Efficient LUNG Cancer detection and monitoring system using medical image segmentation

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Abstract: **Lung cancer, also known as lung carcinoma, is a malignant lung tumor characterized by uncontrolled cell growth in tissues of the lung. The use of image processing for medicinal diagnosis and research is extensively growing and thus improving the lives of people. In the proposed technique uses Magnetic resonance imaging (MRI). Goal of this work is to segmentation of lung parenchyma form MRI scans. Segmentation process used in the proposed technique is Region growing. Region growing methods can provide the clear edges with good segmentation results which is helpful to detect the affected part in lungs. The region growing segmented outputs of MRI are combined to get better results regarding disease. The proposed technique is used to detection and monitoring for better diseases diagnosis. This work will be contributed to technical and medical community.**

Keywords— ***MRI & CT Lung images, Thresholding, Region growing segmentation.***

I. Introduction

Image Segmentation is the process of partitioning a digital image into multiple segments known as super pixels, which aims to simplify and change the representation of an image into some form that is more meaningful and easier to analyze. This provides a platform, where a significant commitment is made during automated analysis by delineating structures of interest and discriminating them from the background. Segmentation of lung tissue is a difficult and laborious task in Computer Aided Diagnosis (CAD) system, to segment the lung parenchyma pathology bearing regions (PBR) from the rest of the chest CT image. CT image provides a vital role in detection of lung cancer. Various segmentation approaches for improving diagnostic accuracy persists. Medical image segmentation can be viewed on two properties. At first, the similarity that focus on dividing an image into some regions based on some conditions and secondly, the intensity depths concerning the discontinuity, dealing with sudden changes in intensity causing the edge. Many data driven approaches have been proposed earlier which includes region growing, clustering, intelligent scissors, grab-cut method, and active contours based approaches etc. These data driven methods may not produce satisfactory results in segmentation when there are noise present in the image or with any low contrast areas, shadows and cluttering. When these things are present in the image then prior knowledge is very necessary for segmenting the given image for producing satisfactory results. Above methods requires some prior information in the deterministic way, ignoring several uncertainties related to the image segmentation process and making very difficult to take users intervention into the segmentation process. Users can give some better ideas and approaches for segmenting the image, segmented results are more satisfactory. Due to this reason, interactive image segmentation is considered to be a preferable solution for segmenting the image.

METHODOLOGY

A. Segmentation

Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (seen edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

- **Pre-processing step:** Image pre-processing is the term for operations on images at the lowest level of abstraction. The aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task. In this step the image is resized to a particular size and color space conversions based on requirement.

- **Region Growing Segmentation:** The region based segmentation is partitioning of an image into similar/homogenous areas of connected pixels through the application of homogeneity/ similarity criteria among candidate sets of pixels. Each of the pixels in a region is similar with respect to some characteristics or computed property such as colour, intensity and/or texture. An initial set of small areas are iteratively merged according to similarity constraints. Start by choosing an arbitrary **seed pixel** and compare it with neighboring pixels. Region is **grown** from the seed pixel by adding in neighboring pixels that are similar, increasing the size of the region. When the growth of one region stops we simply choose another seed pixel which does not yet belong to any region and start again.

II. DESCRIPTION

Proposed Block diagram

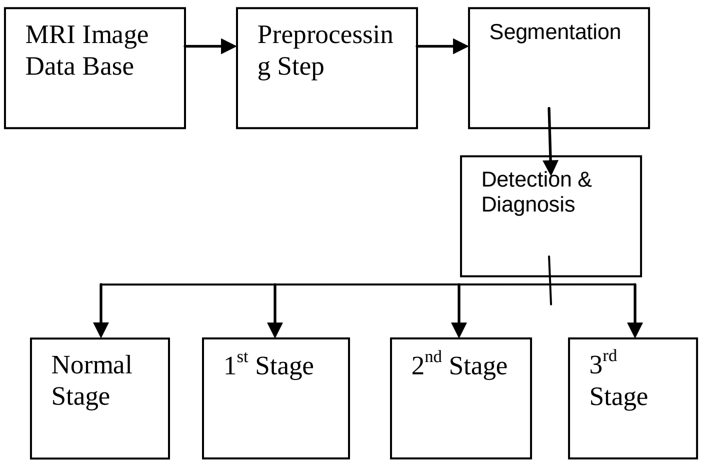

Fig: 1 Block Diagram

In proposed algorithm the inputs are taken from Computer Tomography scan and Magnetic Resonance Imaging scan. Pre-processing steps are applied to the image which includes grayscale contrast enhancement, noise removal and mathematical operations. After preprocessing, the image is applied to segmentation process to extract cancer part present in the lungs image. This process is applied to both the CT and MRI scan images. Segmentation outputs of the CT and MRI are fused for better results. Detection the cancer in the lungs image it is classified in three categories.

Stages of lung cancer:

After a diagnosis is made, doctors will determine the extent of the cancer/stage.

There are four stages of lung cancer, according to the Mayo Clinic:

- Stage I. Cancer is limited to the lung and hasn't spread to the lymph nodes. The tumor is generally smaller than 2 inches (5 centimeters) across.
- Stage II. The tumor may have grown larger than 2 inches, or it may be a smaller tumor that involves nearby structures, such as the chest wall, the diaphragm or the lining around the lungs (pleura). Cancer may also have spread to the nearby lymph nodes.
- Stage III. The tumor at this stage may have grown very large and invaded other organs near the lungs. Or this stage may indicate a smaller tumor accompanied by cancer cells in lymph nodes farther away from the lungs.
- Stage IV. Cancer has spread beyond the affected lung to the other lung or to distant areas of the body.

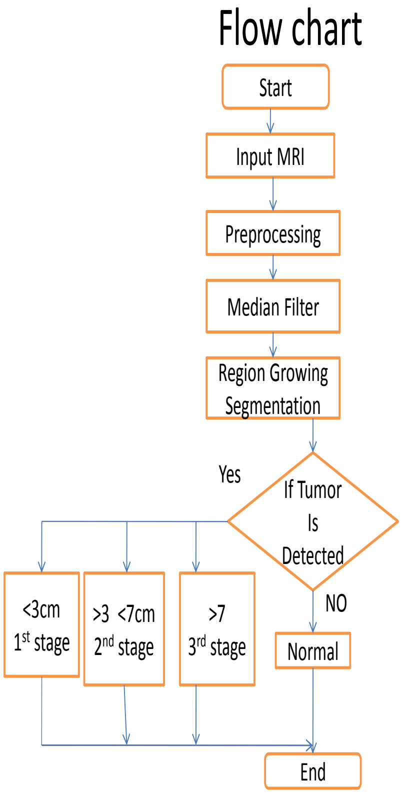

Fig 1.2: Lung cancer Detection Flow Chart

Pre-processing step:

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MEDIAN FILTER:

Median filtering is a nonlinear method used to remove noise from images it is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel over the entire image .The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

Region growing is a simple region-based image segmentation method. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed.

This approach to segmentation examines neighboring pixels of initial seed points and determines whether the pixel neighbors should be added to the region. The process is iterated on, in the same manner as general data clustering algorithms. A general discussion of the region growing algorithm is described below.

Stages of lung cancer:

After a diagnosis is made, doctors will determine the extent of the cancer/stage.

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Staging

Once the above tests have been completed, it should be possible to work out what stage your cancer is, what this means for your treatment and whether it's possible to completely cure the cancer.

Types of lung cancer

Non-small-cell lung cancer

Non-small-cell lung cancer (the most common type) usually spreads more slowly than small-cell lung cancer and responds differently to treatment.

The stages of non-small-cell lung cancer are outlined below.

Stage 1

The cancer is contained within the lung and hasn't spread to nearby lymph nodes. Stage 1 can also be divided into two sub-stages:

- stage 1A – the tumor is less than 3cm in size (1.2 inches)
- stage 1B – the tumor is 3-5cm (1.2-2 inches)

Stage 2

Stage 2 is divided into two sub-stages: 2A and 2B.

In stage 2A lung cancer, either:

- the tumor is 5-7cm
- the tumor is less than 5cm and cancerous cells have spread to nearby lymph nodes

In stage 2B lung cancer, either:

- the tumor is larger than 7cm
- the tumor is 5-7cm and cancerous cells have spread to nearby lymph nodes
- the cancer hasn't spread to lymph nodes, but has spread to surrounding muscles or tissue
- the cancer has spread to one of the main airways (bronchus)
- the cancer has caused the lung to collapse
- there are multiple small tumors in the lung

Stage 3

Stage 3 is divided into two sub-stages: 3A and 3B.

In stage 3A lung cancer, the cancer has either spread to the lymph nodes in the middle of the chest or into the surrounding tissue. This can be:

- the covering of the lung (the pleura)
- the chest wall
- the middle of the chest
- other lymph nodes near the affected lung

In stage 3B lung cancer, the cancer has spread to either of the following:

- lymph nodes on either side of the chest, above the collarbones
- another important part of the body, such as the gullet (esophagus), windpipe (trachea), heart or into a main blood vessel

Stage 4

In stage 4 lung cancer, the cancer has either spread to both lungs or to another part of the body (such as the bones, liver or brain), or the cancer has caused fluid-containing cancer cells to build up around your heart or lungs.

Small-cell lung cancer

Small-cell lung cancer is less common than non-small-cell lung cancer. The cancerous cells responsible for the condition are smaller in size when examined under a microscope than the cells that cause non-small-cell lung cancer.

Small-cell lung cancer only has two possible stages:

- limited disease – the cancer has not spread beyond the lung
- extensive disease – the cancer has spread beyond the lung

Region growing algorithm for image segmentation

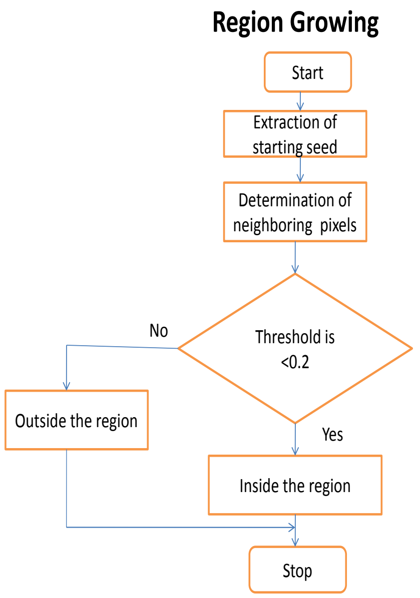

Fig1.3: Region growing flow chart

Region growing:

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If the threshold is less than> 0.2 it means the tumour is inside the region.

If the threshold is <0.2 the is outside the region then it will go back to the determination of neibhourhood pixel point and continuous the process.

EXPECTED RESULTS:

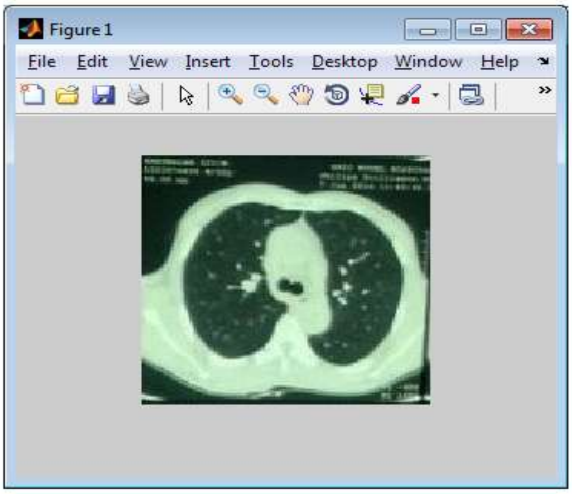


Fig1: Original MRI image (255x255)

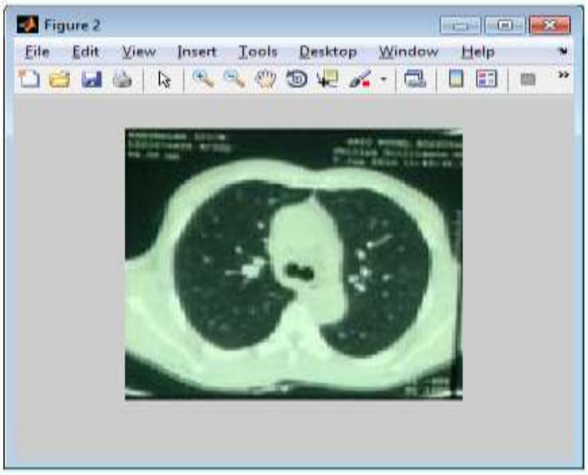


Fig: 2 Resized image (250x250)

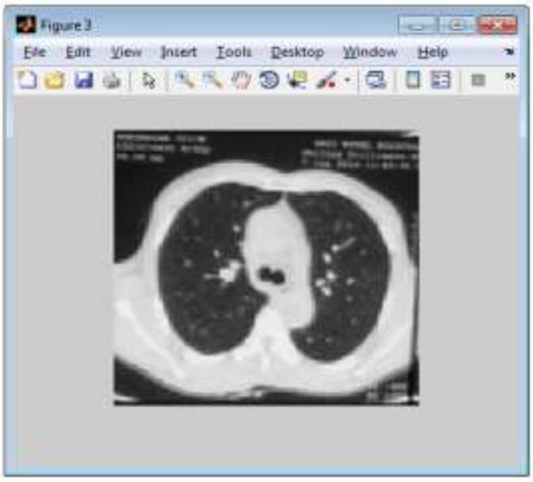


Fig3: RGB To Gray Converted Image

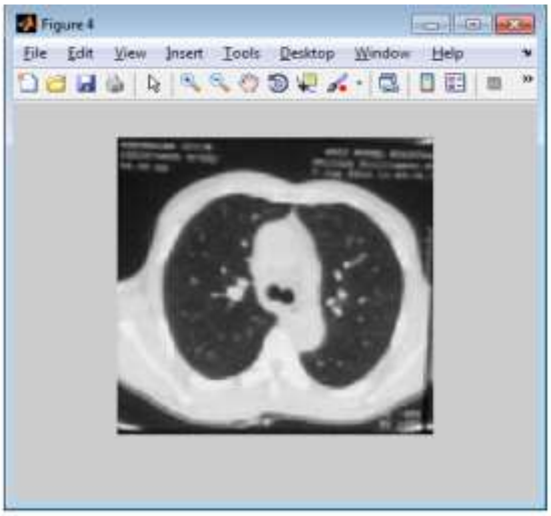


Fig: 4 Filtered Images.

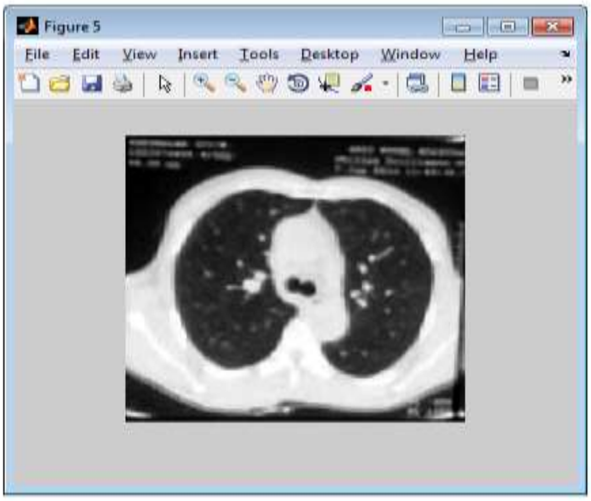


Fig: 5 Image Contrast Adjustments

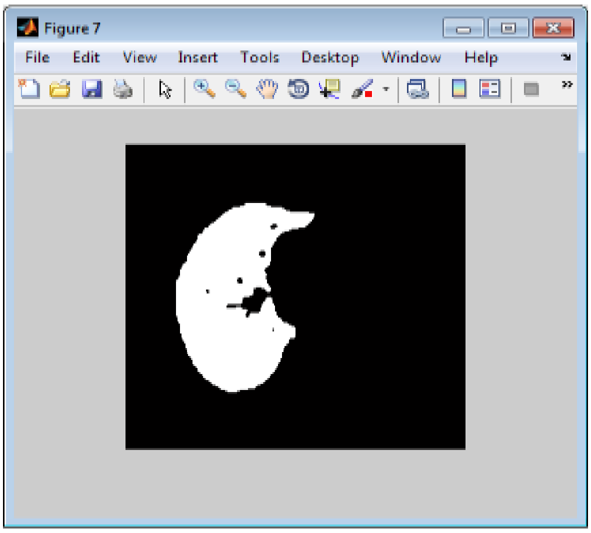


Fig:7 Region Growing Segmentation

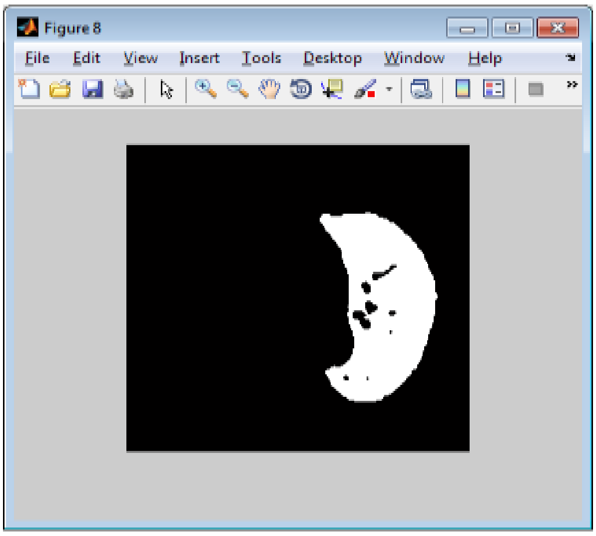
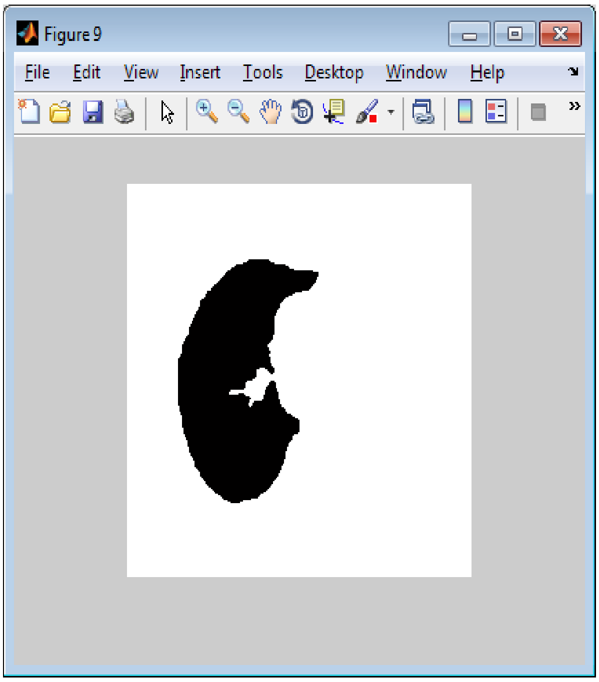
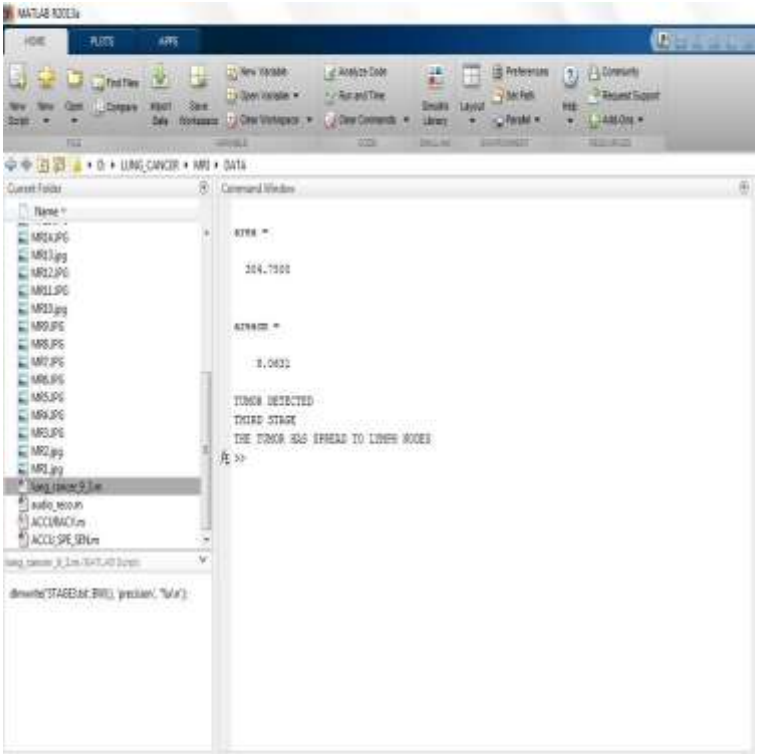
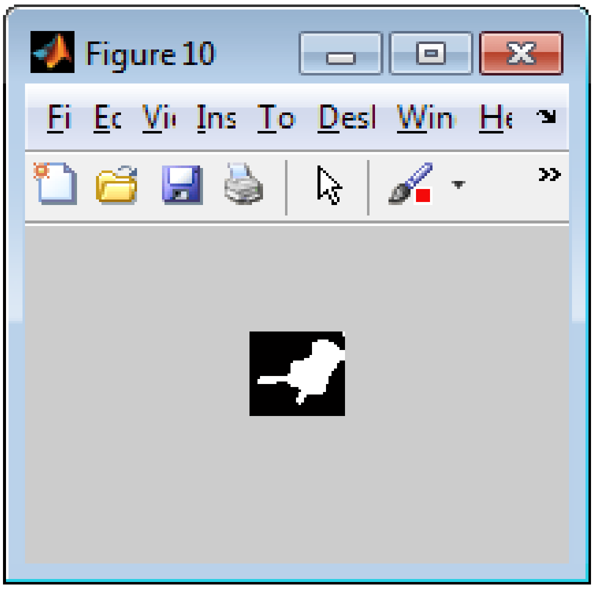


Fig: 8 Complemented Image.

Fig: 9 Complemented Image Fig: 9 Complemented Image



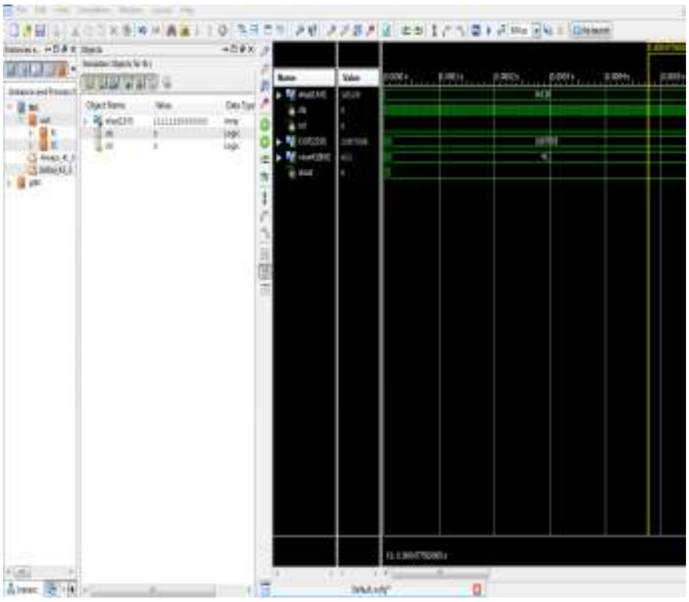


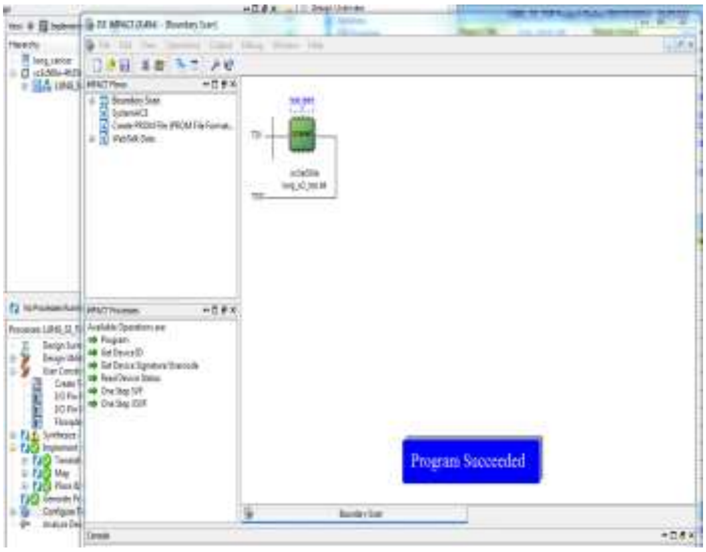


SPARTEN 3E FPGA

Fig: 10 Cropped Tumor Regions

HARDWARE IMPLEMENTATION:





CONCLUSION

MRI scan can be used for lung cancer detection in a healthy population. Lung cancer is the leading cause of cancer death worldwide. The overall 5-year survival rate is approximately 15% in the United States and less than 10% in Europe. Because most lung cancers generate no symptoms at early stages, they are usually diagnosed at an advanced stage and have a poor prognosis. However, many lung cancer deaths could be avoided if tumors were detected at an early stage when they were still resettable. For stage I non-small cell lung cancer, the 5-year survival rate is higher than 80%. Prognosis and treatment outcomes have been found to be related to the disease stage at the time of diagnosis. Various modalities have been investigated for detecting early lung cancer and consequently reducing lung cancer mortality

Until recently, magnetic resonance imaging (MRI) was regarded as an inappropriate tool for lung cancer screening because of its insufficient anatomic detail, along with being time-consuming and expensive. The advanced MRI techniques for lungs have reduced the examination time to less than 10 minute and improved diagnostic sensitivity and specificity.

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