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Lung Nodule Detection Using Image Segmentation Methods

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***Abstract*— Lung cancer is considered as the notable cancer because it claims more than a million lives every year. The early detection of cancer can be helpful in curing the disease completely. The requirement of techniques to detect the occurrence of cancer nodule in the early stage is very much essential. Due to the development and growth in imaging technology and computer science, interpretation of medical images has been significantly refined and has contributed to early diagnosis of cancer. Computer Aided Diagnosis (CAD) is becoming one of the most popular and effective method for diagnosing many diseases including cancer. The main aim of this research is to provide a computer Aided Diagnosis System for detection of lung cancer nodules from the chest computer Tomography images. A computer-aided detection (CAD) system is helpful for radiologists to detect pulmonary nodules at an early stage. In this project, to detect a nodule image segmentation methods like Otsu thresholding method and region growing method are used. This project consists of three steps. First step includes the enhancing the features of CT scan image, and applying the segmentation methods (like Otsu thresholding method and region growing method) on it. Finally, the results are analysed by the two methods.**

I. INTRODUCTION

Pulmonary nodules are small, focal, radiographic opacities that will be solitary or multiple. A classic solitary pulmonic nodule (SPN) could be a single, spherical, well-circumscribed, radiographic opacity measurement but or adequate to thirty millimeter in diameter and is enclosed fully by aerated respiratory organ. Today, most nodules area unit detected by c research streams in medical imaging and diagnostic radiology. A well-developed CAD helps in processing image for detection and extraction of abnormalities and additionally aids in classification of image features between normal and abnormal. In most of the cases CAD offers a really helpful second opinion once specialist examine patient at cancer CT screenings. A CAD system is instrumental in reducing the amount of false negative diagnosis. The success of a CAD system is measured in terms of accuracy in diagnosis, speed and its degree of automation. diagnosis**.** computerized tomography (CT)as a little spherical or oval shaped lesion within the lungs. they need larger radio density than respiratory organ parenchyma, so that they appear white on pictures. respiratory organ nodules would possibly indicate a lung {cancer |carcinoma} and their detection with in the early stage can increase the survival rate of patients. as a result of the development and growth in imaging technology and engineering science, interpretation of medical pictures has been significantly refined and has contributed to early diagnosis of cancer. A computer aided Detection System (CAD) is one among the principal

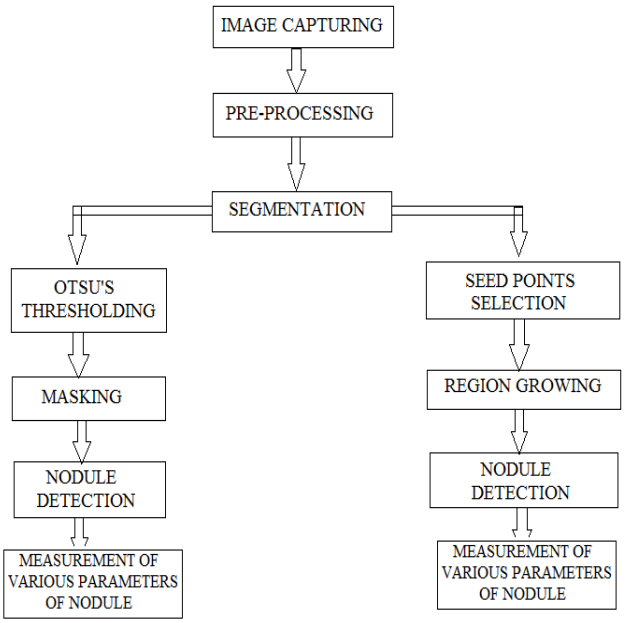

Fig : 1. Block diagram

IMAGE PRE-PROCESSING: This method is to enhance the quality of data through the application of methods for denoising (application of mean filters, median filters, Laplacian filters and Gaussian filters), increasing the edges of image structures (unsharping, wavelet transform), and improving image contrast (histogram equalization).The basic improvement needed in the image is an enhancement in contrast. Contrast between the normal and the tumor region may be present on a MRI but below the threshold of human perception.

SEGMENTATION: This is an essential process for most image analysis. Subsequent task in particular many of the existing techniques for image description and recognition depend highly on the segmentation result. In this Thresholding & region growing segmentation techniques

are used. Thresholding is one of the most powerful tools for image segmentation. The segmented image obtained from thresholding has the advantages of smaller storage space, fast contains 256 levels.

OTSU THRESHOLDING: Among all the segmentation strategies, Otsu methodology is one among the foremost flourishing ways for image thresholding as a result of its straightforward calculation. Otsu is Associate in Nursing automatic threshold choice region based mostly segmentation technique. Thresholding is a crucial technique in image segmentation applications. the fundamental plan of thresholding is to select an optimum gray-level threshold worth for separating objects of interest in a picture from the background supported their gray-level distribution. Thresholding creates binary pictures from grey-level ones by turning all pixels below some threshold to zero and every one pixels this threshold to at least one. If g(x, y) could be a threshold version of f(x, y) at some global threshold T, it are often outlined as ,

g(x, y) = 1 if f(x, y) ≥ T
= 0 other wise
Thresholding operation is outlined as:
T = M [x, y, p(x, y), f (x, y)]
during this equation, T stands for the threshold; f (x, y) is that the gray value of point (x, y) and p(x, y) denotes some native property of {the point|the purpose} such as the average gray value of the neighbourhood centered on point (x, y).
In this equation, T stands for the threshold; f (x, y) is that the gray value of point (x, y) and p(x, y) denotes some local property of {the point |the purpose} like the average gray value of the neighbourhood centered on point (x, y).
REGION GROWING: it's an easy region-based image segmentation technique. it's conjointly classified as a pixel-based image segmentation technique since it involves the selection of initial seed points. This approach to segmentation examines neighbour pixels of initial seed points and determines whether or not the pixel neighbours ought to be value-added to the region. the method is iterated on, within the same manner as general information cluster algorithms.
learning algorithm of the planned algorithm consists of 7 phases:
Phases 1: within the region growing segmentation, the primary aim is to work out the initial seed points and threshold value.
Phases 2: the size of the image is calculated for checking the condition of the loop.
Phases3: Compare the primary initial seed point with neighboring pixels consistent with threshold value.
Phases 4: in this neighboring pixels area unit value-added to the region, if these area unit almost like seed point. in this pixels are added to p and pixel q to the region of pixel p, if (p-q) < T for a few threshold T.
Phases 5: Region growing ought to stop once no a lot of pixels square measure found to satisfy the criteria for inclusion therein region. Then, another seed purpose is chosen that doesn't belong to the other region.
Phases 6: This method is sustained till all pixels (equal to the dimensions of the image) belong to 1 region.
Phases 7: Finally, the realm of the regions is calculated. Indeed, segmentation could be a method that partitions a picture like R into 'n' sub regions, like R1, R2, and R3, …, Rn, such that

$$\bigcup_{i=1}^{n} R_i = R$$

$$R_i \bigcap R_j = \text{ø for all I and j, } \neq j$$

The basic formulation is:

$$(a)\ \bigcup_{i=1}^{n} R_i = R.$$
$$(b)\ R_i \text{ is a connected region, i} = 1,\ 2,\ \ldots,\ \text{n}$$
$$(c)\ R_i \bigcap R_j = \varnothing \text{ for all } i = 1, 2, \ldots, n.$$
$$(d)\ P(R_i) = TRUE \text{ for } i = 1, 2, \ldots, n.$$
$$(e)\ P(R_i \bigcup R_j) = FALSE \text{ for any adjacent region } R_i \text{ and } R_j.$$

$P(R_i)$ is a logical predicate outlined over the points in set R_i and $\varnothing$ is the null set.

(a) implies that the segmentation should be complete; that is, every pixel must be in a very region.

(b) needs that points in a very region should be connected in some predefined sense.

(c) indicates that the regions should be disjoint.

(d) deals with the properties that has to be glad by the pixels in a very segmental region. As an example $P(R_i) = \text{TRUE}$ if all pixels in R_i have the similar grayscale.

(e) indicates that region R_i and R_j area unit completely different in the sense of predicate P.

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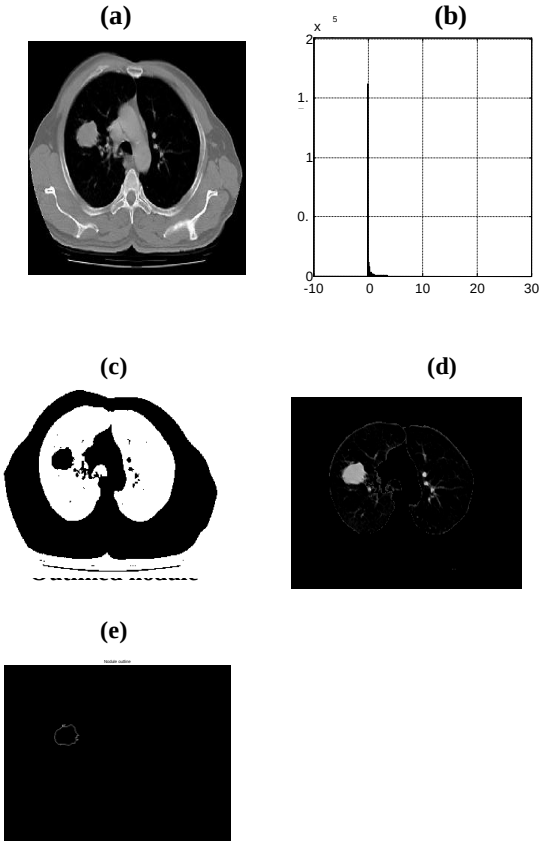
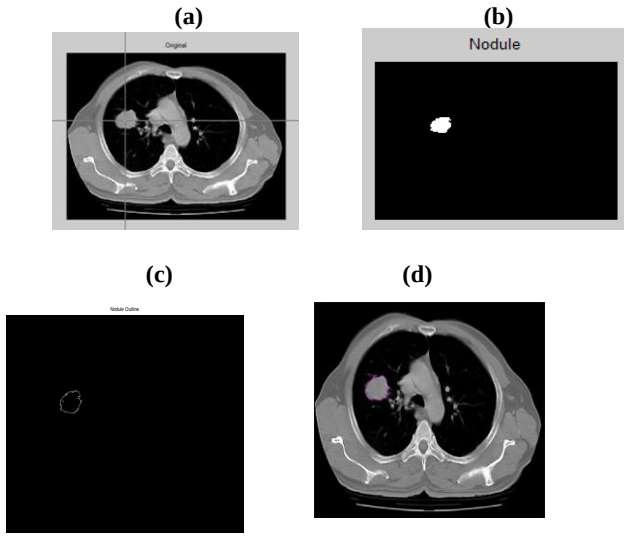
RESULTS

FIG: 2 OTSU THRESHOLDING SAMPLE 1



(a) Gray scale image
(b) Histogram of gray scale image
(c) Binary image
(d) Lung mask
(e) Outlined nodule

FIG: 3 REGION GROWING SAMPLE 1



(a) Original gray scale image
(b) Lung masking
(c) Nodule outline to find perimeter
(d) Outlined nodule to find area

IMPLEMENTATION:

reading the image:

the ct image of lungs is read

PREPROCESSING:

The CT image (if not a gray level image) is first converted into graylevel image and is enhanced by sharpening and contrast adjustment.

NODULE DETECTION:

OTSU THRESHOLDING:

- Histogram of the gray level image is plotted.
- Threshold for the image is obtained using otsu multi thresholding computations.
- Based on the threshold obtained, the gray level image is converted into a binary image.
- The lungs region is obtained as a mask from the binary image.
- Using this mask, the lung region is segmented from the original image.
- From the segmented Image, Nodules can be identified using the lung mask and the binary image.

REGION GROWING:

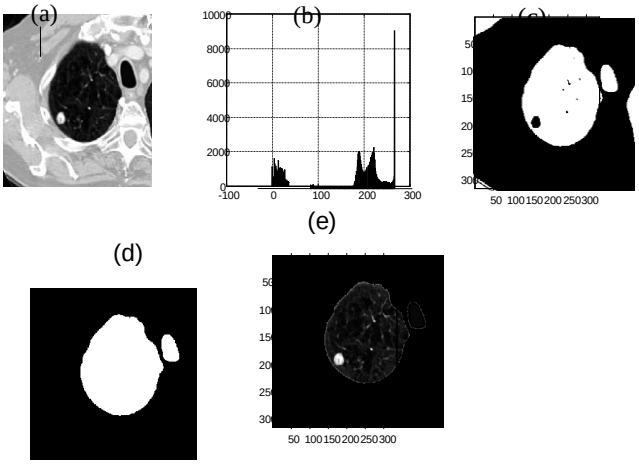
- Seed is selected from the enhanced image. Selection of seed point decides the accuracy of nodule detection.

- The identified nodule's outline is obtained. This outline is marked on the original image. Hence the nodule present is detected and its locationn is obtained.

TRUE POSITIVE (TP):

The case where the nodule present is correctly detected.

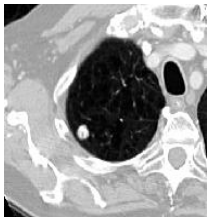
FIG: 4 OTSU THRESHOLDING SAMPLE 2

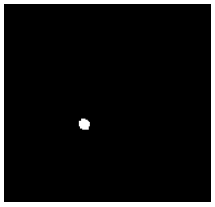


(a) Original gray scale image
(b) Histogram processing
(c) Segmented image
(d) Lung masking
(e) Nodule detection

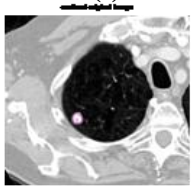
FIG: 5 REGION GROWING SAMPLE 2

(a) (b)





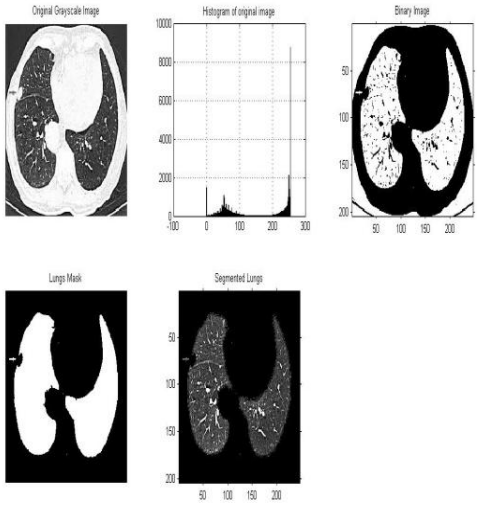
(c)



(a) Nodule location
(b) Nodule outline
(c) Outlined gray scale image with nodule

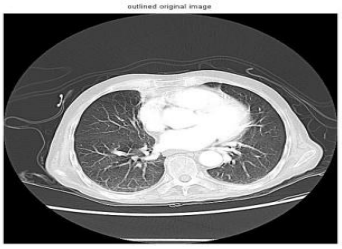
TRUE NEGATIVE (TN):
The case without any nodule is identified correctly.

FIG: 6 OTSU THRESHOLDING SAMPLE 3



(a) Original gray scale image
(b) Histogram processing
(c) Binary image
(d) Lung mask
(e) Segmented lungs

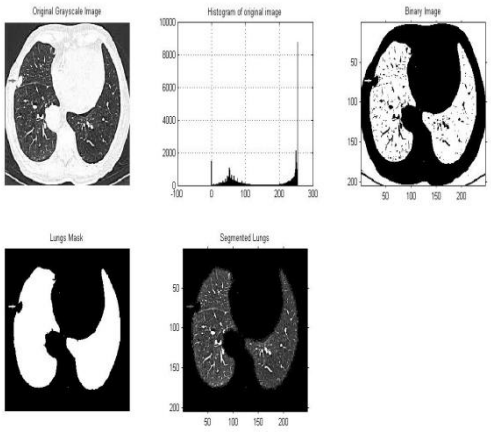
Outlined original image



FALSE POSITIVE (FP): (Only in Otsu Thresholding)
The case where nodule present is not detected.

FIG:7 OTSU THRESHOLDING SAMPLE 4

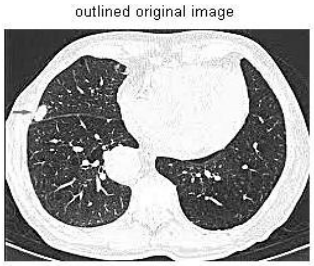
(a) (b) (c)



(d) (e)

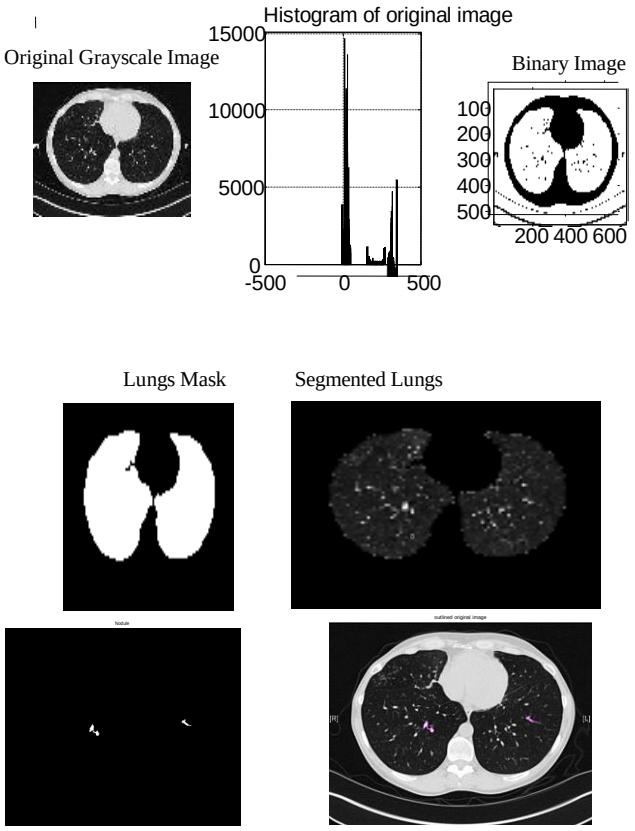
(a) Original image
(b) Histogram processing
(c) Binary image
(d) Lung mask
(e) Segmented lungs

Outline original image



FALSE NEGATIVE (FN):
The case where nodule is not present but it is detected. This happens when a blood vessel or any other structure other a nodule is misinterpreted as nodule.

FIG: 8 OTSU THRESHOLDING SAMPLE 5



Some results of various cases of nodule detection in CT images of lungs are as below:

FIG:9 OTSU THRESHOLDING SAMPLE 6

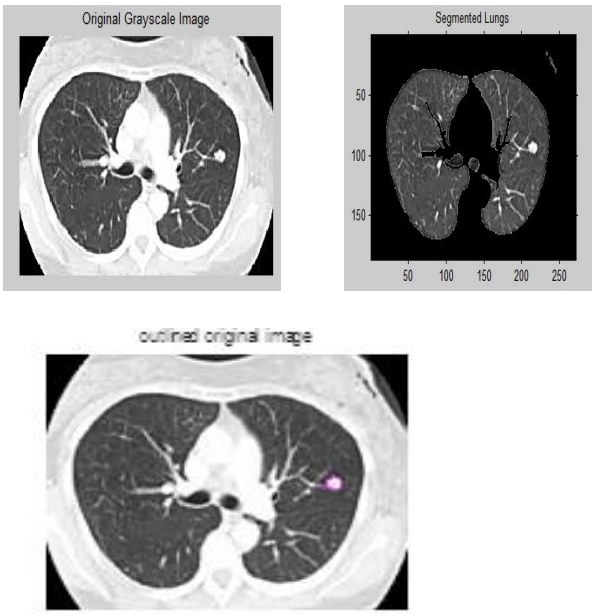


FIG :10 REGION GROWING SAMPLE 6

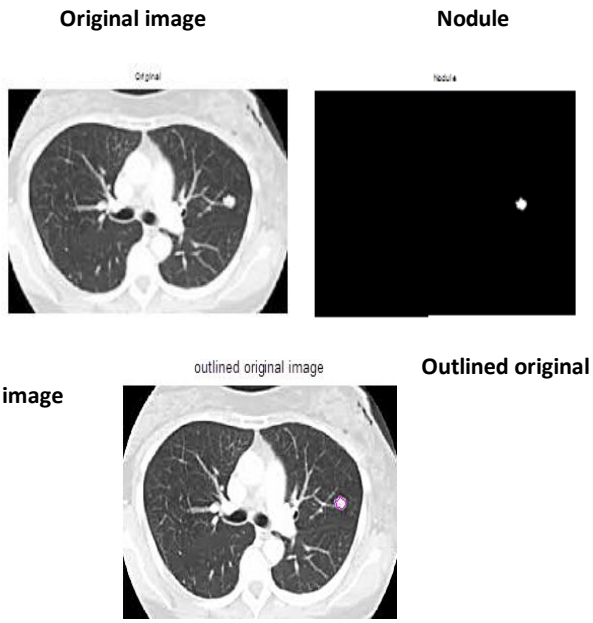


FIG : 11 OTSU THRESHOLDING SAMPLE 7

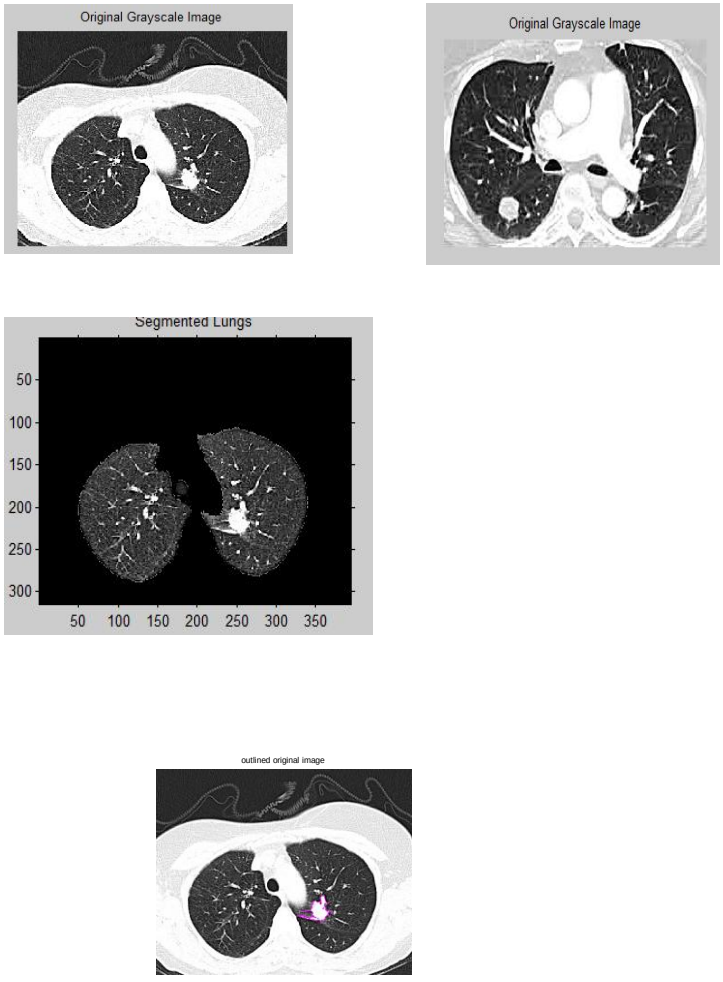
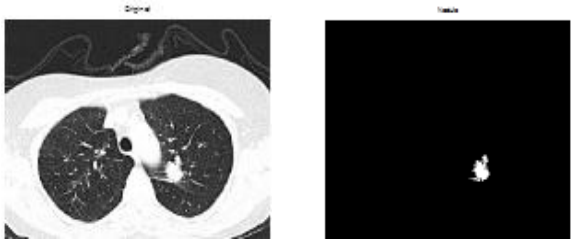
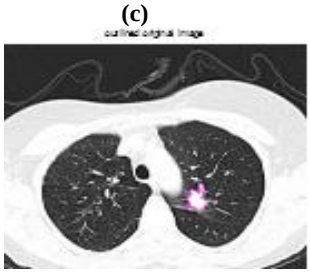


FIG : 12 REGION GROWING SAMPLE 7

(a) **(b)**

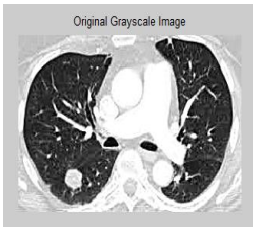


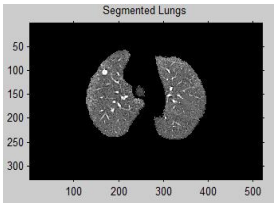
(c)



(a) Original image
(b) Nodule
(c) Outlined original image

FIG:13 OTSU THRESHOLDING SAMPLE 8





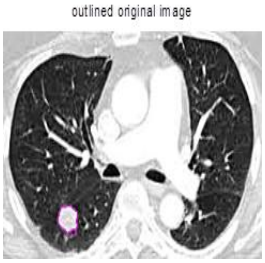
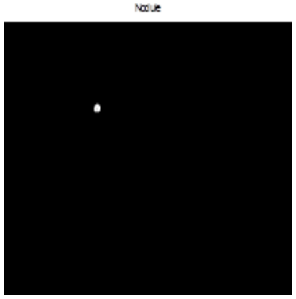
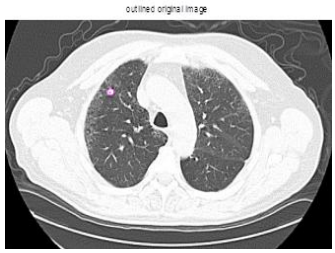


FIG :14 REGION GROWING SAMPLE 8



(a)

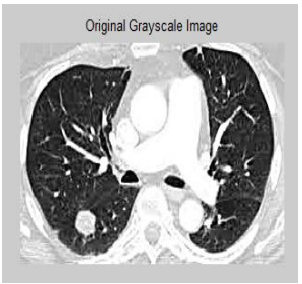


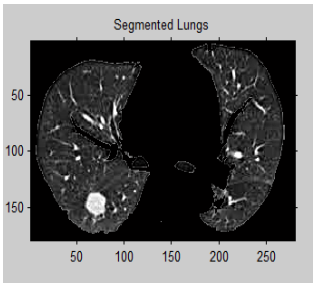
(b)

(c)

(d)

FIG :15 OTSU THRESHOLDING SAMPLE 9





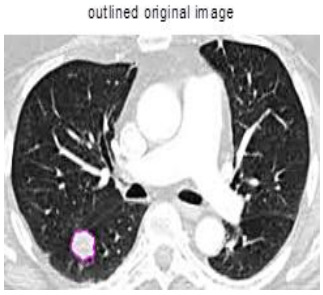
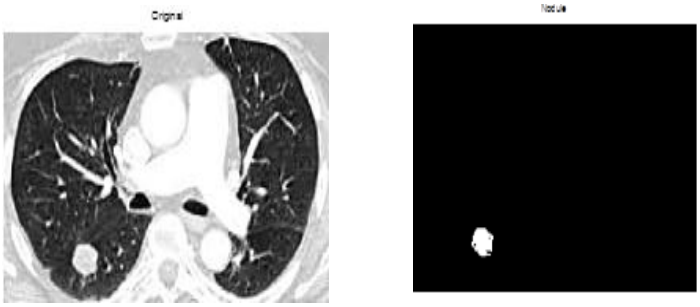


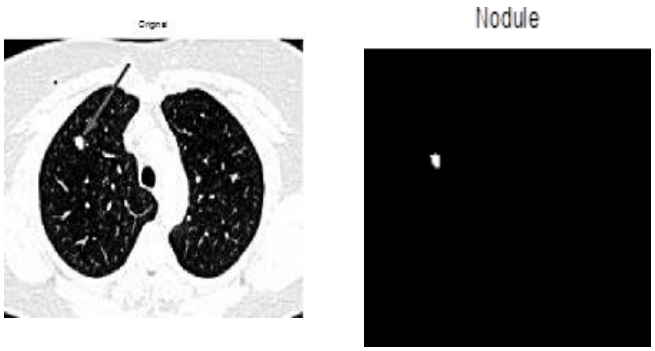
FIG : 16 REGION GROWING SAMPLE 9

(a) **(b)**



(a) Nodule in gray scale image
(b) Nodule

FIG: 17 OTSU THRESHOLDING SAMPLE 10



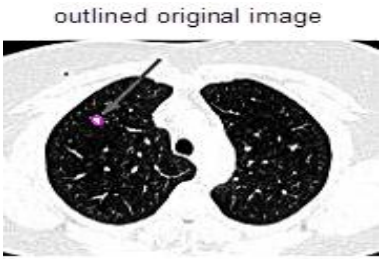
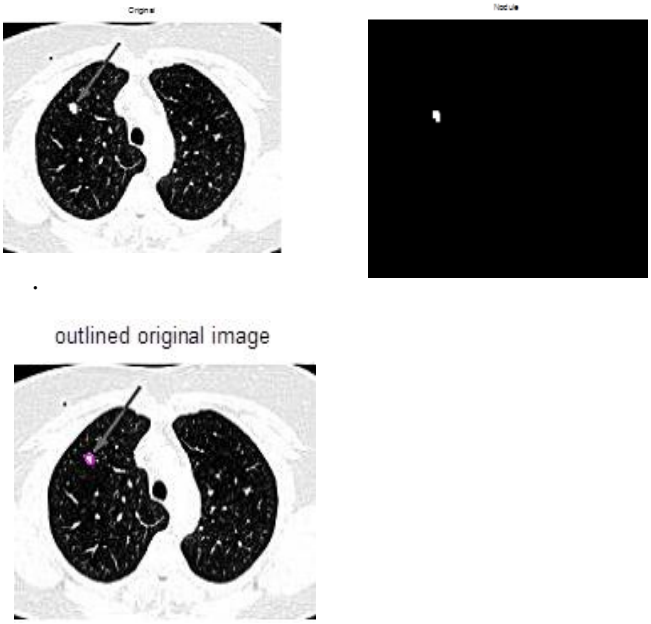


FIG7.18: REGION GROWING SAMPLE 10



(a) Nodule
(b) Nodule in binary image
(c) Outlined nodule

		AREA	CONTRAST	COORELATION	ENERGY	HOMOGENITY
Sample 1	OT	60	0.0025	0.9898	0.98	0.9991
	RG	70	0.0052	0.9783	0.9816	0.9991
Sample 2	OT	16	0.0182	0.9316	0.9879	0.9978
	RG	20	0.0757	0.9877	0.9818	0.9956
Sample 6	OT	8	0.0839	0.9878	0.3969	0.97
	RG	9	0.0824	0.988	0.397	0.97
Sample 7	OT	39	0.0475	0.919	0.9742	0.9951
	RG	30	0.0485	0.9016	0.9889	0.9991
Sample 8	OT	15	0.0137	0.8132	0.996	0.9989
	RG	10	0.0063	0.8729	0.9988	0.9999
Sample 9	OT	16	0.0447	0.9297	0.9786	0.9964
	RG	10	0.0429	0.9319	0.9863	0.9992
Sample 10	OT	3	0.0177	0.8068	0.996	0.9998
	RG	6	0.0227	0.7598	0.9976	0.9996

Table 1: Parameter measurements of Nodule

	NODULE	OT	RG
Sample 1	YES	YES	YES
Sample2	YES	YES	YES
Sample 3	NO	NO	NO
Sample 4	YES	NO	NO
Sample 5	NO	NO	-
Sample 6	YES	YES	YES
Sample 7	YES	YES	YES
Sample 8	YES	YES	YES
Sample 9	YES	YES	YES
Sample 10	YES	YES	YES

Table 2: Detection of Nodule

CONCLUSION:

As Lung Cancer has become one of the most life threatening diseases, early detection of the cancer can be helpful in curing the disease. The requirement of techniques to detect the occurrence of cancer nodule in the early stage is very much essential. Computer Aided Diagnosis(CAD) involving Image Processing techniques for nodule detection helps in the diagnosis of cancer.

In this project, Image Processing algorithms namely region growing and Otsu thresholding are implemented to detect nodules in lungs from a CT Scan image of Lungs. In this 10 samples are considered of various CT scans of lungs. Of them, 2 samples(Sample 3 and Sample 5) doesn't contain any nodules and the remaining others contain a nodule in each.

Of the samples, Otsu Thresholding gave accurate results for 9 samples. For samples 4, Otsu thresholding didn't detect the nodule as the location of nodule is close to the boundary of lungs. In sample 5, there is no nodule, but Otsu Thresholding gave the location of nodule,this is due to the misinterpretation of blood vessels in the lungs.

The sample 4 has a nodule very close to the lung boundary. Region Growing couldn't differentiate the nodule and hence no nodule nodule is detected in this case.

For All the nodules detected, various parameters of the nodules are measured and are tabulated in Table2. These parameters may be further used for classification of benign and malignant nodules in lungs.

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[5] International Journal of Advanced Science and Technology Vol. 38, January, 2012
67 An Efficient Medical Image Segmentation Using Conventional
OTSU Method Ch. Hima Bindu1 and K. Satya Prasad2

[7] ISSN: 2278 – 1323 International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 2, February 2013387 All Rights Reserved © 2 A Review on Otsu Image Segmentation Algorithm Miss Hetal J. Vala, Prof. Astha Baxi

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