as erosion, dilation, and opening can be used for the project, and the segmentation process flowchart is shown below. However, medical images often have noise intensity, homogeneity, and weak boundaries, requiring complex procedures.

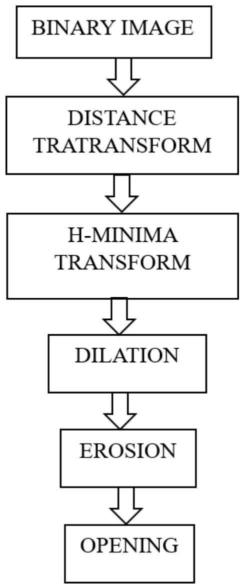


Fig. (3.1) Segmentation

3.2 MORPHOLOGICAL OPERATIONS:

Morphological image processing is a set of nonlinear operations that deal with the shape or morphology of features in an image. These operations rely on the relative order of pixel values, rather than their numerical values, making them well-suited for binary images. They can also be applied to grayscale images where pixel values are not of significant interest. To perform morphological operations, a small template called a structuring element is used. This element is compared to the corresponding neighborhood of pixels at all possible locations in the image. Some operations check whether the element fits within the neighborhood, while others check whether it intersects with the neighborhood. The result of a morphological operation on an image is a new binary image in which pixels have 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, typically a matrix of pixels, where each pixel has a value of either zero or one. The size of the structuring element is determined by its matrix dimension, and its shape is defined by the pattern of ones and zeros. The origin of the structuring element is usually one of its pixels, although it can be outside the element.

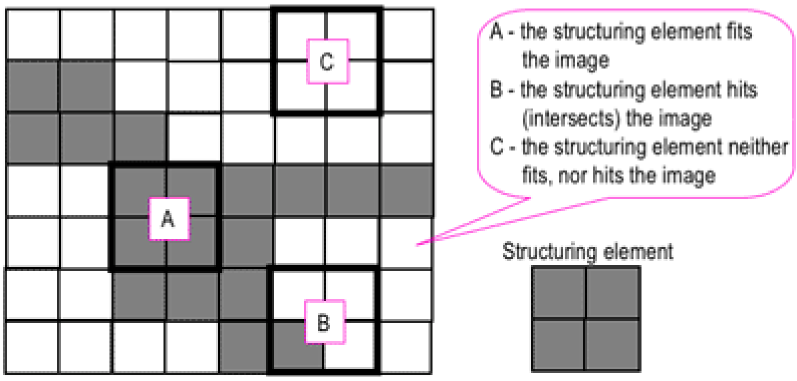


Fig. (3.2). structuring element

The fundamental morphological operations image processing operations are;

- Dilation
- Erosion
- Opening
- Closing

3.2.1 DILATION:

Dilation is a process used to expand the binary image from its original shape based on a structuring element. The size of the structuring element is usually smaller compared to the image itself and is commonly 3x3. Dilation is similar to the convolution process where the structuring element is reflected and shifted from left to right and from top to bottom. At each shift, the process checks for any overlapping pixels between the structuring element and the binary image. If an overlapping exists, the pixel under the centre position of the structuring element will be turned to 1 or black. The dilation operation can be defined using an equation where X is the reference image and B is the structuring element. The outcome element z will have at least one element in B that intersects with an element in X. The dilation process is illustrated in a diagram where the black square represents the image and the white square represents 0. Initially, the centre of the structuring element is aligned at a particular position, and if there is no overlapping between the black squares of B and X, the square will remain white. The structuring element is then shifted from left to right and top to bottom, and the black squares of B overlapping with the black squares of X will be changed to black. Dilation is an expansion operator used to enlarge binary objects and bridge gaps in an image.

The dilation is an expansion operator that enlarges binary objects. Dilation has many uses, but the major one is bridging gaps in an image, due to the fact that B is expanding the features of X.

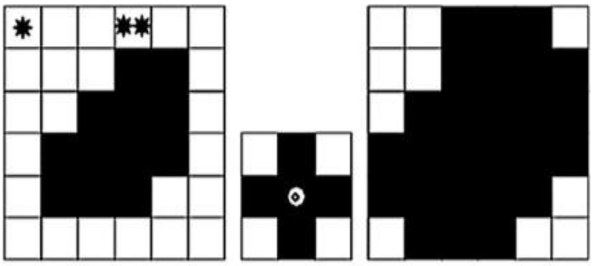


Fig. (3.2.1). dilation

3.2.2 EROSION:

Erosion is the opposite of dilation, as it shrinks binary images. The size of the structuring element used in erosion is typically smaller than the image, with a 3 x 3 size being common. Like dilation, erosion also moves the structuring element from left to right and top to bottom over the image.

The procedure verifies whether the structuring element and the image's corresponding pixels overlap completely at each position. Assuming there is no finished cross-over, the middle pixel relating to the organizing component will be set to white or 0. The equation AB= Z| (B _z) A can be used to describe the erosion operation, where A is the reference binary image and B is the structuring element.

The process of erosion is depicted in Fig. b, where the black square stands for one and the white square stands for zero. The structuring element is moved to the right starting at position •, but there is no complete overlap at position u, so the corresponding pixel is set to white. At position •• •, where the center pixel that corresponds to the image is set to black, complete overlap is eventually achieved as the structuring element moves further to the right. Figure depicts the end result of the erosion process. b, with the image being reduced in size and any narrow areas removed. One of the most common applications of erosion is the removal of thin or small areas from an image.

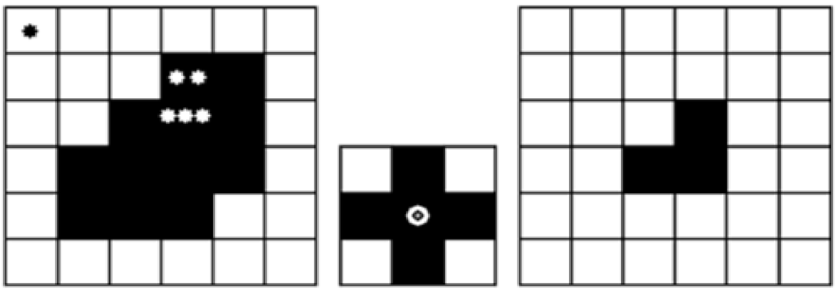


Fig. (3.2.2). Erosion

3.2.3 OPENING:

Combining erosion and dilation, the opening operation is a potent operator. It is frequently used to distinguish items in an image. Erosion reduces the size of an image, whereas dilation makes it bigger. When used to open an image, it makes the contours smoother, breaks up tight connections, and gets rid of protrusions. Additionally, by placing small objects in the background, the opening can remove them from an image's foreground. Identifying particular features like edges and corners can be done with ease using this procedure. Before using segmented images for digital analysis, the opening is frequently used to clean them up.

The opening of image A with structuring element B, where AB is equivalent to performing erosion followed by dilation, is referred to by the notation "A o B." This can be expressed mathematically as A o B = (A B) B.

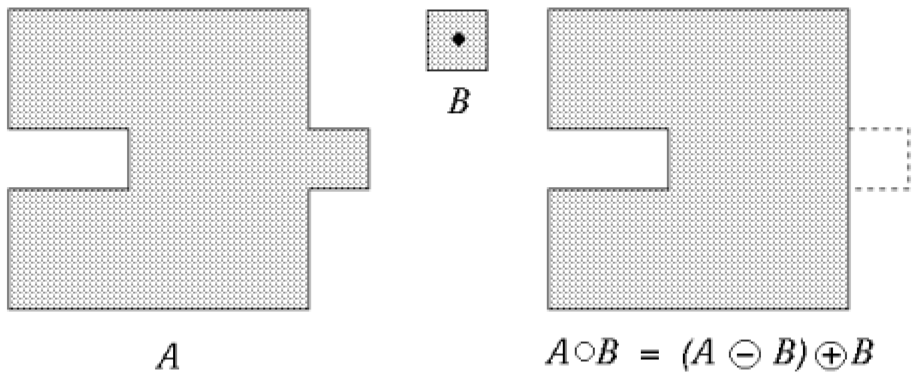


Fig. (3.2.3). opening

3.2.4 CLOSING:

The end activity is made by joining enlargement and disintegration to unite objects. It eliminates small holes, fills in gaps, and smooths out the image's contours. The closing operation A•B is accomplished by applying dilation followed by erosion to an image A using the structuring element "B." A dilated image will be eroded, and it may also fuse small cracks and close gaps. The consequence of the end activity can be gotten by applying disintegration on the widened picture in the wake of applying enlargement on the first picture with the organizing component 'B'.

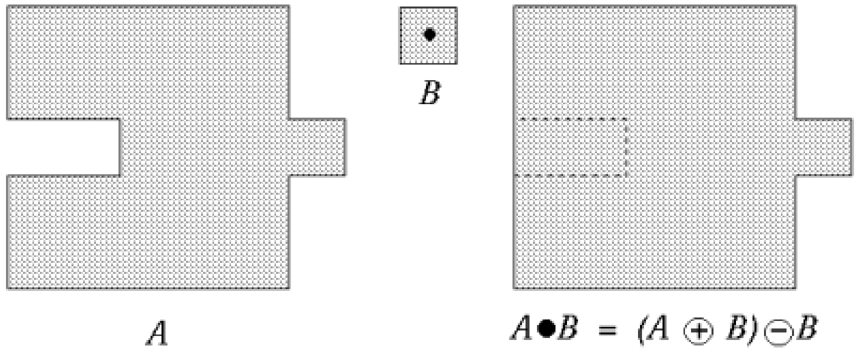


Fig. (3.2.4). closing

3.3 WATERSHEDALGORITHM:

Luc Vincent and Pierre Soille created the watershed algorithm, which is commonly used for image segmentation and is based on the idea of "immersion." In a grayscale image, the algorithm looks for local minima—surfaces with holes—and "immerses" them in water. After that, the water fills various catchment basins, beginning at the local minima with the lowest intensity value. During the immersion process, dams are constructed to prevent the merging of water from various minima. Dams corresponding to the image's watershed surround each local minimum after the process. For up to 64 processors, this algorithm is fast and parallelized, with a reported almost linear speedup. It creates a total division of the picture into independent locales, in any event, when the difference is poor, and evades the requirement for shape joining. There are three primary techniques for executing the watershed calculation: the distance change approach, the slope technique, and the marker-controlled approach.

3.3.1 DISTANCE TRANSFORM APPROACH:

For image segmentation, the distance transforms and the watershed transform are frequently utilized together. It estimates the separation from each pixel in a picture to the closest non-zero pixel and can be figured utilizing the best capability. Using various distance transform functions, a binary image can be transformed into a gray-level image with varying effects. For instance, the city block distance transform can cause image components to be over-segmented due to its diamond-shaped propagation, while the Euclidean distance transform may result in "salt and pepper" over-segmentation. On the other hand, because it propagates in a square shape, the chessboard distance transform can help reduce the jaggedness of the Euclidean distance transform and prevent the city block distance transform's over-segmentation.

3.3.2 GRADIENTAPPROACH:

The gradient magnitude is frequently used as a pre-processing step to prepare a grayscale image for watershed transform segmentation. This produces a high pixel esteem along the edges of items and low pixel esteems somewhere else. At the point when the watershed change is applied, it brings about watershed edge lines along the edges of articles. Over-segmentation, on the other hand, frequently hinders this approach. By providing a global analysis of the image and significantly reducing noise-induced unwanted contours, the topological gradient approach addresses this issue. According to the findings of the experiments, this method is capable of reducing excessive segmentation and producing superior segmentation results when compared to the conventional watershed method. Additionally, this method divides the segmentation procedure into two steps: first, identifying the image's main edge, and then calculating the gradient's watershed.

3.3.3 MARKER CONTROLLED METHOD:

While straightforwardly applying the watershed change to a slope picture, the presence of clamour can cause over-division, meaning an enormous number of portioned districts. Markers are used to control the segmentation in order to address this issue. In an image, markers are connected parts that can be internal, which belong to interesting objects, or external, which belong to the background. Marker-controlled watershed division is an adaptable and hearty technique for dividing objects with shut shapes communicated as edges. The division interaction includes figuring a division capability, deciding closer view markers (masses of pixels inside objects), deciding foundation markers (pixels not piece of any item), changing the division capability to just have minima at marker areas, and registering the watershed change of the altered capability. With this method, foreground and background locations can be better separated.

CHAPTER 4
IMAGE FEATURE EXTRACTION

4.1 WHAT IS FEATURE EXTRACTION?

Feature extraction is a critical step in computer vision and image processing because it marks the transition from pictorial to non-pictorial data representation. It involves reducing the number of resources required to describe a large set of data and constructing combinations of variables to describe the data with sufficient accuracy. Because it marks the transition from pictorial to non-pictorial data representation, feature extraction is an essential step in computer vision and image processing. It includes diminishing the number of assets expected to depict a huge arrangement of information and developing mixes of factors to portray the information with adequate precision. Because of the large number of variables involved, complex data analysis necessitates feature extraction to avoid overfitting and poor generalization to new samples. A lot of people who work in machine learning think that the best way to build a good model is to optimize feature extraction. Highlight extraction has been utilized in numerous applications, including character acknowledgment, record confirmation, perusing bank store slips, and looking at arranging. 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 features, and Gabor feature are among the most frequently used methods for extracting features. The essential undertaking of example acknowledgment is to take an info design and appoint it to one of the conceivable result classes. Pattern recognition consists of two general stages: feature selection and classification, and feature selection are essential to the process. The objective of component extraction is to separate a bunch of highlights that boost the acknowledgment rate with the most un-number of components and produce comparative capabilities for various occurrences of a similar image.

4.2 WHY FEATURE EXTRACTION IS USEFUL?

In machine learning, important information is extracted from data through a process called feature extraction. There are two kinds of methods for extracting features: both with and without supervision. Unsupervised learning employs unlabelled examples, whereas supervised learning makes use of labelled examples to identify the most crucial characteristics for predicting performance on new examples. Reducing redundant data and increasing machine learning process efficiency are two benefits of feature extraction. Segmentation is used to break up a large dataset into smaller subsets during the feature extraction phase, where features are extracted from each subset to create a model for making predictions in the future. There are different procedures accessible for including extraction and the choice of a reasonable technique is pivotal for accomplishing high acknowledgment execution. Nodal observation uses eye movements to generate data points indicating where people look when they see an image, while pixel-level segmentation identifies similar pixels in an image and groups them according to their similarities.

Segmentation:

Segmentation is a process of dividing a larger dataset into smaller subsets or segments based on some criteria such as similarities, differences, or patterns. In computer vision and image processing, segmentation involves dividing an image into different regions or segments based on visual characteristics such as color, texture, or intensity. In natural language processing, segmentation can refer to breaking down a text into smaller units such as words, phrases, or sentences. The purpose of segmentation is to simplify the analysis of data and extract relevant information from the data subsets. The process of dividing a large dataset into smaller subsets or segments based on specific criteria like patterns, similarities, or differences is known as segmentation. Segmentation is a technique used in computer vision and image processing to divide an image into various regions or segments based on visual characteristics like intensity, color, or texture. Segmentation is the process of breaking down a text into smaller units like phrases, words, or sentences in natural language processing. The primary goal of segmentation is to make data analysis easier and to find relevant information in smaller data subsets.

Extraction:

Extraction is the process of converting unprocessed data from a source into a format that can be used for analysis and decision-making purposes. For instance, it could involve transforming an email list to extract customer names and adding them to a database, or converting raw data from web logs into a more usable format.

4.3 APPLICATIONS OF FEATURE EXTRACTION:

Applications for feature extraction are used to extract significant data characteristics or information, which can then be used to construct models or make predictions. Applications for feature extraction include image processing, a bag of words, and autoencoders. Machine learning algorithms are made to work better with these applications, especially for things like object detection and image recognition. Because it enables us to extract more information from our data than we could with a straightforward analysis, feature extraction is crucial. The bag of words method of text analysis is useful for tasks like sentence segmentation and text classification because it presents the text as a list of words. In feature extraction, image processing involves extracting relevant features from an image and providing them to machine learning algorithms as input. A type of neural network known as an autoencoder is capable of learning how to automatically convert input data into output data.

Processing images: For image classification, facial recognition, and object recognition, feature extraction can be used to extract features from images.

Recognition of speech: For tasks like speaker identification and speech recognition, features can be extracted from speech signals with feature extraction.

Using feature extraction, relevant features can be extracted from raw data for use in machine learning model training or analysis. A few instances of uses of element extraction include:

Analyzing a text: For tasks like sentiment analysis, topic modeling, and spam detection, features from the text can be extracted using a bag of words and other feature extraction methods.

Processing images: For image classification, facial recognition, and object recognition, feature extraction can be used to extract features from images.

Recognition of speech: For tasks like speaker identification and speech recognition, features can be extracted from speech signals with feature extraction.

Bioinformatics: For purposes such as the prediction of protein structure and the analysis of gene expression, feature extraction can be used to extract features from genetic and proteomic data.

Finance: Financial data features can be extracted using feature extraction for tasks like stock price prediction and fraud detection.

In general, a feature extraction is a powerful tool that can be used in a wide range of fields to extract relevant information from complex data sets.

4.4 WHAT IS PIXEL?

The pixel is the smallest unit of a computer monitor or television display. A pixel can be red, green, or blue.

In a matrix of pixels, each pixel has a value from 0 to 255. The number of pixels in an image is determined by the dimensions of the image--the number of rows and columns.Pixel values are the smallest unit of digital colour. They're used to represent red, blue and green in an image.

Matrices are used to combine pixels into an image. For example, if you have a red pixel at location (0, 0) and a blue pixel at location (0, 1), then you would add them together to get a total of 3 pixels: (red + blue)/2 = 2 + 1 = 3. The good thing is that a pixel cannot be seen as they are very small which result in a smooth and clear image rather than "pixelated." Each pixel has a value, or we can say a unique logical address. It can have only one colour at a time. Colour of a pixel is determined by the number of bits which is used to represent it. A resolutionof a computer screen depends upon graphics card and display monitor, the quantity, size and color combination of pixels.

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.

The bounding box of a binary object is the smallest rectangle that contains all the pixels within it. The bounding box of a binary object is an important part of the definition of what it is because it can be used to determine how big an object is, how far away it is from another object, and how much light it reflects.

The stats object holds information about the bounding box of each object in the scene. It contains three properties: width, height, and depth. The width and height properties represent the width and height of the bounding box respectively; these values can be used to determine whether or not an object has been placed within a certain area using raycasting methods such as ray casting or point cloud processing methods such as point clouds (which are useful for determining if an object has been placed within a certain area). The depth property represents how deep into space that this object's pixel data extends; this value can be used by developers who wish to render their models using multiple passes over their models instead of rendering them once at full resolution.

[region props] are a way to define a region within a binary object. The bounding box of the object is defined as the smallest area which contains all of the regions in the object and no more than one region.

The syntax for defining these props is given below:

<prop name="region prop"><box-length> #number of pixels in the box</box-length><box-width> #number of pixels in the box</box-width><box-height> #number of pixels in the box</box-height><top-left corner x>,<top-left corner y>,<top-right corner x>,<top-right corner y></top-left corner x>,<top-right corner y>,

4.5.1 DEFINITIONS RELATED TO REGIONPROPS

A region, also known as a face in graph theory, is a connected region in the plane that is bounded by the edges of a planar graph. Understanding a planar graph's structure and behavior requires an understanding of the properties of its regions. These properties incorporate the level of every area (i.e., the number of edges that bound the locale), the number of levels, everything being equal, and the number of districts in the chart. These properties can be utilized to determine different imbalances and hypotheses connected with planar diagrams.

"PixelIdxList," which is a vector that contains the indices of the pixels in the region, "PixelList," which is a matrix that contains the coordinates of each pixel in the region, and "Solidity," which is only applicable to 2D images, is the ratio of the area of the region to the area of its convex hull.

BoundingBox: Bounding boxes are used to define regions in space. They are defined by three points, which are called corners. Each corner can be described by two coordinates (x1 and y1), which represent its distance from the origin (0, 0).

Centroid: The centroid of a region is defined as the point at which its bounding box intersects with the axes. It is also called "centre of mass".

ConvexImage: A convex image is an image that can be described by only one direction (vertically or horizontally).

ConvexArea: A convex area is an area that has no holes or crevices. Its shape can be described as "elongated rectangle", "rectangle", etc.

Area: The area of a region is the sum of all its bounding box's area.

Eccentricity: Eccentricity describes how far from a centre point someone needs to go before they reach another centre point on an arc (or circle). This value ranges from 0

Eccentricity: The inverse of the radius of a circle.

EquivDimeter: The length of the equator divided by its radius.

EulerNumber: A number that is equal to or greater than zero and less than or equal to one in decimal notation. For example, e=2.718281828459045235361795036842105 2732. The Euler number is also called "e."

Extrema (numerical): A point on a function whose values are 0 or 1. Extrema are also called "maxima" or "minima." Extrema point on a function with real-valued arguments is called an "absolute maximum" or an "absolute minimum." Truncated functions have only positive extrema points.

FilledImage: A region that is filled with an image.

Image: A region that contains an image.

MajorAxisLength: The length of the major axis of the ellipse. Orients the ellipse along its major axis.

Orientation: The orientation of the ellipse. Can be horizontal or vertical.

Perimeter: The length of the perimeter of the ellipse. Can be used to compute area and perimeter given a known radius, which can then be used to calculate other properties such as area and volume using formulas from trigonometry.

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:

1. The sum of all the vertices' degrees on a planar graph with 'n' vertices are n i=1 deg(Vi) = 2|E|

2. As per the Amount of Levels of Districts Hypothesis, in a planar diagram with 'n' locales, Amount of levels of locales is -

n ∑ i=1 deg(ri) = 2|E|

In light of the above hypothesis, you can reach the accompanying determinations −

In a planar chart,

- If level of every area is K, the amount of levels of locales is

K|R| = 2|E|

- If the level of every area is essentially K (≥ K),

K|R| ≤ 2|E|

- If the level of every area is all things considered K(≤ K),

K|R| ≥ 2|E|

Note − Accept that every one of the areas has the same degree.

3. • If a planar graph with 'K' components is a connected planar, then |V| + |R|=|E| + (K+1), where |V| is the number of vertices, |E| is the number of edges, and |R| is the number of regions, according to Euler's formula for planar graphs.

4. Edge Vertex Imbalance

If 'G' is an associated planar diagram with the level of every district essentially 'K' then,

|E| ≤ k/k - 2{|v|-2}

You know, |V| + |R| = |E| + 2

K.|R| ≤ 2|E|

K(|E| - |V| + 2) ≤ 2|E|

$(K - 2)|E| \leq K(|V| - 2)$

$|E| \leq k/k - 2\{|v| - 2\}$

5. There is at least one vertex V G, such that deg(V) 5 6. If "G" is a straightforward connected planar graph, then |E| 3|V| 6 |R| 2|V| 4 If 'G' is a straightforward associated planar chart (with no less than 2 edges) and no triangles, then, at that point,

$|E| \leq \{2|V| - 4\}$

7. Kuratowski's Theorem A graph called "G" is non-planar only if it has a subgraph that is homomorphic to either K5 or K3,3.

4 major regions:

'ConvexHull'

'ConvexImage'

'ConvexArea'

'FilledImage'

CHAPTER 5

CLASSIFICATION

5.1 CLASSIFICATION

The process of labeling groups of pixels or vectors within an image according to particular rules is referred to as image classification. This can be accomplished utilizing either phantom or textural attributes. There are two primary classification methods: both with and without supervision. In supervised classification, the user selects sample pixels from an image that are representative of particular classes and makes use of those pixels as references for classifying all of the image's other pixels. In unsupervised classification, the software sorts the pixels into classes based on shared characteristics after analyzing the image without the user providing any sample classes. While the algorithm and desired number of output classes can be specified by the user, relating the groupings to actual ground features requires knowledge of the area being classified. For both supervised and unsupervised learning, various algorithms like linear regression, cluster analysis, neural networks, and k-nearest neighbor are utilized.

Supervised Classification

In image processing, a technique called "supervised classification" is used to classify groups of pixels within an image according to particular rules. A user selects training sites that represent particular classes in the image as part of the process. The client then guides picture-handling programming to utilize these preparation destinations as references for the arrangement of any remaining pixels in the picture. The client additionally sets limits in light of ghostly attributes to assemble pixels and assigns the number of classes for the picture. Each information class is statistically characterized, and the image is then classified by choosing which signature it most closely resembles by analyzing the reflectance of each pixel. The development of predictive models for supervised classification makes use of a variety of classification algorithms and regression methods, including linear regression, logistic regression, neural networks, decision trees, support vector machines, random forests, naive Bayes, and k-nearest neighbor, among others.

Unsupervised Classification

Without the need for user-defined classes or training samples, unsupervised classification categorizes pixels or vectors in an image based solely on their inherent properties. The software analyzes the image and creates clusters of pixels that share similar spectral or textural characteristics, each cluster representing a distinct class. The user can choose a specific clustering algorithm and the number of output classes they want, but they can't change anything else about the classification process. However, to interpret the results and assign real-world characteristics to the clusters produced by the algorithm, the user must know the classification area. Cluster analysis, anomaly detection, neural networks, and latent variable models are all common unsupervised classification algorithms.

5.2 SUPPORT VECTOR MACHINE ALGORITHM

Support Vector Machine, or SVM, is a common Supervised Learning technique for Classification and Regression issues. However, it is mostly utilised for Classification issues in Machine Learning.

The SVM algorithm's purpose is to find the optimal lines or judgment boundary that can divide the space with n dimensions in categories so that we may simply place fresh data points in the proper categories in the future. This optimal choice boundary is referred to as a hyperplane.

SVM selects the most extreme points/vectors that aid in the formation of the hyperplane. These extreme situations are known as vectors of support, and the technique is known as the Support Vector Machine. Consider the image below, which shows two distinct groups identified using

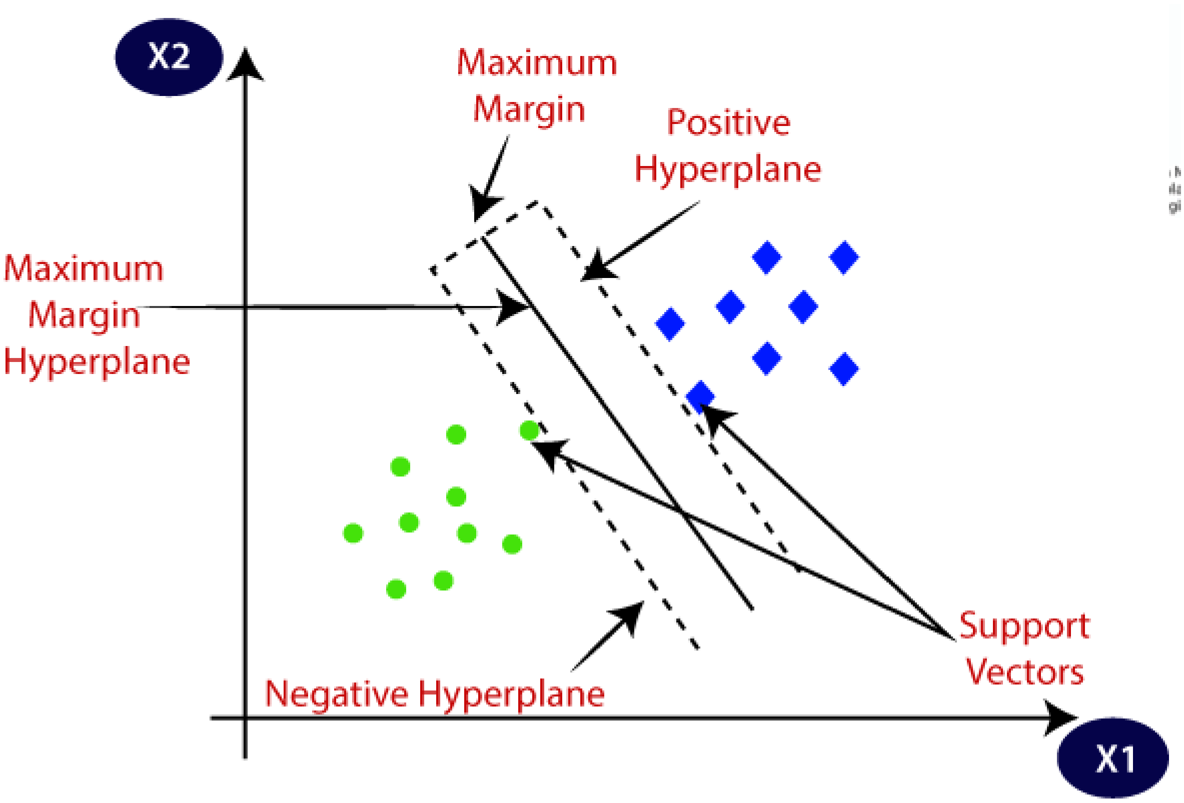


Fig. (5.2.1). Support vector machine

SVM can be of two types:

Linear SVM:

Linear SVM is used for linearly separable data, which means if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is used called as Linear SVM classifier.

Non-linear SVM:

Non-Linear SVM is used for non-linearly separated data, which means if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is called as Non-linear SVM classifier.

5.3HYPERPLANE AND SUPPORT VECTORS IN THE SVM ALGORITHM:

Hyperplane:

Multiple lines/decision boundaries can be used to separate classes in space with n dimensions, but we must select the optimum decision boundary to help categorise the data points. The optimal border is referred to as the SVM hyperplane.

The size of the hyperplane are determined by the number of features in the the data set, which implies that if there are just two characteristics (as shown in the figure), the hyper plane will be a line that is straight. So if there are three characteristics, the hyperplane is a two-dimensional plane.

We always make a hyperplane with a maximal margin, which indicates the shortest distance that can be traveled among the data points.

Support Vectors:

Support Vectors are the information's bits and vectors that are nearest to the hyper plane and have an effect on its location. Because the vectors in question support the hyperplane, they are referred to as Support vectors.

The hyperplane in multi class SVM will be non-linear. For the tumours segmented using the Watershed method, the characteristics retrieved during the feature extraction stage include area, perimeter, eccentricity, and centroid. To train an SVM model, a data set including multiple CT scan pictures of lungs is employed. To determine the stage of each cancer in the system, a fresh picture is imposed. The SVM recognises the stage and shows the associated image according to the maximum score obtained when decoding the stage.

CHAPTER 6

RESULTS AND CONCLUSION

6.1 EXPERIMENTAL RESULTS:

As a stated in the preceding section, based on the stages of the stages of cancer data, various stages are determined for the tumour according to radius values of the tumour. Fig 6.1 shows that cancerous lung cancer CT scan image which was collected from cancer imaging archive (CIA) database. the various experiments proposed in the above section for the lung cancer detection were implemented using MATLAB, which is necessary and suitable for better classification of the stage of the cancer and accuracy in the process of prediction using segmentation and feature extraction. "Fig 6.2, 6.3, 6.4 "illustrates the pre-processing output results namely Grayscale image, Filtered Image, Binary converted Image and "fig 6.5,6.6,6.7,6.8,6.9,6.10,6.11,6.12" shows the segmentation results and feature extraction results of desired regions. "Fig 6.13" exhibits numbering for the tumours detected.

Table 1 shows the regional properties of the tumours that were extracted in the segmentation.

Fig 6.1 CT Scan Image

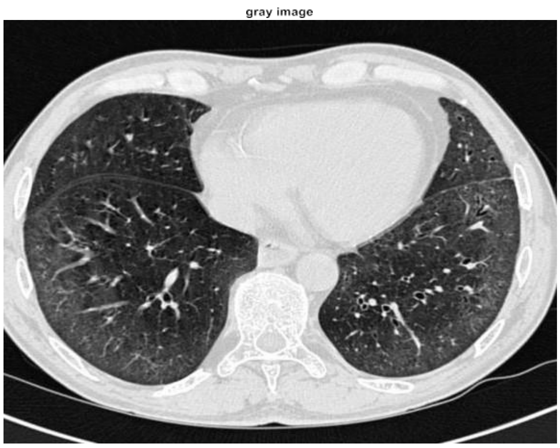


Fig 6.2 Gray scale Image

Fig 6.3 Median Filtered Image

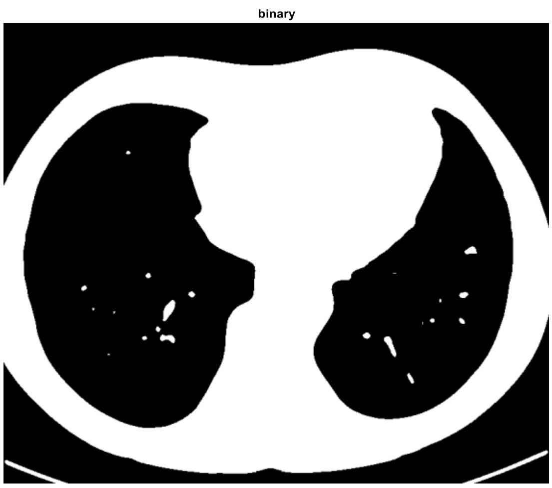


Fig 6.4 Binary converted Image

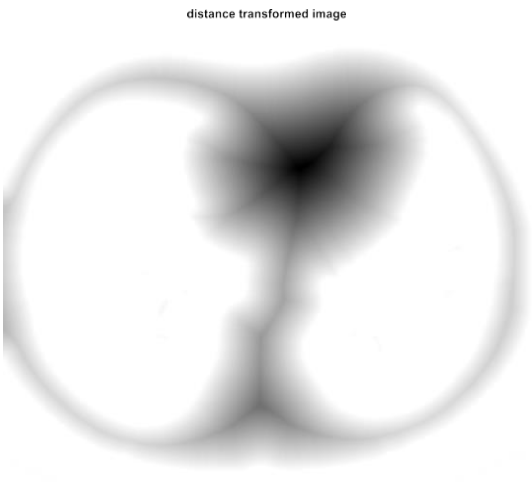


Fig 6.5 Distance Transformed Image

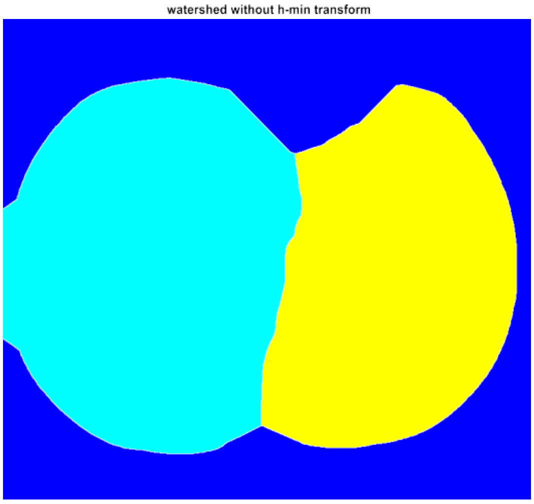


Fig 6.6 Over Segmented Image

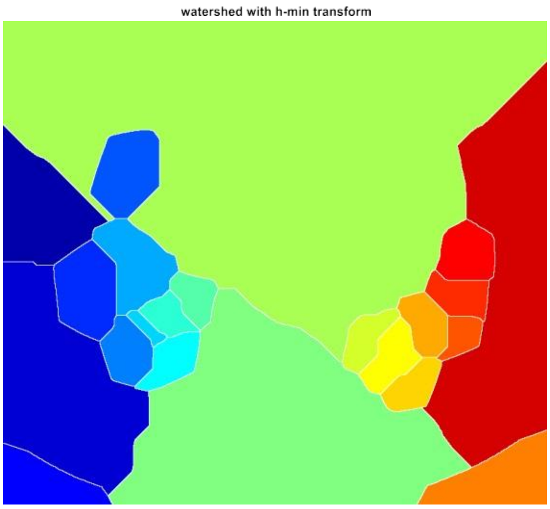


Fig 6.7 Segmented image with H-Minima

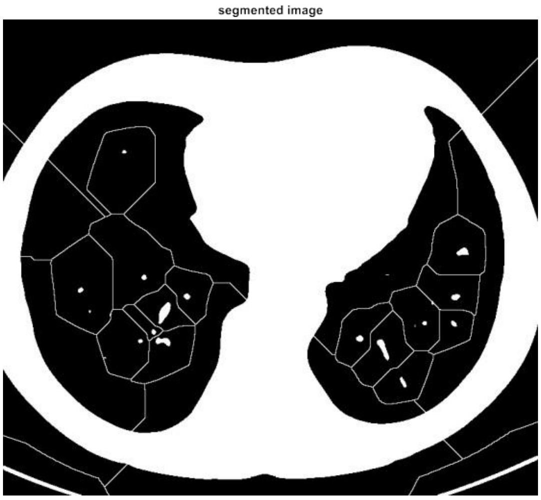


Fig 6.8 Segmented image

Fig 6.9 Big Mask

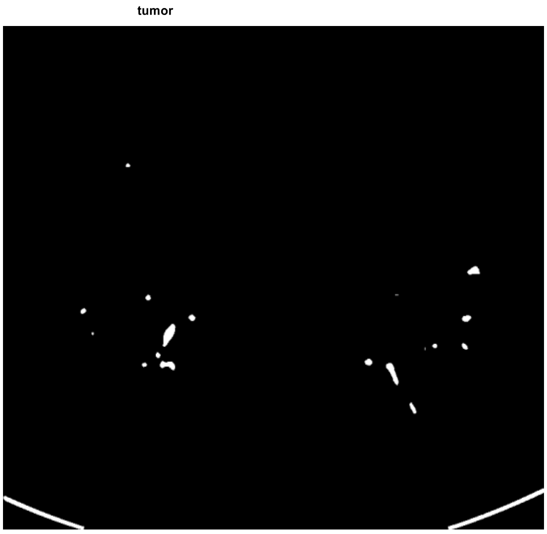
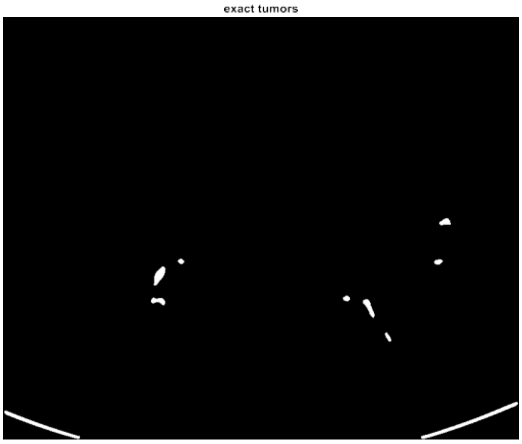


Fig 6.10 Detected Tumour regions



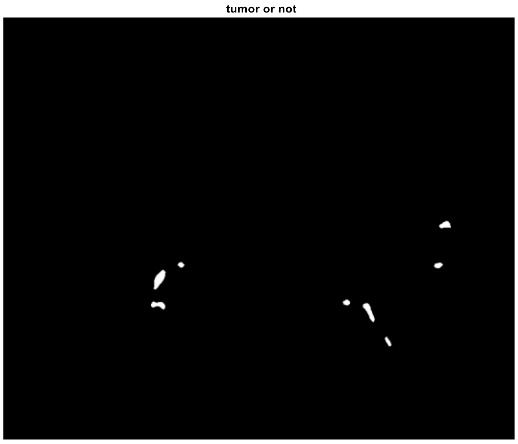


Fig 6.11 Exact tumours

Fig 6.12 Region of Interest

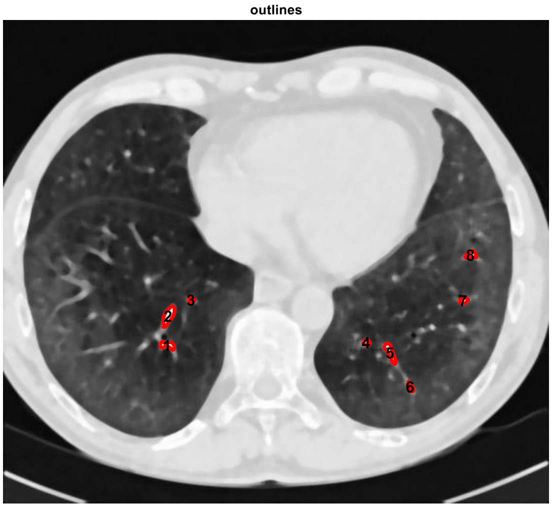


Fig 6.13 Labelling of Tumour Regions

Region	Area	Perimeter	Centroid	Diameter	Eccentricity
1	177	57.3	241.0 476.4	15.0	0.9
2	322	75.6	242.4 433.7	20.2	0.9
3	54	26.6	276.0 410.1	9.0	0.5
4	78	29.2	532.2 472.3	10.0	0.5
5	239	72.9	567.0 487.2	17.4	0.8
6	80	36.2	596.5 537.0	10.1	0.9
7	91	33.1	674.2 410.9	10.8	0.8
8	148	45.3	684.9 344.2	13.7	0.8

Table 1. Regional Features of tumours

The accuracy of proposed model to detected lung cancer stage is highlighted based on these results shown in below table.

REGION	**STAGE**
1	III
2	I
3	II
4	II
5	I
6	II
7	II
8	III

Table 2. Results

6.2 CONCLUSION:

The study carried out in this project entirely is about predicting the stage of cancer using watershed algorithm and any one of the four features extracted. From the results obtained it is observed that using the eccentricity value of the tumour part, that exact tumours are separated. the stage of cancer is classified based on the radius of the tumour (radius values 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 results is an exact finding of cancer stages with accuracy. the motivation behind lung cancer identification is to help that the radiologist and doctors to take an exact decision regarding the cancer stage instantly and this methodology can be used to prevent wrong prediction. 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 and radiologists.

6.3 FUTURE SCOPE:

We are aiming to get more accurate results by using various enhancement and segmentation technique and 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 various survival from the diagnosis disease. future scope could be we can also develop the system as a real time system which means the system will works at the time of diagnosis as well as with the time when we take the computed tomography (CT) images. The technology 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 early treatment so the survival chances can be increase, in future by parameters and area calculations 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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Detection and of lung cancer and identification of tumor stage in image processing using segmentation

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Abstract— **Cancer is an extensive global and universal disease nowadays which pretends to be the most 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 damagingother 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 intodifferent 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, morphology segmentation

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. Cancer is a condition that causes abnormal cell growth with the ability to assault and spread to other parts of the body. Lung cancer may cause due to air pollution, inheritance where familybackgroundmay have lung cancer, exposure to any harmful radiation gases, carcinogens, and of course smoking also. Cancer cellsfrom the breast, kidney, or any other organs canbe carried away in the blood or the lymph fluid to the lungs. Suppose ifcancer cells from the breast spread to the lungs, itis metastaticbreast cancer, not complete lung cancer, but thelungs 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 orradiologists.

CT stands for computerized tomography, a procedure that involves sending X-rays through the human body. Although there are numerous different image processing techniques and technologies, including MRI, Ultrasound, DEXA, X-ray,and PET, a CT scan is the most highly recommended for 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 thirdreason 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 CTimage 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] which is used to remove the salt and pepper noise effectively rather than the other filters such as smoothing or order statistics filters. Thenconversion 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 whitepixel 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 whichnot 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.

I. METHODOLOGY

Implemented methodology

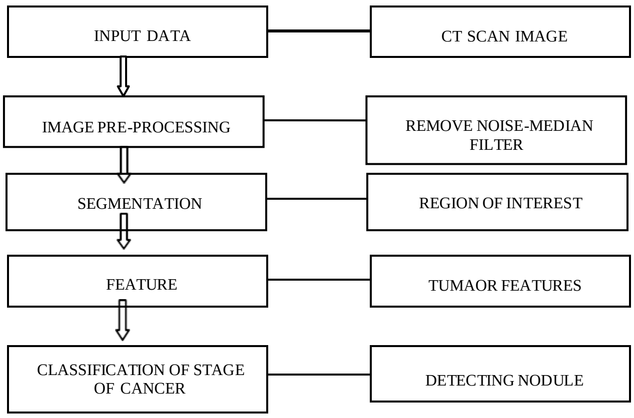


Figure 1.Implemented methodology

II. PRE-PROCESSING

Generally, CT scan images, Magnetic Resonance Image (MRI) and other techniques provide more effective information about the anatomy of the human body in the diagnosis process. Whereas the CT scan images mainly have salt and pepper noises (impulse noise) and Gaussian noise which are effectively eliminated by using the median filtering approach.

The median filter is a kind of smoothing technique which can effectively remove the noise in smooth patches or smooth regions of the image, but adversely affect edges. Often though, by preserving the edges the noise can bereduce for better result. Edges are the critical and very important for the visual appearance of the images. The median filter is demonstrably better then Gaussian blur at removing noise whilst preserving the edges for a given fixed widow size. Whereas, for the speckle noise and salt and pepper noise, it is particularly effective that's why median filter is widely used in the image processing.

Pre-processing is the second step to enhance image quality by suppressing the noise where the median filter is used in this paper. 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 andwhite 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.

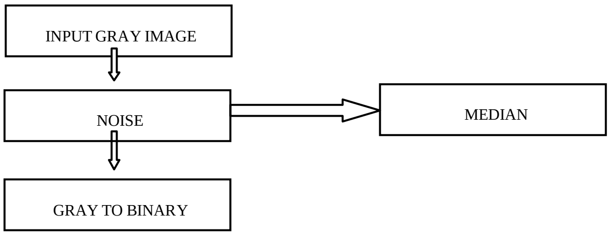


Figure 2.Flow chart for pre-processing

III. SEGMENTATION

Segmentation is the process which divides an image into regions with similar properties such as texture, brightness, and contrast. The medical image segmentation it is more essential to extract the region of interest (ROI) through a semiautomatic or automatic process which divides the image into areas based on specified description for organs, tissues, etc.

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). Morphological image processing pursues the goals of removing the imperfection by accounting form and structure of the image. Whereas the morphological image processing is a collection of non-linear operations related to the shape or morphology of feature in an image by using the erosion and dilation operations.

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. Dilation has the opposite effect to erosion where it adds a layer of pixels to both the inner and outer boundaries of region. 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.

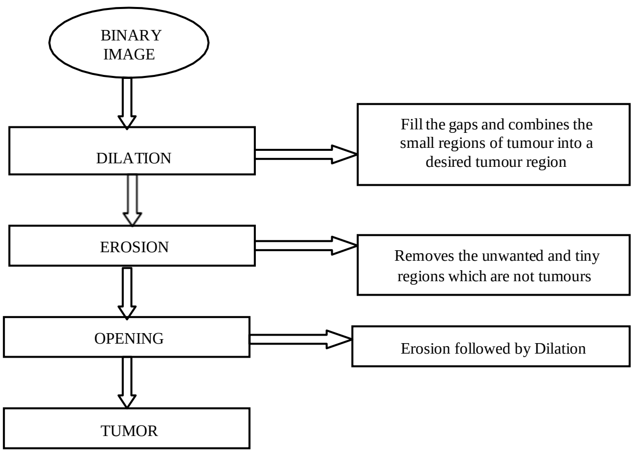


Figure3. Steps implemented in segmentation process

The next big mask is applied using the openingoperation to fill the complete image and now subtracting or removing the eroded image from the big mask image, wegot the exact tumors separated. But by the end ofsegmentation, 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.

A. 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 pixilated 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.

IV. 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

IMAGE	REGION	AREA	PERIMETER	CENTROID	DIAMETER	ECCENTRICITY
1	1	278.0	73.4	125.4 167.4	18.8	0.8
	2	56.0	24.7	156.0 163.1	8.4	0.8
2	1	196.0	51.4	244.6 206.5	15.8	0.8
3	1	180.0	45.6	237.6 172.3	15.1	0.6

Table2. Cancer stages classification based on radius value (R) [7].

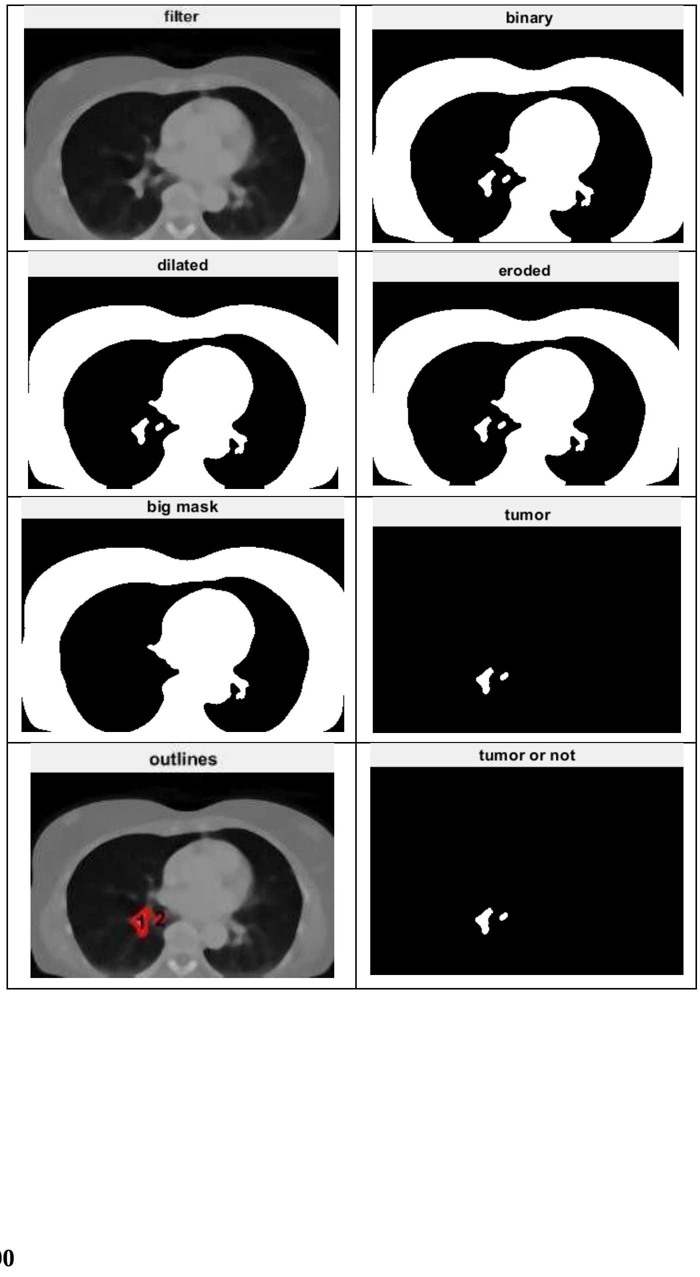
STAGE OF CANCER	REQUIREMENT
I	R < 3 cm
II	3cm < R < 7cm
III	R > 7cm
IV	R > 10 and above

V. RESULTS

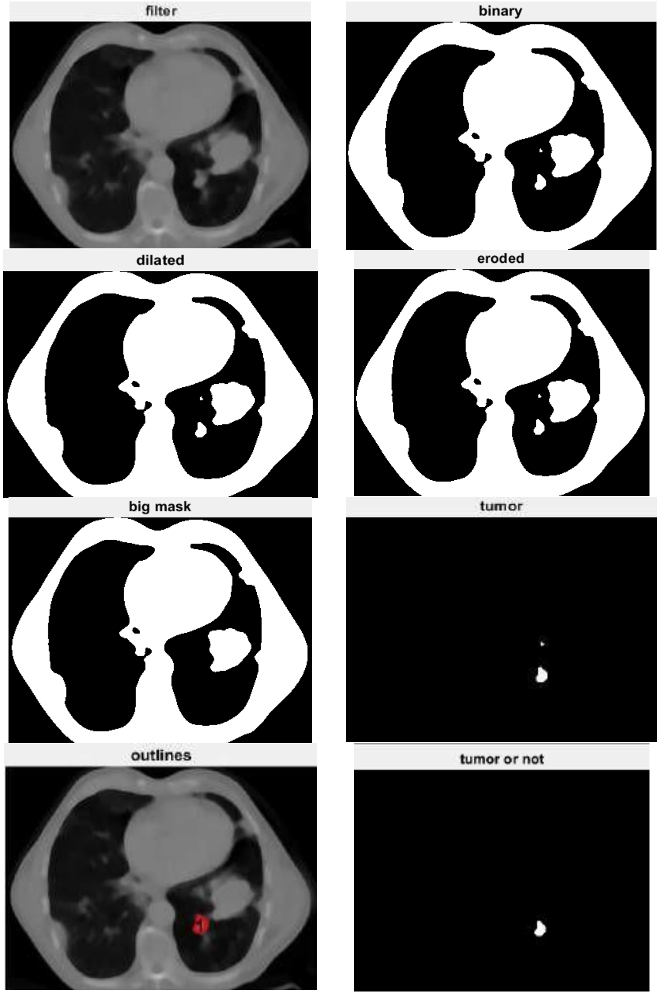
As stated in the preceding section, based on the stages of cancer data, various stages are determined for the tumor according to the radius value of the tumor. –Fig. 4‖ shows cancerous lungs CT scan image which was collected from Cancer Imaging Archive (CIA) database. Thevarious experiments/processes proposed in the above sections for the lung cancer detection were implemented using mat lab, which is necessary and suitable for better classification of the stageof cancer and accuracy in the process of prediction using segmentation and feature extraction.

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

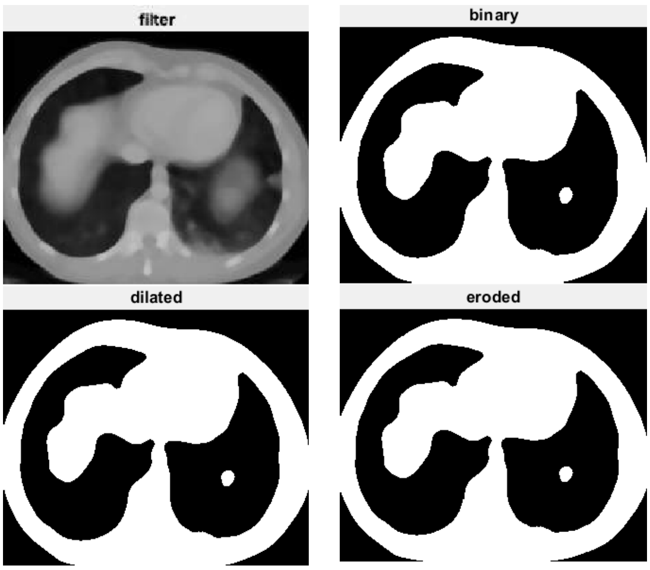
Results for IMAGE-1:

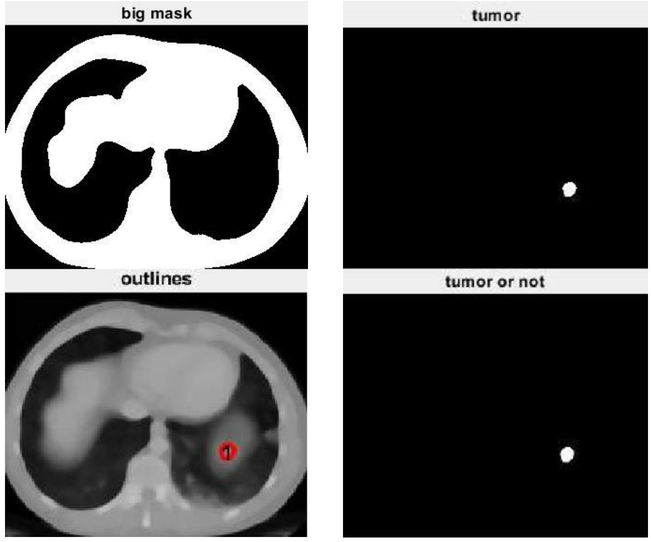


Results for IMAGE-2:



Results for IMAGE-3:





CONCLUSION

Thus, Lung cancer can be detected easily and the stage of the cancer can be identified by using above proposed algorithm. Parameter evaluation is performed using MATLAB 2022a TOOL. The parameters area, perimeter, radius, diameter and eccentricity are obtained for every CT scan lung cancer images.

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