CHAPTER 1
MEDICAL DIAGNOSIS AND IMAGING

Medical images are significant diagnostic evidence that can provide essential information about anatomical pathology. This chapter presents the description of normal lung and four lung diseases namely bronchitis, emphysema, pleural effusion and pneumonia. Section 1.1 gives an introduction to lung diseases. Section 1.2 provides details about lung anatomy. Section 1.3 presents a description of lung diseases. Sections 1.4 to section 1.7 explain in brief about the symptoms, causes, diagnosis and treatments of bronchitis, emphysema, pleural effusion and pneumonia respectively. Section 1.8 gives the details of image processing and its purpose, medical imaging facts, need for image retrieval systems and demand for radiologist. Section 1.9 presents the motivation of the proposed approach. Section 1.10 projects the objectives of the research. Finally, section 1.11 explains the organization of the thesis.

1.1 Introduction

Developing countries are changing fast due to socio-economic development, industrialization, urbanization, changing age structure and changing lifestyles. These position the countries to face an ever increasing burden of Non-Communicable Diseases (NCD). In India NCD were estimated to have accounted for 53 percent of all deaths and 44 percent of Disability-Adjusted Life-Years (DALYs) in 2011, in which lung diseases like Chronic Obstructive Pulmonary Disease (COPD) contribute to significant percentage. India contributes to a significant and growing percentage of
COPD mortality, which is estimated to be amongst the highest in the world (i.e.,) more than 64.7 percent of estimated age standardized death rate per 100,000 amongst both sexes. This would translate to about 556,000 in case of India (>20%) out of a world total of 2,748,000 annually. Such massive volumes of disease have the potential to overwhelm health systems and state economy.

Smoking is found to be the major cause of lung diseases. India has got a peculiar tobacco smoking pattern with a large number of people using non-conventional form of tobacco in hookah, beedi or chillum. Exposure to biomass fuels like crop residues or woods or animal dung is also widely prevalent in India. Women who do most of the cooking for households in rural villages are the most affected.

Many NCD related healthcare interventions are cost effective, especially compared to costly procedures that may be necessary when detection and treatment are late and the patient reaches advanced stages of the disease. Health systems need to be further strengthened to deliver an effective, realistic and affordable package of interventions and services for people with NCDs. This study helps to diagnose the lung condition effectively and accurately which might aid the treating physician in effective management of the disease.

1.2 Lung anatomy

The lungs are the organs in which external respiration takes place through the extremely thin and delicate lung tissues which are situated in the chest cavity. The lung is divided into left and right. Each lung has an apex, base, three borders and two surfaces. The left lung is divided into two lobes by an oblique fissure. The right lung is divided into three lobes by oblique and horizontal fissure.
Air enters lungs through a tube called trachea which divides into two other tubes namely right and left main bronchus.

1.2.1 Bronchopulmonary segments

Each bronchus enters the lung at the hilus and immediately subdivides. The main bronchus divides within the lung into lobar bronchi (secondary bronchi), each of which supplies a lobe. The lobar bronchi further divides into segmental bronchi (tertiary bronchi) which leads bronchopulmonary segments [1].

Within each bronchopulmonary segment, the segmental bronchi give rise to multiple generations of bronchioles. However, as the bronchi become smaller, the cartilage decreases in amount. At the end of each of the smallest subdivisions of the bronchial tree called terminal bronchioles is a cluster of air sacs resemble a bunch of grapes. These sacs are known as alveoli. This very thin wall provides easy passage for the gases and blood.
1.2.2 Blood supply and lymphatic

Lung has two functionally distinct circulatory pathways. They are pulmonary artery to convey deoxygenated blood to the alveolar walls and drain oxygenated blood back to the left side of the heart. The vessel derived from the main circulation, namely pulmonary vein provides oxygenated blood to lung tissues. Lymphatic ultimately drains into regional nodes.

1.2.3 Pleura

Each lung is covered by a thin elastic layer called pleura, a closed invaginated sac. The pleura have two parts namely visceral pleura and parietal pleura. The visceral or pulmonary pleura adhere closely to the lung. Its continuation the parietal pleura, lines the corresponding half of the chest wall.
The potential space between these two pleura is called the pleural cavity. The pleural fluid circulates in the pleural cavity, acts as a lubricant, ensuring minimal friction during breathing. Any breach of the parietal pleura or visceral pleura leads to the accumulation of air or fluid or blood.

1.2.4 Imaging Characteristics

Some of the medical imaging characteristics [2] are:

- **Fissures** - Conventional Computed Tomography (CT) fissures are less visible on plain radiographs. They are seen as regions of relative avascularity on the outer cortex of the lobe, where tapering vessels are less visible. CT slice sometimes occurs in parts of the oblique fissure but not in the transverse fissure.

- **Bronchi** - The bronchi may be seen depending upon their size and orientation. Narrow slices improve visualization. The horizontally orientated bronchi, such as the anterior segment bronchus of the upper lobes may be seen as tubular structures. The vertically orientated bronchi, such as the main bronchi may be seen as circular air-filled structures.

- **Vasculature** - The vessels account for most of the lung markings and these can be seen on CT. The relationships of the pulmonary arteries and veins to the bronchi can be well seen at hilar level.

The CT image of the lung is presented in Fig.1.3 which shows the view of the lung with its labeled parts. The lung CT is one of the resources used in diagnosing the lung diseases of the patients.
1.3 Lung Diseases

Lung diseases are one of the major health problems in the world. Lung diseases can be caused by infection, an exposure at the workplace, medications and various disorders. Majority of the lung diseases fall into three major categories:
a) Obstructive lung diseases such as asthma, bronchiectasis, chronic bronchitis, etc.
b) Restrictive lung diseases include sarcoidosis, amyotrophic lateral sclerosis, chronic pleural effusion, kyphoscoliosis, etc.
c) Pulmonary vasculature diseases are pulmonary embolism, pulmonary artery hypertension, etc [3].

Other lung diseases include malignancy related bronchogenic carcinoma, metastatic disease and infection related like pneumonia and bronchitis. Few of these diseases are taken for this work.

Chronic respiratory diseases are on the rise in India, accounting for approximately 9% of all deaths in 2005. Chronic obstructive pulmonary disease was the fourth leading cause of death worldwide in 2001 and is expected to be the third
leading cause of death by 2020. Other diseases like chronic bronchitis, pneumonia and tuberculosis are ranked as one of the top five causes of deaths in rural India. Because of the high disease prevalence with an impact on the economy, accurate diagnosis and management of these diseases are significant.

1.4 Bronchitis

It is the inflammation of the mucous membrane of the bronchus. It can be of two types (i.e.,) acute and chronic bronchitis. Acute bronchitis is characterized by fever and sputum production which is commonly caused by viral organisms and also bacterial organisms. Chronic bronchitis is a clinically defined condition with chronic cough and phlegm for most days of the month (i.e.,) for three consecutive months or for more than two years in a row without other underlying disease to explain the cough [American lung association]. There is hypertrophy of the mucus-secreting glands of the bronchi and the secretions are more viscous than usual, leading to interference with the mucociliary transport mechanisms and plugging of the small airways.

![Fig.1.4: Chronic bronchitis-blocked bronchioles](image.png)
1.4.1 Symptoms

Acute bronchitis accompanies fever, generalized body ache, fatigue and expectoration. The person may be subjected to blocked or runny nose, chest pain or discomfort, fever and chills, wheezing and shortness of breath. The symptoms of chronic bronchitis are present with persistent cough of more than three months associated with sputum production, which is usually not associated with fever.

**Signs:** Generally bronchitis has a normal physical appearance. Chronic bronchitis is more likely to be hefty and have cyanotic (blue bloaters) appearance. Current smokers may have signs of active smoking, including an odour of smoke or nicotine staining of fingernails. Advanced disease may be accompanied by systemic wasting with significant weight loss, bitemporal wasting and diffuse loss of subcutaneous adipose tissue.

1.4.2 Causes

Acute bronchitis is caused by viral organisms like influenza. Chronic bronchitis is caused by air pollution, tobacco smoking, genetic causes and occupational exposures like coal mining, gold mining and cotton textile dust.

1.4.3 Diagnosis

Pulmonary function test shows an obstructive pattern. In chest X-ray an appearance which suggests chronic bronchitis is the so called *dirty chest*. There is a generalized accentuation of the broncho vascular markings. Small, poorly defined opacities may be seen anywhere in the lungs, but their perception can be extremely subjective. There is some correlation between the dirty chest and the presence of perivascular and peribronchial oedema, chronic inflammation and fibrosis. Computed tomography shows following abnormalities like bronchial wall thickening, interlobular septal thickening, mucous plugging of bronchioles resembling a
branching tree in the lungs (tree in bud) and central arterial dilatation reflecting pulmonary arterial hypertension.

![Computed tomography showing chronic bronchitis](image)

**Fig.1.5:** Computed tomography showing chronic bronchitis

### 1.4.4 Treatment

1. Pharmacology therapy: Medications like bronchodilators, steroids and oxygen therapy cure the symptoms and antibiotics for secondary infections.
2. Cessation of smoking.

### 1.5 Emphysema

It is an anatomically defined condition of the lung marked by abnormal enlargement of the alveoli with loss of pulmonary elasticity.

#### 1.5.1 Symptoms

The symptoms of emphysema are persistent cough with sputum production and breathing difficulty on exertion. Many patients have such symptoms for months or years before seeking medical attention.
**Signs:** In early stages of this condition, patients usually have an entirely normal physical examination. Emphysema persons were termed "pink puffers", as they are thin and noncyanotic at rest and have prominent usage of accessory muscles of respiration. Signs of overt right heart failure in advanced case were noticed. For the patients with severe disease, the physical examinations are notable for a prolonged expiratory phase and expiratory wheezing. As the severity of the airway obstruction increases, physical examination may reveal hyperinflation (e.g. increased resonance to percussion), decreased breath sounds, wheezes, crackles at the lung bases and/or distant heart sounds.

1.5.2 Causes

The causes of emphysema are classified into localized and generalized. The localized causes include congenital, compensatory due to lung collapse, scarring or resection and partial bronchial obstruction like malignancy, foreign bodies in anatomical structure. The generalized causes include idiopathic, senile and familial (alpha-1-anti-trypsin deficiency) associated with chronic bronchitis, asthma or pneumoconiosis.

1.5.3 Diagnosis

Diagnosis of emphysema is established by clinical features and with investigations like pulmonary function test, spirometry, arterial blood gas analysis and radiological imaging.

**Characteristics of CT image**

The features noted in emphysema were hyper translucency of lung fields, widened intercostal spaces, low flat diaphragm, decreased vascular pattern and increased retrosternal translucency. The lung volumes are often larger than normal
and the lungs appear more radiolucent. In CT scan bullae, which are rounded areas of hyper translucency with thin hairline shadow forming the margin are noted.

![Bulla](image)

**Fig. 1.6: Computed tomography showing bullae in the right lung**

1.5.4 Treatment

1. Acute attack

Antibiotics are required as infection which often precipitate acute attacks. Oxygen therapy is required to attain adequate oxygenation. Broncho dilators relax muscles but also stimulate the respiratory centre and assist in clearing the respiratory tract. The role of corticosteroids in acute exacerbations is uncertain, but it is still given to decrease the symptoms. Medications like diuretics, digitalis, anti hypertensive tablets and potassium salts are given for treating heart failure.

2. Long term management

Antibiotics like tetracycline or erythromycin 0.5 mg at 12 hours interval are given orally prophylactically to reduce the number of exacerbations. Other supportive medications like expectorants, mucolytics, bronchodilators and corticosteroids are required to decrease the symptoms. In a preventive way, it is better to avoid bronchial irritants like tobacco smoke, dust and pollutions. Chest physiotherapy is required. In advanced condition lung volume reduction surgery, lung transplantation may be done.
1.6 Pleural effusion

Pleural effusion is a collection of excess quantity of fluid in the pleural cavity. It is usually produced at the rate of 0.01 cc/kg/hr. Normal volume of pleural fluid is about 16 cc for a 70-kg person. The rate of absorption is 20 times the rate of production.

![Diagram of Pleural Effusion](image)

**Fig.1.7: Pleural Effusion**

1.6.1 Symptoms

Patients suspected to have pleural effusion usually have with chest pain, which increases on coughing and sneezing associated with difficulty in breathing. They may also have non-specific symptoms like fever, anorexia, malaise and weight loss.

**Signs:** 500 cc of fluid is required to produce signs. During the examination, bulging of chest wall spaces on the affected side with fullness of hypo-chondrium can be noticed. There is diminished mobility of the chest wall on the affected side and stony dullness with increased resistance. On auscultation, there are diminished or absent breath sounds below the level of the effusion [4].
1.6.2 Causes

Pleural effusion is formed by two ways namely: Transudate and Exudate:

a) Transudate fluid is the ultra filtrate of blood plasma formed by increased hydrostatic pressure and decreased colloid pressure. There are many causes like cardiac failure, kidney failure and liver cirrhosis.

b) Exudate material is composed of serum, fibrin and white blood cells that escape from blood vessels into a superficial lesion or area of inflammation. There are various causes for exudates like tuberculosis, bacterial infection, septicemia, cancer, bleeding disorders and collagen vascular disease.

1.6.3 Diagnosis

1. Complete blood count to identify any indirect evidence of infections.

2. Sputum examination for identifying the causative agent for pleural effusion.

3. X-ray: Homogenous opacity noted in the lung fields with obliteration of the costophrenic angle on the affected side (150 ml of fluid) which has a concave upper border. The mediastinum is shifted to the opposite side.

4. Imaging: Ultrasound and CT scan.

5. Thoracocentesis: It is an invasive procedure to remove fluid for both diagnostic and therapeutic purposes.

6. Pleural Biopsy: A sample of the pleura is removed with a special biopsy needle or during surgery to determine if infection, cancer or another condition is present.

7. Thoracoscopy: An invasive endoscope procedure to examine the pleura, lungs and media sternum and to obtain tissue for testing purposes.
Fig. 1.8: Computed tomography showing pleural effusion in the right lung

1.6.4 Treatment

In both forms of effusion, the underlying causative agents are to be identified and treated (e.g.,) the transudate formed by cardiac failure the underlying cardiac condition is to be treated. The symptomatic pleural effusion must be removed by thoracocentesis. Uncomplicated parapneumonic effusions, generally resolve with antibiotics alone. The complicated parapneumonic effusions require antibiotic therapy and also tube thoracostomy, fibrinolytics, thoracoscopy, open thoracostomy and decortications. In malignant pleural effusion regular removal of fluid is required by inserting tube into chest wall and followed by obliteration of pleural space.

1.7 Pneumonia

Pneumonia is inflammation of the parenchyma of the lung. It affects primarily the microscopic air sacs known as alveoli. It is usually caused by infection with viruses or bacteria and less commonly by other microorganisms, certain drugs and other conditions such as autoimmune diseases.
1.7.1 Symptoms

A. **Pneumococcal infection**: Patients have symptoms like common cold or upper respiratory tract infection with dry, painful cough with rusty sputum and pleuritic pain.

B. **Staphylococcal infection**: It commonly occurs during epidemics of influenza. Pneumonia can be very severe. It may be fatal within a few hours.

C. **Klebsiella infection**: This is common in middle aged or elderly alcoholics. It commonly involves the upper lobes or more than one lobe. This infection has a strong tendency to form abscess.

D. **Viral infection**: The presenting symptoms are headache, general aches, prostration and fever. There may be no respiratory symptom or sign and it is often discovered when a routine X-ray of the chest is taken.

**Signs**: Patient have fever with rigors and they may be flushed and cyanosed. The temperature, pulse and respiration are raised. Paroxysmal cough and mucoid sputum may be present. Radiologically hazy, relatively uniform density opacities are noted, which look like a thin-walled cyst on X-ray.
1.7.2 Causes

**Microbial organisms:** There are many organisms which cause pneumonia like pneumococcus, staphylococcus, streptococcus, H. influenza, E. coli, klebsiella pseudomonas. The atypical organism includes viral, rickettsial and mycoplasma. The fungal organism includes actinomycosis, aspergillosis, histoplasmosis and nocardiosis. Chemical cause includes aspiration of vomitus or dysphagia as in hiatus hernia achalasia cardia, toxic gases and smoke inhalation. Other miscellaneous causes are allergic: loeffler's syndrome, collagenosis: Systemic Lupus Erythematosus (SLE), rheumatoid arthritis and polyarteritis nodosa.

Most of the pneumonia are self-resolving but becomes critical in conditions like debilitating illnesses, poor nutrition, immunological deficiencies, corticosteroid therapy, uncontrolled diabetes, chemotherapy and immuno-suppressive therapy.

1.7.3 Diagnosis

- It is established by clinical condition with investigations like sputum culture and sensitivity to identify the disease causing organisms.
• A blood test that measures white blood cell count may be performed. An individual's white blood cell count can often give a hint as to the severity of the pneumonia and whether it is caused by bacteria or a virus.

• Chest X-ray: The more common radiographic findings include segmental or lobar consolidations and patchy broncho pneumonic pattern.

• Computed tomography: This shows features of multiple poorly defined nodules and patchy consolidation in the involved lung zones. Cavity formation is also commonly noted. Diffuse bilateral interstitial and/or interstitial-alveolar (mixed) infiltrates are most commonly caused by viruses.

![consolidation](image1)
![Multiple nodules](image2)

**Fig. 1.10: Patchy consolidation of nodules in the lungs(a, b)**

1.7.4 Treatment

General measures include light diet and copious fluid intake is advised as patient loses fluid from sweating and over breathing. Symptomatic medication for cough and expectorants are recommended as treatment. Regular physical activity and breathing exercises increase the person’s immunity against the infections. Adequate
oxygen is required and ventilator support may be provided in critical situation. Health care providers usually treat bacterial pneumonia with antibiotics. Antibiotics often used in the treatment of this type of pneumonia include penicillin, amoxicillin and clavulanic acid and macrolide antibiotics [4,5].

1.8 Image Processing

Image Processing is a technique for analysing and manipulating images with a computer. Image processing generally involves three steps:

- Import an image with an optical scanner or directly through digital photography.
- Manipulate or analyse the image that includes image enhancement and data compression or the image may be analysed to find patterns that are not visible to the human eye.
- Output the result: The result might be the image altered in some way or it might be a report based on analysis of the image.

Image Processing includes image display and printing, image editing and manipulation, image enhancement, feature detection and image compression. It has many advantages in processing medical images such as X-ray, CT and Magnetic Resonance Imaging (MRI) images. Major Applications include biology, astrology, medicine, biometrics, personal pictures and satellite images.

The term “digital image processing” generally refers to processing of a two-dimensional picture by a digital computer as a two-dimensional data. The principal advantages of digital image processing methods are its versatility, repeatability and the preservation of original data precision.
Image enhancement techniques can be divided into two broad categories:

1. Spatial domain methods.
2. Frequency domain methods.

Spatial domain techniques are performed to the image plane itself and they are based on direct manipulation of pixels in an image.

The operation can be formulated as \( g(x, y) = T[f(x, y)] \) (1.1)

where

- \( g \) is the output image.
- \( f \) is the input image.
- \( T \) is an operation on \( f \) defined over some neighborhood of \( (x,y) \).

Spatial domain: \( g(x, y) = f(x, y) * h(x, y) \) (1.2)

Frequency domain enhancement methods enhance an image \( f(x,y) \) by convoluting the image with a linear, position invariant operator. The 2D convolution is performed in frequency domain with discrete Fourier transform.

Frequency domain: \( G(w_1, w_2) = F(w_1, w_2) H(w_1, w_2) \) (1.3)

1.8.1 Medical imaging

Medical imaging technology has revolutionized health care over the past 30 years, which ensures the production of high quality of radiological service with consequent improvement of health care service delivery. The growth of medical images in database is enormous in the past decade where the medical digital image equipments such as CT, MRI and Positron Emission Tomography (PET) are used in the clinic works [6]. The goal of medical information systems is to deliver necessary information to right person at appropriate time which enables to improve the quality and efficiency in health care system.
Automatic medical image classification is a technique for assigning a medical image to a specific class among a number of images categorizes. Various medical image retrieval systems are available today that classify image according to image modalities, orientations and parts of the body or disease [7].

In every medical image modality, physicians must combine the information from different images. Therefore, it is needed to archive all kinds of medical imaging modalities with their imaged orientations and anatomical structure information. Medical tomography has not only successfully been accomplished with x-rays, but also with radioisotopes, ultrasound and magnetic resonance [8].

CT scan is one of the most commonly used methods for screening patients. From the CT scan images, the radiologist will be able to diagnose the abnormalities in the tissues. The Computer Aided Diagnosis (CAD) system will assists the physicians as a “second option” in diagnosing the cancerous cell by using CT scan images [9].

In medical imaging, automatic classification and retrieval is useful to insert the new radiographs into existing archive without interaction and searching for a specific diagnoses based on an image input. [10].

Medical image retrieval systems play an important role in aiding diagnosis and treatment in precise manner. Medical image database used for image retrieval contain images of many different modalities, taken under varied conditions with variable accuracy of annotation. Image modality is an important, fundamental visual characteristic of an image that can be used to aid in the retrieval process.

The tasks of image retrieval system is to retrieve relevant medical images from an image database based on the similarity of visual content of the query image. Histogram, texture analysis and color are some of the low level features in an image
which has been effectively used for the image retrieval problem. However low level image features are prone to give a larger classification error due to the semantic gap. Features which are extracted from the whole images are called global features, while local features cover parts of region of interest.

Medical imaging has provided significant technological advancements within medicine, contributing to MRI, X-ray, CT, ultrasound and optical imaging. Medical imaging helps in retrieving the exact image that assists in diagnosis of the diseases. Imaging helps as a standard of modern care for virtually all major medical conditions and diseases. It provides physicians with new capabilities to substitute for riskier or more invasive procedures. It also enables doctors to see inside a patient without having to cut them open.

1.8.2 Need for image retrieval systems

Initial image retrieval techniques were text-based that associated textual information like filename, captions and keywords with every image in the repository. For image retrieval, keyword based matching was employed for finding the relevant images. The manual annotation required prohibitive amount of labor. Moreover, it was difficult to capture the rich content of images using a small number of key words apart from being an unnatural way of describing images. With Digital Imaging and Communications in Medicine (DICOM), a standard for image communication has been set and patient information can be stored with the actual image(s), although still a few problems prevail with respect to standardization [11]. In several articles, content-based access to medical images for supporting clinical decision-making has been proposed. It would ease the management of clinical data and scenarios for the integration of content-based access methods into Picture Archiving and
Communication Systems (PACS). Clinical and efficient usage of CBIR systems for
digital pathology computer aided diagnosis systems require sub-image retrieval for
querying specific structures in the high resolution images along with the diagnosis. In
digital pathology, the relevance of CAD systems requires sub-image retrieval rather
than whole image retrieval [12]. Pathologists are interested in specific structures in
addition to the whole image for diagnosis.

1.8.3 Demand for radiologist

A decade back, diagnosis of medical conditions was based on clinical
knowledge but with the age of investigations varied from different types of imaging to
blood tests, the angle of diagnosis has changed with the inculcation of these
parameters. One of the prime investigating modalities is radiologic imaging where the
radiologist plays a key role. MRI and CT scans are available in small towns. Evolving
latest technology like the spectral CT ensures that the field of radiology in India is
blooming and growing at a rapid pace. Unfortunately, the growth of the radiologist
and trained technologist is not keeping pace with the growth of the number of
machines and centers that are up coming in the country. This is a reason which can
hamper the growth of radiology. A radiologist, apart from diagnostic purpose in doing
the X-ray, ultrasound and CT/MRI now plays a role in treating patients in the form of
interventional radiologist. India will need about above 50,000 radiologists if the
benefits of imaging are to reach every corner of the country.

1.9 Motivation of the proposed approach

Lung diseases are considered one of the most threatening diseases which cause
infirmity and leads to death all around the world. A study in 2010 stated, there were
approximately 6.8 million emergency department visits for respiratory disorders in the
U.S. for patients under the age of 18. Respiratory diseases (including lung cancer) are responsible for over 10% of hospitalizations and over 16% of deaths in Canada. The bad quality of air, which leads to acute respiratory ailments, was the biggest cause of deaths due to diseases in 2011. According to the latest world health organization data, lung disease deaths in India reached 11% of total deaths. Death rate is 142.09 per 100,000 of population and India ranks first in the world. The statistical handbook of India 2013 states that many thousands of people died owing to respiratory diseases in 2011, much more than the deaths caused by water-borne diseases.

The lung diseases are one of the major health challenge faced in the world. The lung diseases are diagnosed and treated by the physician with the use of imaging modalities like chest X-Ray, CT scans and the required medications. Smoking, infections, inhaling polluted air and genetics are responsible for most lung diseases that can affect any age group of people. The continuous ill health in lung problem, if left untreated for long time will lead to major problems.

The work was motivated to help the society in assisting the doctors to diagnose the lung diseases by computed approach in more precise manner. Nowadays, computer programs are supporting doctors in diagnosing the diseases. The medical diagnosis software serves as a consultant to the physician. Computer technology can be used to detect the complexity of the disease thus reducing the number of transience. The software is not meant to replace the specialist or doctor, yet it has developed to assist general practitioner and specialist in diagnosing and predicting patient's condition. The computer technology employed in medical applications could reduce the cost, time, human expertise and medical error. The software system deals with medical data and knowledge domain in detecting the diseases. With regard to a
limited medical staff, an automated system can significantly decrease the manual labour involved in diagnosing the lung diseases with additional care.

The normal lung and diseases such as pleural effusion, emphysema, bronchitis and pneumonia are suggested for this work as these diseases require CT imaging for diagnosing and these diseases are some of the most common lung diseases which affect the human community widely. For assisting the doctors in rapid finding of the diseases, the proposed work has been carried out in an appropriate manner.

1.10 Objectives

The research work has been taken with the following objectives:

- To extract the texture and shape features from lung images using different methods.
- To apply the proposed MAD fusion method and proposed multiscale filter feature extraction for the texture and shape features.
- To apply the proposed M$^3$ (Combination of proposed Median absolute deviation, Moment invariants and proposed Multiscale filter) feature extraction technique for extracting the features of lung CT images and the classification of lung diseases namely bronchitis, emphysema, pleural effusion and pneumonia.
- To implement various feature selection techniques including proposed hybrid genetic algorithm method for selecting the top ranked features for lung diseases.
- To evaluate the various classifiers for the proposed methods and to estimate the performance measures including classification accuracy, sensitivity, specificity, etc.
By using the proposed feature extraction and proposed feature selection methods, different classifiers are used to detect the lung diseases using computed tomography images.

1.11 Organization of the thesis

The focus of the thesis is to aid the physicians in automated manner for classification of the lung diseases using computed tomography images. The contents of the thesis are organized as follows:

In chapter 2, review of the various methods available in the literature for medical imaging, genetic algorithm, neural networks, data mining and support vector machines for medical diagnosis of lung diseases is presented.

In chapter 3, introduction to CT images, working and advantages of computed tomography are detailed. The details of the data collection and preprocessing of the lung diseases are also discussed.

In chapter 4, various feature extraction methods including proposed methods on texture, shape and $M^3$ are discussed.

In chapter 5, feature selection methods are discussed and a novel hybrid genetic algorithm approach is proposed.

In chapter 6, various classifiers based on tree based, decision tree, probability based, soft computing, distance based and support vector machine are discussed and presented.

In chapter 7, results of various methods, classification accuracy and performance measures of the various classifiers are discussed.

Chapter 8 summarizes the work presented in the thesis. The contributions of this research work and the directions for future research are highlighted.