**Pulmonary Nodule Analysis for Lung Cancer Detection in Low Dose CT Images**

**FINAL YEAR PROJECT REPORT**

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**SESSION 2013-2017**

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**(DEC 2016)**

###### STUDENT’S DECLARATION

I declare that this project entitled “Pulmonary Nodule Analysis for Lung Cancer Detection in Low Dose CT Images”, submitted as requirement for the award of BS (CS) degree, does not contain any material previously submitted for a degree in any university; and that to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text.

ABDUL QADIR AHMED ABBASI p13-6108 SIGNATURE:

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**Pulmonary Nodule Analysis for Lung Cancer Detection in Low Dose CT Images**

**APPROVAL**

THE DEPARTMENT OF COMPUTER SCIENCE, NATIONAL UNIVERSITY OF COMPUTER & EMERGING SCIENCES, ACCEPTS THIS THESIS SUBMITTED BY ABDUL QADIR AHMED ABBASI P13-6108 IN ITS PRESENT FORM AND IT IS SATISFYING THE DISSERTATION REQUIREMENTS FOR THE AWARD OF BACHELOR DEGREE IN COMPUTER SCIENCE.

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***ABSTRACT***

*Lung Cancer is a leading cause of cancer related deaths worldwide. Screening high risk individuals for lung cancer with Low Dose CT scans is now being implemented in United States and other countries are expected to follow soon. In CT Lung Cancer screening, many millions of CT scans need to be analyzed, which is enormous burden for radiologists. Therefore there is lot of interest to develop computer aided systems to optimize screening. The goal of this work is to detect Lung Cancer in an early stage, for which Pulmonary Nodules have to be located which are the early manifestation of Lung Cancers. I purpose to work for a system that will automatically detect Pulmonary Nodules in Low Dose CT images and will identify if a subject of interest has Lung Cancer or not.*

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**CHAPTER 1**

INTRODUCTION

**Motivation:**

Lung Cancer is a leading cause of deaths worldwide. The National Lung Screening Trial (NLTS) is a randomized controlled trial in the U.S. including more than 50,000 high risk subjects, showed that lung cancer screening using annual low dose computed tomography (CT) reduces lung cancer morality by 20% in comparison to annual screening with chest radiography [1]. In 2013, the U.S. Preventive Services Task Force (USPSTF) has given low dose CT screening a grade B recommendation for high risk individuals [2] and early 2015, the U.S. Center of Medicare and Medicaid Services (CMS) has approved CT Lung cancer screening for Medicare recipients. As a result of those developments lung screening programs using low dose CT are being implemented in the United States and other countries. Computer Aided Detection (CAD) of pulmonary nodules can play an important role when screening is implemented on large scale.

**Objective:**

To develop a system that detects and classifies Lung nodules in Low Dose CT Images.

**SWOT Analysis:**

**Strengths**

* Annotated dataset available
* Quick, painless and non-invasive approach
* Automatic detection of Lung Cancer

**Weaknesses**

* Noisy input images
* Detection with 100% accuracy not possible due to noisy nature of biological images

**Opportunities:**

* Helpful for radiologists and hospitals
* Ongoing research area

**Threats:**

* Approval from patient privacy law authorities
* No collaboration of academia with hospitals in Pakistan

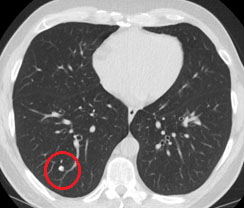
**CHAPTER 2**

LITERATURE REVIEW

**What is Nodule?**

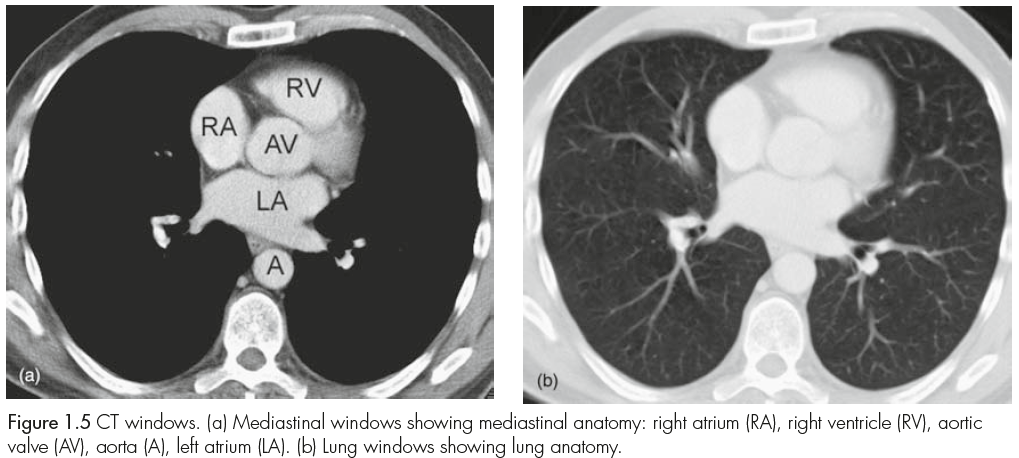
A nodule is a small round or oval shaped growth in the Lung. It may also be called a “spot on the lungs” or a “coin lesion”. Nodules are smaller than 3 centimeters in diameter. If the growth is larger than that, it is called a pulmonary mass and is more likely to represent cancer [3].

It has two types namely malignant & benign. Malignant are cancerous. Unfortunately no apparent symptoms are associated with its presences and they can only be detected with computed tomography or traditional X-rays. A nodule can be seen in figure shown below:



**What is Computed Tomography (CT)?**

CT is an imaging technique whereby cross-sectional images are obtained with the use of X-rays. In CT scanning, the patient is passed through a rotating gantry that has an X-ray tube on one side and a set of detectors on the other. Information from the detectors is analyzed by computer and displayed as a grey-scale image. Owing to the use of computer analysis, a much greater array of densities can be displayed than on conventional X-ray films. This allows accurate display of cross-sectional anatomy, differentiation of organs and pathology, and sensitivity to the presence of specific materials such as fat or calcium. As with plain radiography, high- density objects cause more attenuation of the X-ray beam and are therefore displayed as lighter grey than objects of lower density. White and light grey objects are therefore said to be of ‘high attenuation’; dark grey and black objects are said to be of ‘low attenuation’. By altering the grey-scale settings, the image information can be manipulated to display the various tissues of the body. For example, in chest CT where a wide range of tissue densities is present, a good image of the mediastinal structures shows no lung details. By setting a ‘lung window’ the lung parenchyma is seen in detail (Fig.) [4].



The relative density of an area of interest may be measured electronically. This density measurement is given as an attenuation value, expressed in Hounsfield units (HU) (named for Godfrey Hounsfield, the inventor of CT). In CT, water is assigned an attenuation value of 0 HU. Substances that are less dense than water, including fat and air, have negative values (Fig); substances of greater density have positive values. Approximate attenuation values for common substances are as follows:

• Water: 0

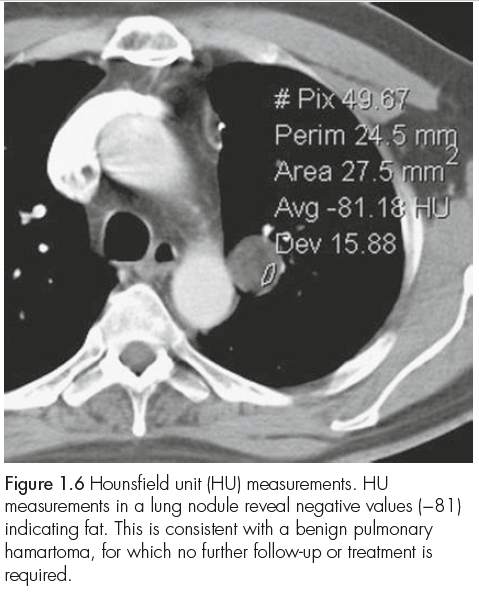
• Muscle: 40

• Contrast-enhanced artery: 130

• Cortical bone: 500

• Fat: −120

• Air: −1000



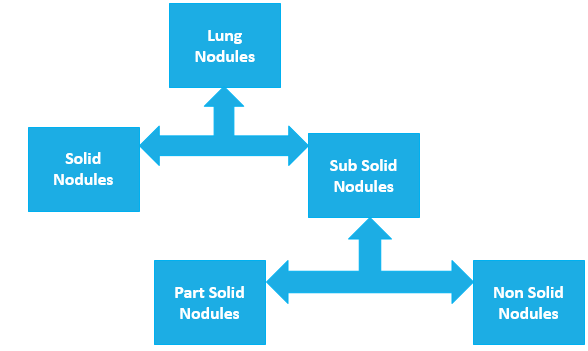
**What is Multidetector Computed Tomography (MDCT)?**

Helical (spiral) CT scanners became available in the early 1990s. Helical scanners differ from conventional scanners in that the tube and detectors rotate as the patient passes through on the scanning table. Helical CT is so named because the continuous set of data that is obtained has a helical configuration. Multidetector row CT (MDCT), also known as multislice CT (MSCT), was developed in the mid to late 1990s. MDCT builds on the concepts of helical CT in that a circular gantry holding the X-ray tube on one side and detectors on the other rotates continuously as the patient passes through. The difference with MDCT is that instead of a single row of detectors multiple detector rows are used. The original MDCT scanners used two or four rows of detectors, followed by 16 and 64 detector row scanners. At the time of writing, 256 and 320 row scanners are becoming widely available.

Multidetector row CT allows the acquisition of overlapping fine sections of data, which in turn allows the reconstruction of highly accurate and detailed 3D images as well as sections in any desired plane [4].

**Classification of Nodules:**

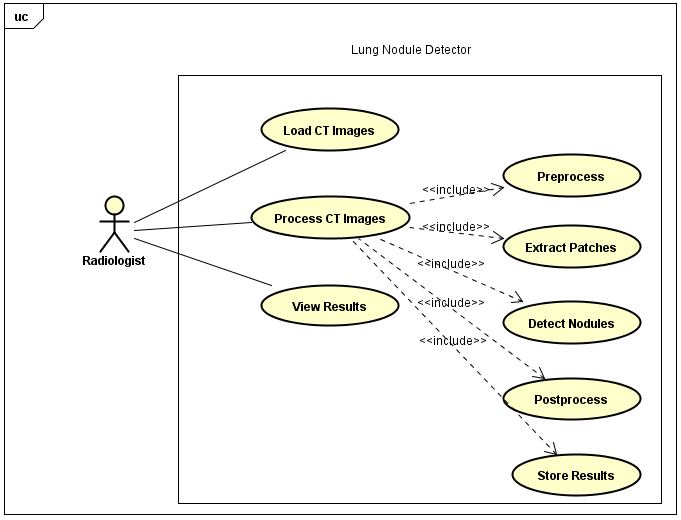
Lung nodules can be distinguished in solid nodules and sub solid nodules. Sub solid nodules can be further classified as nonsolid nodules and part solid nodules. This classification is significant because different nodules require different approaches for their detection, measurement & management [5].



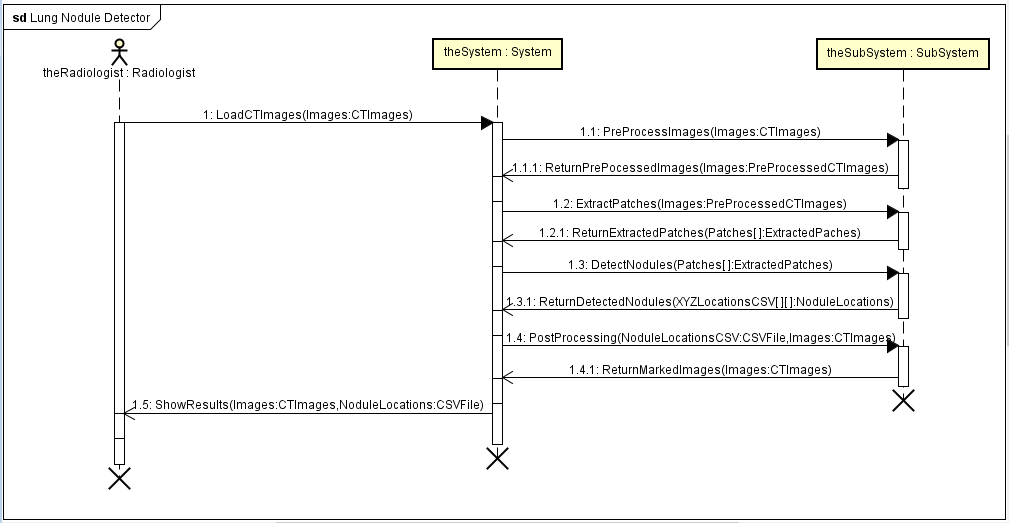
**CHAPTER 3**

SYSTEM ANALYSIS and DESIGN

**Use case Diagram:**



**Sequence Diagram:**



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