**Ministry of education and science of the Russian Federation**

Federal state-founded educational institute of high professional education

**«NATIONAL RESEARCH TOMSK POLYTECHNIC UNIVERSITY»**

Institute Cybernetics
Educational programme Computer Science and Engineering
Department Software Engineering

# MASTER THESIS

| Research title |
|---|
| **Detection Of Lung Diseases Based On Fibrosis Of The Lung** |

UDC 616-003.7.620.179.152.1

Student

| Group | Name | Signature | Date |
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| 8ВМ5И | Natzina Juanita Francis | | |

Supervisor

| Position | Name | Academic degree | Signature | Date |
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| Associate professor | S.V. Axyonov | PhD | | |

## CONSULTANTS:

On «Financial management, resource efficiency and resource saving» chapter

| Position | Name | Academic degree | Signature | Date |
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| Associate professor | N.O. Chistyakova | PhD | | |

On «Social responsibility» chapter

| Position | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Associate professor | Y.V. Anischenko | PhD | | |

## PERMIT TO DEFENCE:

| Head of department | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Head of department | M.A. Ivanov | PhD | | |

Tomsk – 2017

## Планируемые результаты обучения по ООП

| Код Результата | Результат обучения (выпускник должен быть готов) |
|---|---|
| ***Профессиональные компетенции*** | |
| Р1 | Применять глубокие естественнонаучные и математические знания для решения научных и инженерных задач в области информатики и вычислительной техники. |
| Р2 | Применять глубокие специальные знания в области информатики и вычислительной техники для решения междисциплинарных инженерных задач. |
| Р3 | Ставить и решать инновационные задачи инженерного анализа, связанные с созданием аппаратных и программных средств информационных и автоматизированных систем, с использованием аналитических методов и сложных моделей. |
| Р4 | Выполнять инновационные инженерные проекты по разработке аппаратных и программных средств автоматизированных систем различного назначения с использованием современных методов проектирования, систем автоматизированного проектирования, передового опыта разработки конкурентно способных изделий. |
| Р5 | Планировать и проводить теоретические и экспериментальные исследования в области проектирования аппаратных и программных средств автоматизированных систем с использованием новейших достижений науки и техники, передового отечественного и зарубежного опыта. Критически оценивать полученные данные и делать выводы. |
| Р6 | Осуществлять авторское сопровождение процессов проектирования, внедрения и эксплуатации аппаратных и программных средств автоматизированных систем различного назначения. |
| ***Универсальные компетенции*** | |
| Р7 | Использовать глубокие знания по проектному менеджменту для ведения инновационной инженерной деятельности с учетом юридических аспектов защиты интеллектуальной собственности. |
| Р8 | Осуществлять коммуникации в профессиональной среде и в обществе в целом, активно владеть иностранным языком, разрабатывать документацию, презентовать и защищать результаты инновационной инженерной деятельности, в том числе на иностранном языке. |
| Р9 | Эффективно работать индивидуально и в качестве члена и руководителя группы, в том числе междисциплинарной и международной, при решении инновационных инженерных задач. |
| Р10 | Демонстрировать личную ответственность и ответственность за работу возглавляемого коллектива, приверженность и готовность следовать профессиональной этике и нормам ведения инновационной инженерной деятельности. Демонстрировать глубокие знания правовых, социальных, экологических и культурных аспектов инновационной инженерной деятельности. |
| Р11 | Демонстрировать способность к самостоятельному обучению, непрерывному самосовершенствованию в инженерной деятельности, способность к педагогической деятельности. |

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Educational programme Computer Science and Engineering
Department Software Engineering

APPROVED BY:
Head of department
_____ _____ M.A.Ivanov
(Signature)(Date) (Name)

**TASK**
**For the final qualifying research**

Form:

| Master thesis |
|---|

To student:

| **Group** | **Name** |
|---|---|
| 8ВМ5И | Natzina Juanita Francis |

Title:

| **Web application to manage and monitor many Linux servers** | |
|---|---|
| Approved by the rector's order (date, ID) | |

| Date of research completion: | 02.06.2017 |
|---|---|

**TECHNICAL TASK:**

| **Initial data**<br><br>*(Product requirements, User services, Description of solution, Market analysis, Impact on the Environment)* | The purpose of this thesis is to detect fibrosis of the lungs, with the help of image processing and machine learning. This helps in identifying many diseases related to fibrosis and also helps in the process of speedy recovery of diseases. |
|---|---|

| | |
|---|---|
| **List of tasks must be presented in the thesis**<br>*(Review. Related research, Task description, Research procedure, Development and design procedures, Results obtained, Additional chapters, Appendix, Conclusion).* | Introduction, Methods and Technologies, Methods to Detect and Classify Computer Tomographic Images for Fibrosis of Lungs, Requirement Specification and Software for the Detection of Lung Fibrosis, Finance Management, Resource Efficiency and Saving, Social Responsibility, Conclusion |
| **List of graphical data**: | Presentation |

**Consultants**

| Part | Consultants |
|---|---|
| Financial management, resource efficiency and resource saving | N.O. Chistyakova, Associate professor, PhD |
| Social responsibility | Y.V. Anischenko, Associate professor, PhD |

| | |
|---|---|
| **Date of task obtaining** | 22.03.2017 |

**The task was given by:**

| Position | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Associate professor | S.V. Axyonov | PhD | | |

**The student gets the task:**

| Group | Name | Signature | Date |
|---|---|---|---|
| 8ВМ5И | Natzina Juanita Francis | | |

**Ministry of education and science of the Russian Federation**
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**«NATIONAL RESEARCH TOMSK POLYTECHNIC UNIVERSITY»**

Institute Cybernetics
Educational programme Computer Science and Engineering
Educational level Master
Department Software Engineering
Research period Summer term 2016-2017

Form:

| |
|---|
| Master thesis |

## CALENDAR RATING PLAN
## Of the final qualifying research

| | |
|---|---|
| Date of research completion: | 02.06.2017 |

| Checkpoint date | Research section | Max score |
|---|---|---|
| *22.03.2017* | *Methods and Technologies* | *10* |
| *29.04.2017* | *Methods to Detect and Classify Computer Tomographic Images for Fibrosis of Lungs* | *20* |
| *15.05.2017* | *Requirement Specification and Software for the Detection of Lung Fibrosis* | *20* |
| *20.05.2017* | *Finance Management, Resource Efficiency and Saving* | *20* |
| *25.05.2017* | *Social Responsibility* | *20* |
| *30.05.2017* | *Presentation* | *10* |

**The task was given by:**

| Position | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Associate professor | S.V. Axyonov | PhD | | |

**ARGEED BY:**

| Head of department | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Head of department | M.A. Ivanov | PhD | | |

**TASK FOR**
**«FINANCIAL MANAGEMENT, RESOURSE EFFICIENCY AND RESOURSE SAVING» PART**

To student:

| Group | Name |
|---|---|
| 8ВМ5И | Natzina Juanita Francis |

| | | | |
|---|---|---|---|
| **Institute** | **Cybernetics** | **Department** | **Software Engineering** |
| **Educational level** | **Master** | **Educational programme** | **Computer Science and Engineering** |

| **Initial data to «Financial management, resource efficiency and resource saving » chapter:** | |
|---|---|
| 1. *Costs of research, including technical, financial, energy, information and human costs*<br>2. *Norms of expenditure of resources*<br>3. *The taxation system used, the rates of taxes, discounting and lending* | *Work with related research presented in articles, journals, bulletins, and official documents* |
| **List of tasks:** | |
| 1. *Evaluation of commercial and innovative potential*<br>2. *Development of the charter of the technical project*<br>3. *Planning of management process: structure and schedule, budget, and risks*<br>4. *Estimation of resource, financial and economical efficiency* | *Analysis of potential consumers. Assessment of the quality and prospective of the project. Research planning.* |
| **List of graphical data**: | |
| 1. *«Portrait»of consumer*<br>2. *Market segmentation*<br>3. *Assessment of the competiveness of solution*<br>4. *FAST diagram*<br>5. *SWOT matrix*<br>6. *Calendar and budget of the research*<br>7. *Assessment of resource, financial and economical efficiency*<br>8. *Potential risks* | |

| **Date of task obtaining** | |
|---|---|

**The task was given by the consultants:**

| Position | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Associate professor | N.O. Chistyakova | PhD | | |

**The task was accepted by the student:**

| Group | Name | Signature | Date |
|---|---|---|---|
| 8ВМ5И | Natzina Juanita Francis | | |

**TASK FOR**
**«SOCIAL RESPONSIBILITY» PART**

To student:

| Group | Name |
|---|---|
| 8ВМ5И | Natzina Juanita Francis |

| | | | |
|---|---|---|---|
| **Institute** | **Cybernetics** | **Department** | **Software Engineering** |
| **Educational level** | **Master** | **Educational programme** | **Computer Science and Engineering** |

| **Initial data to «Social responsibility» chapter:** | |
|---|---|
| *1. Description of work place:*<br>*Harmful factors in the industrial environment (meteorological conditions, harmful substances lighting, noise, vibrations, electromagnetic fields, ionizing radiation)*<br>*dangerous industrial factors (mechanical, thermal, electrical, etc.)*<br>*negative impact on the environment (atmosphere, hydrosphere, lithosphere)*<br>*emergency situation(industrial, natural, ecological types)* | *Work place located in the office 421 in the Institute of Cybernetics Building* |
| *2. Legislative and normative documents on the topic* | *State standards, GOST, SNiP, NPB, SanPiN, federal laws* |
| **List of tasks:** | |
| *1. Analysis of the identified harmful factors of the industrial environment in the following sequence:*<br>*the physical and chemical nature of harmfulness, its relation to the topic being developed;*<br>*the effect of the factor on the human body;*<br>*reduction of permissible norms with the required dimensionality (with reference to the relevant normative and technical document);*<br>*proposed remedies* | Identification of all the harmful factors when researching, including physical, chemical and biological |
| *2.Analysis of identified hazards of the industrial environment in the following sequence*<br>*mechanical hazards (sources, means of protection;*<br>*thermal hazards (sources, means of protection);*<br>*electrical safety (including static electricity, lightning protection - sources, protective equipment);*<br>*fire and explosion safety (causes, preventive measures, primary* | Identification of the all possible hazards when researching |

| | |
|---|---|
| *means of fire extinguishing)* | |
| *3.Protection of the environment:*<br>*protection of the residential area*<br>*analysis of the impact of the facility on the atmosphere (emissions);*<br>*analysis of the impact of the object on the hydrosphere (discharges);*<br>*analysis of the impact of the object on the lithosphere (waste);*<br>*develop solutions to ensure environmental safety with references to environmental standards.* | Identification of the all possible kinds of waste when researching |
| *4.Protection in emergency situations:*<br>*List of possible emergencies on the site;*<br>*Choice of the most typical emergency situation;*<br>*Development of preventive measures to prevent emergencies;*<br>*Development of measures to improve the stability of the facility to this emergency situation;*<br>*The development of actions as a result of the emergencies and measures to eliminate its consequences* | Identification of the all possible emergencies when researching |
| **List of graphical data:** | |
| *Graphical plans* | |

| | |
|---|---|
| **Date of task obtaining** | |

**The task was given by the consultants:**

| Position | Name | Academic degree | Signature | Date |
|---|---|---|---|---|
| Associate professor | Y.V. Anischenko | PhD | | |

**The task was accepted by the student:**

| Group | Name | Signature | Date |
|---|---|---|---|
| 8ВМ5И | Natzina Juanita Francis | | |

JUNE 6, 2017

# DETECTION OF LUNG DISEASE BASED ON FIBROSIS OF THE LUNGS

## THESIS PAPER AND FINAL PROJECT

NATZINA JUANITA FRANCIS
SUPERVISOR: SERGEY V AXYONOV

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# Introduction

The detection of various lung diseases have evolved over the years with the rapid increase of science and technology. However, some diseases that involves the lungs cannot be detected due to the rapid change in the cell structure, thereby reducing chances of technology and help in detecting such changes and hence unable to produce accurate results.

In order to achieve the results through these Computer Tomographic images, Researchers have used various data sets to train the system in order to identify and detect the problem. The output however accurate took a longer time to process and thus was inconvenient when applied to the field of Medical Science. Some researchers found out that this can be resolved by the removal of noise and this has proven to be successful which is based on the Hidden Markov model for the identification of lung cancer. 2D and 4D Computer Tomographic images were also sometimes insufficient to provide a confidence in the diagnosis. Thus this was solved by using a combination of both Positron Emission Tomography and Computer Tomography images. By this the output produced was far more inferior and made tumor identification in the lungs possible which was achieved by a proper joint posterior probability with that of a Fuzzy Markov Random Field Model.

All the methods involved however successful failed on one occasion which involved that of the blood tissue lining the lung. This makes it one of the biggest problem faced by the researchers today on how to identify a weak lung based on the lining of blood tissues along the walls of the lungs. The most common of all lung diseases includes the pulmonary edema where fluids leak from the blood vessels in the air sacs. Lung fibrosis can also denote various other respiratory problems but with enhanced software and technology, a confidence in the diagnosis regarding the border of the lungs can be produced.

Neural Networks have been created and developed to be trained with different data sets for various problems of the lung. Some of them include that of lung cancer, detection of pulmonary nodules and various other respiratory problems involving pneumonia. By training the neural network with appropriate data sets involving that of computer tomographic images with fibrosis, the respiratory problems such as Pleurisy can be detected at an early stage and also be able to distinguish a weak lung from that of a strong one and hence be able to use it further for surgical implants.

Thus in this research we aim at detecting the extent of fibrosis by using various computer tomographic images of various patients by improving the image processing techniques used and further more combining algorithms of various edge detection methods followed by manipulation of pixels to enhance the image used to produce accurate results. The extent of fibrosis in the particular image under research is found by comparing two computer tomographic images after application of the enhanced algorithm.

# Chapter 1: Methods and Technologies

The technologies that have evolved throughout the years have helped in detection of lung problems and other pulmonary disorders. Some of the methods involve that of the wavelet analysis for the identification of lung abnormalities published in the Electrical Engineering and Informatics (MICEEI) in 2014 (1). The method involves the use of Daubechies (2) wavelet as one of the features of extraction and also confusion matrix. This formed as principle parameter for the accuracy percentage level and thus producing a confidence in the diagnosis. The various levels in this method involved that of the image pre-processing, lung segmentation, feature extraction and finally the training phase. The output involved three comparisons which are images of a normal lung, one with pleural effusion and another with pulmonary tuberculosis. The training data set used in this method involves thorax samples. The accuracy of the method attained results with 91.65% correctness and also showed a composition at a level 7 with the order of db6 which is one of the best configurations for feature extraction.

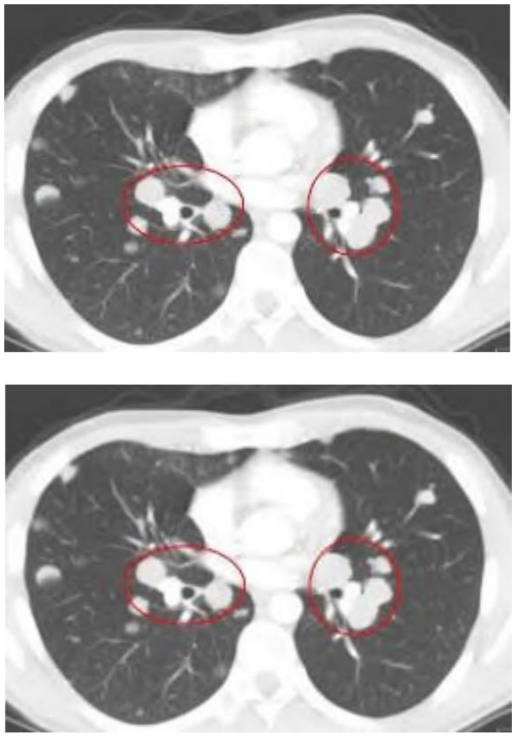

**Figure 1: Computer Tomographic Image of a Lung Showing Affected Area**

The above is an example of the CT images used with that of diminishing lesions. Thorax samples that were taken into consideration also helped in identifying the lungs with various other respiratory problems.

The lungs with weak blood vessels cause damage and penalize the airways. To identify such a defect was at first rather impossible to apprehend but was later improvised in a Neural Network that was published in the Biomedical Imagining (ISBI) (4). This method was developed on the 3D Frangi (7). Based lung vessel enhancement. Here a fully automatic simultaneous lung filer and air enhancement filter was taken into consideration. It also involves the use of a Frangi based multi scale vessel enhancement and was designed specifically for lung vessel and airway detection. While using these specially designed filters, the arteries and veins were considered to have a high contrast to that of the lung parenchyma. According to the filters in this method the airway walls were shown to be hollow tubular structures without a negative response.

The method was carried about by deriving values from that of a Hessian matrix (7, 8) that were used to detect the centerlines and further derive the approximation of the walls from the matrix. Now validation of the images is done with 20 CT scan images with different pathological states with that of a particular challenge framework.

The method was formulated by introducing the principles of vessel detection which is based on the features extracted from that of the Hessian Matrix (4). This can be efficiently computed using the Gaussian derivatives which are as follows:

$$\mathbf{H_\sigma(I,x)} = \partial^2 \mathbf{I_\sigma} / \partial \mathbf{x}^2 = \mathbf{I(x)} * \partial^2 \mathbf{G_\sigma(x)} / \partial \mathbf{x}^2$$

Where,

$G_\sigma$ = Gaussian Function with Standard Deviation
I = Image

The values from the Hessian Matrix were thus introduced into the Frangi Filter. The next approach was to find a way to decrease the vesselness in the airway walls. Further in order to avoid the erroneous detection in the airway walls, it became a necessity to get information about the bronchial tree. The segmentation of the lung was used to observe various segments of the lungs and thus used an independent method for airway detection and morphological operations. This ensured the attenuation of airway walls. Usually a constant wall thickness was taken into consideration for every bronchial generation and was not very realistic according to the approach. These increased the number of computations and furthermore the complexity of the algorithm. This proposal performs vessel and airway enhancement and also at the same time it suggest an adaptive airway wall attenuation in order to achieve more accurate and thus an efficient vessel enhancement. The method was generally based on a penalty function which when applied in the wall of the lung areas helped to decrease the response of the vessels filter.This method proved to produce good results with a limited number of false positives in the output. The experiments (4) were used with a range of scales from $\sigma = 0.5, 1.5,.. 3.5$ And parameters $= \beta = 0.5$, $c = 500$ and the filtered output was thus normalized to the range of [0,255].

**Table 1: Results on the Dataset Using Positive-Points/Negative-Points as Reference Standard**

| | Az | Specificity | Sensitivity |
|---|---|---|---|
| All vessels/Non-vessels | 0.978 | 0.900 | 0.973 |
| Small vessels/Non-vessels | 0.947 | 0.887 | 0.953 |
| Medium vessels/Non-vessels | 0.985 | 0.968 | 0.953 |
| Large vessels/Non-vessels | 0.987 | 0.991 | 0.965 |
| Vessels/Airways walls | 0.918 | 0.756 | 0.973 |

The table shows the results of one experiment where Az is the area under the ROC curve and the Specificity and the sensitivity is at an optimal threshold range which is 0 to 1. Thus the mean areas under the ROC curve i.e. from $0.978 \pm 0.013$ represent that it has quite good performance of the algorithm used in vessel detection. As it was expected, the values became lower when the vessels were smaller due to the size of the filter and this was denoted by the quantity of information that was used to evaluate the value of vessels. This method was proven to outperform the values slightly by using the same sector values. However, the evaluation of the framework was made possible with the use of comparatively low amount of positive and negative values and thus the method proved to have some limitation where the evaluation was made border specific and this helped to improve the results.

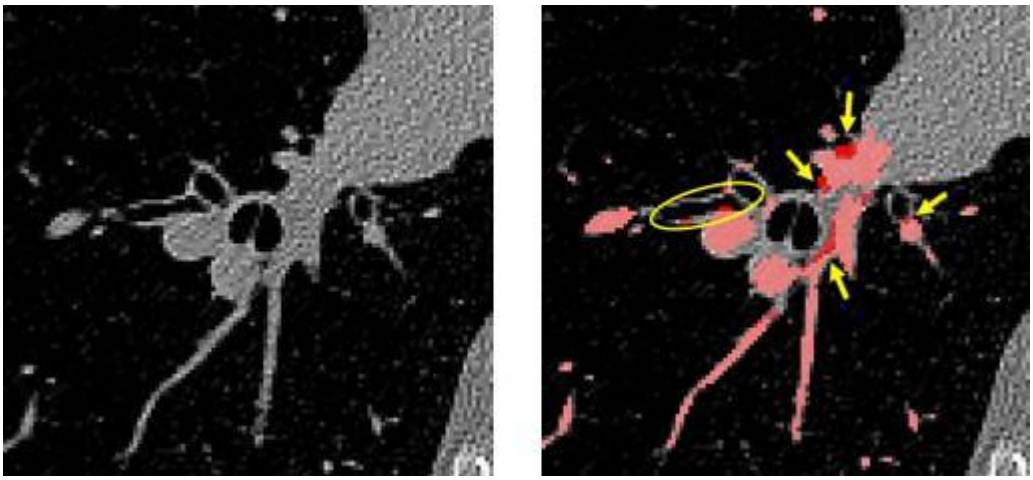

**Figure 2: (A) An Example of Critical Area with Vessels and Airway Walls in Contact; and (B) Segmentations Obtained Using Frangi Filter**

The above are examples of some of the CT images used in the method (2) which shows a few critical areas with the blood vessels involved where the light pink areas are the common affected areas and the yellow part is the improved area.

Furthermore, the methods that were used to evaluate the problems in the lungs improved. Pulmonary Nodule Classification was made possible with artificial neural networks only based CT images. This method which was proposed in the Medical Image Computing Laboratory of Ministry of Education in China proved that the Computer Aided detection (CAD) systems could only assist the radiologists by offering a second opinion in the early stages of the lung cancer and also was found that the classification and feature representation always play an important role in the false-positive reduction (FPR) when it came to lung nodule CAD (5). Hence, these researchers found a method in which a deep convolutional neural networks method for such kind of nodule classification was used. This had an advantage of auto learning and also ability with a strong generalization. For this a specified network structure for only nodule images was proposed and this helped to solve the recognition pf three types of nodules which were the solid, semi solid and the ground glass opacity (GGO). This method used the Deep Convolutional Neural Networks to be trained by 62,492 regions-of-interest samples which included 40,772 nodules and also 21,720 non-nodules which was used by the Lung Image Consortium database. These experimental results were effective in terms of sensitivity and accuracy and were proven to constantly outperform the various other competing methods.

The data set used in this method is the LIDC (9) IDRI database that consists of 1010 CT scan images with nodule size reports and the diagnosis served as a medical imaging research resource. Two blinded phases were used for each scan by for radiologists. The results were gathered and compiled together to form the final review of this method. The LIDC annotations of the radiologists involved freehand outlines of the nodules that were greater than or equal to 3mm in diameter on each of the scan slices here the nodules were visible. The following pathological features were taken into consideration. They are as follows: [1] Calcification [2] Internal structure [3] subtlety [4] lobulation [5] margins [6] Sphericity [7] malignancy [8] Texture and [9] Speculation. The inputs also include a single mark of nodules that are lesser than or equal to 3 mm in diameter as well as non-nodules that are greater than or equal to 3 mm. The average width and height of these nodule images were 14 pixels and the median were used with 12 pixels. The effectiveness of this method was evaluated for the neural networks for different image sets, the data set that was used was made with the 64 * 64 size using the same procedure as that of the annotated non nodules and nodules images that were extracted and used. As a result a total of 62,492 images patches were extracted.

The Deep Convolutional Neural Networks (10) were introduced because of their ability to simulate the various behavioral activities of the human vision system and also learn the various hierarchical behaviors. These types of neural networks were used because of their robustness to translation and distortion in the model and also the invariance in the local objects used. The neural networks generally are built based on the size of the input images. Hence this method is constructed on a 32*32 image ROI data in the deep CNN proposed.

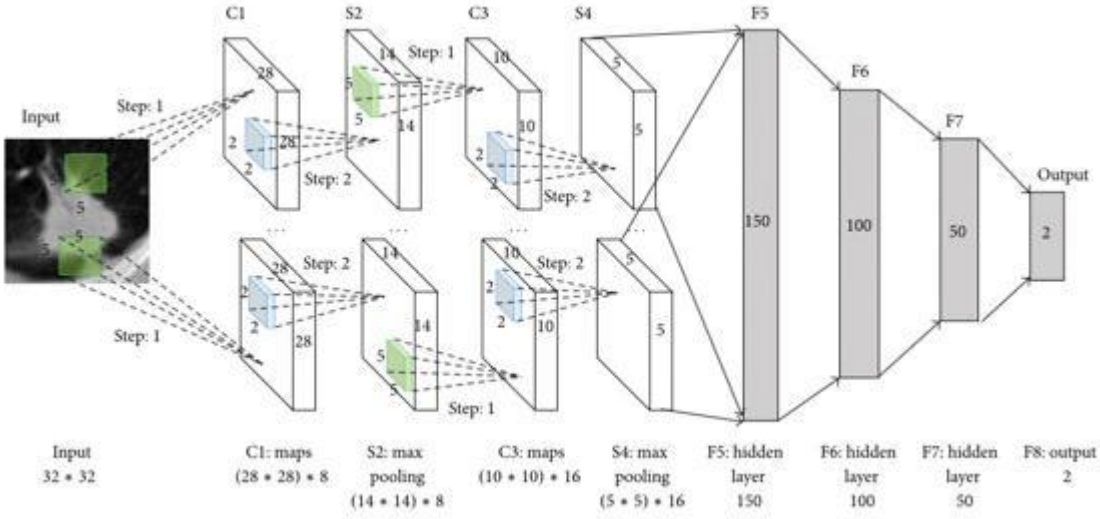


**Figure 3: Convolutional Neural Network for Nodule Recognition**

ROI image pixels is taken as input as 1024 - dimensional vector and 2 is the number of the output neurons in the network. The total numbers of neurons that are established in the other layers are set to 6272, 1568, 1600, 250, 150, 100, and 50 respectively.

One of the main reasons to develop a Computer Aided Detection System with the Convolutional Neural Network is that it can enhance the workflow of the radiologists and thereby potentially reduce the false-negative findings. Hence the scheme helps to automatically detect lesions that are suspicious in the medical images and provide the specific regions to the radiologists. This has been applied to various medical imaging modalities including that of the Computer Tomography, Magnetic Resonance Imaging (11) and Ultrasound Imaging (12). The following stages are involved in indicating the Region of Interest(ROI) which are detection, feature Extraction and nodule classification. The feature extraction and nodule classification stage belong to a step called the false-positive reduction. The current CAD schemes for nodule characterization have been able to achieve levels of high sensitivity and also be able to improve the performance of the radiologists in the characterization of the nodules. Current schemes for nodule detection have reported may false positives and this is because the detection algorithms have high sensitivity that some non-nodule structures are labelled as nodules in the beginning stages of the nodule identification step. As every identified object should be examined by the radiologists, the false-positives should be eliminated while retaining the true positives. Hence there is a significant amount of effort that is needed to enhance the performance levels of the current CAD schemes and techniques.

The diagram above shows the main components in a current CAD scheme without the use of a convolutional neural Network. This method enhances the process by the use of a deep Convolutional Neural Network as depicted in the diagram below:

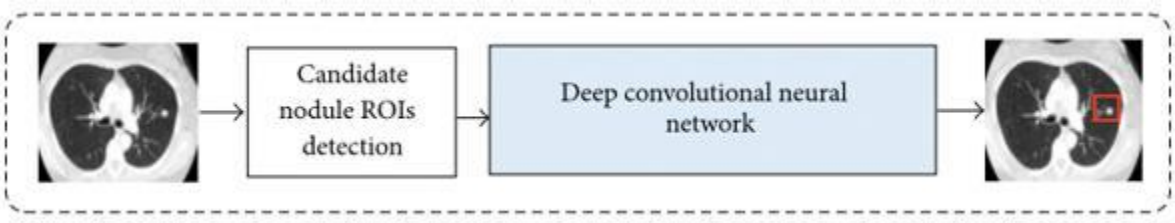


**Figure 4: Main Components of CAD**

The purpose of the false-positive reduction (13, 14) in this method is to remove all possibilities of the false possibles while retaining a high sensitivity. Thus aiming at a binary class-action between the nodules and the non-nodules and thus develop new methods in order to accurately distinguish the suspicious regions and thereby reducing the false positives by machine learning

techniques. The false positive reduction or classification step, both aim to learn if the system is capable for predicting the output of a previously unseen suspicious nodule and is also a critical part in the nodule detection system. Deep learning can be used in both feature extraction and classification of various fields.

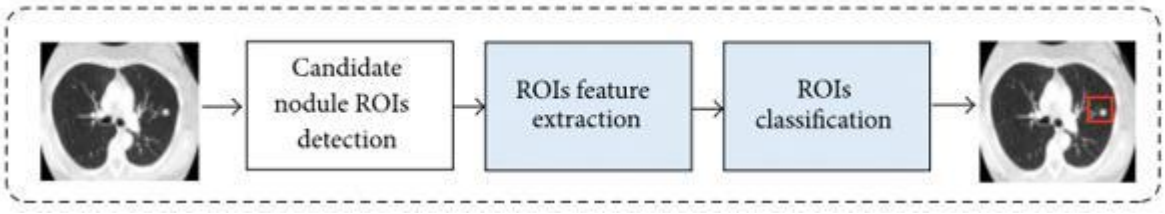


**Figure 5: Main Components of the Pulmonary Nodule Classification**

This method also used the CAD system to replace the components of feature extraction and classification where the input of the neural network is the work of the ROI pixel data with any feature extraction and selection. Thus when this method was taken in comparison to other traditional methods, it had four advantages which are as follows:

- The nodule representation is critical for discrimination between a false and a true one. On the Contrary it is impossible to obtain good feature representations by only human efforts. The method used proved that it could learn a good feature representation without extraction and also selection.
- The method also took advantage of relationships between that of the internal and external region of the respective ROI and this was done so by to learn more discriminative knowledge for the reduction of the false-positives.
- This method could also be executed based on the center of the ROI rather that the entire ROI region. Thus there was no need to obtain the exact margin of the affected region in the first step of the CAD system.
- Finally the neural networks could be trained by large scale ROI data sets with 60,000 nodulated and non nodulated images which is the largest in respect to any traditional method. Thus the neural networks were capable of recognizing nodule representations of a wide range.

A number of related works to pulmonary node recognition using Neural Networks have been created in the recent times. Some of the other related work to the method involves the texture feature identification by Haralick, Garbor and local binary pattern were used to identify lung nodules in MR8 (15). Local

Binary Patterns (LBP), Shift Descriptor and MHOG (Multi orientation Histogram and Oriented Gradients) are some of the various other works that are used in feature extraction (16, 17). The Speed-Up Robust Feature and the Local Binary Patterns are commonly used to thereby generate the features that enable to describe the nodules in a common lung structure. One of the researchers was able to apply an improved version of the Local Binary Pattern and this made it robust for noise (18). A researcher by the name of Sui et al used @D features for circularity, compactness, elongation and finally moment and also 3D features for volume, surface area, sphericity and centroid offset (19). These features were all considered in the process of the lung nodule elongation.

In general, supervised learning approaches in the machine learning domain like SVM, k-Nearest Neighbor, Artificial Neural Networks and the decision tree have all been used in some related work not only to lung nodule classification but many other related defected lung region problems (20). In addition to this a researcher by the name of Zhang et al (16) designed a classifier which was developed in a semi supervised way and this was able to explore information from various unlabeled images. The ensemble classification of the lung nodule recognition was thereby improved with the help of a random forest algorithm. This had the structure of a random hybrid forest which was enabled by a method called clustering. The imbalance between nodulated and non nodulated candidates were seen in almost all datasets. Hence Sui et al presented a SVM classifier which was combined with a random under sampling for the detection of the affected lung area (19). In addition to the a researcher by the name of Cao et al (13) extended this to a Cost Sensitive Adaptive Random Subspace (CSARS) and this helped to overcome the imbalance of data classification.

In the recent times the deep neural networks have gained importance in the field of pattern recognition and machine learning. The image net classification benchmark was achieved in 2012 by the convolutional neural network. A popular research in the field of medicine imaging uses this deep learning. Researchers over the past few years have used convolutional neural networks in the field of neuro imaging of the brain by the Deep Boltzmann Machine (22) for the diagnosis of AD/MDC, feature learning for the deformable registration of the brain, feature extraction for medical image analysis, auto encoder feature extraction for detection of benign or malignant node in the lungs and many more. Thus the Convolutional Neural Networks were proven to have a strong representation in learning useful features from the input provided (10). Based on all of the related work the method proved to be possible for any lung aided problem.

The results (5) of the method proved to demonstrate larger values in terms of momentum and the learning rate could achieve a fast convergence performance. Furthermore, throughout the process training the dataset, the method was able to only obtain results with much more general characteristics of the pulmonary nodules and also higher accuracy while retaining the robustness. Hence the approach was planned to be extended in the future.

One of the various other methods involving neural networks was that of the artificial neural networks to support the diagnosis of pleural tuberculosis that were performed by a few researchers in the Federal University of Rio De Janeiro. The main aim was to evaluate the role of an article neural network and hence aid in the diagnosis of pleural Tuberculosis (6). It involved two methods that helped in the evaluation. First the clinical history and the HIV status of 137 was taken into consideration and were further entered in a database. Pleural Tuberculosis can mostly be found only in patients with HIV and thereby the respective database was taken into consideration. In this method both the Artificial Neural Network (ANN) and the linear Fisher Discriminant was taken to calculate the particular performance indexes and these were based on the clinical grounds. After this the same procedure was performed which also included results from a pleural fluid test. The performances of the various classifiers were based on three factors which are the sensitivity, accuracy and specificity. And in addition to this the sum product and the index was taken into consideration. The index (23) is computed as follows:

**ISP = √(S + E / 2) * √S * E**

Where,

S = Sensitivity
E = Specificity

Simulations were then performed based on the pre-test and the post-test. In the pre-test only the HIV status and the variables for the anamnesis were used. The results thus produced could be accessed immediately and it was important for the immediate treatment in laboratories with poor infrastructure. For the past test the new classical variables in addition to the variables of the anamnesis were used. This also excluded histopathological and pleural tissue culture (26). Hence the aim was to provide a fast and non-invasive result where the results of the last two tests were also ignored.

The Neural Network used in this method consisted of a two layer multilayer perceptron (MLP) topology (25) and this can approximate any arbitrary mapping function. Thus to produce a mode with a high accuracy of prediction, network parameters were investigated thus emphasizing on the choice of the neurons in the hidden layers and other aspects related to the training process. A cross validation approach was used to define these parameters and was based on a SP index.

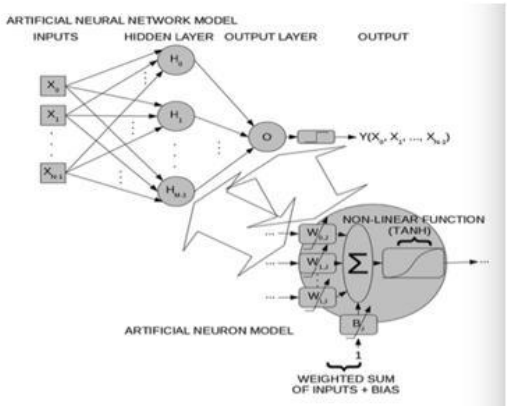


**Figure 6: Multilayers Perceptron (MLP) Model**

This model depicts how information can be inputted and processed, and further how the artificial neuron was implemented in the process. The cross validation was does done by basing it on a stratified random sampling method. The data set was then split randomly forming different test and training sets. Furthermore, these training sets were used in determining the parameters of the network and the test sets were used the estimation of the performance of the network Thus 1 to 20 hidden neurons were produced for every data split and the network was trained a 100 times with the use of different initial random variables and this was done so as to avoid the local minimum problem (25). Thus the researchers found that the best set of initialization parameters were done by selecting it according to the SP index.

Now to ensure a very good generalization in the performance, the early stop method in the control of the learning mechanism was adopted (24). This consisted of interrupting the train phase when a loss could be observed during generalization because of over training. This was computed by the use of the mean-squared error between target and the output value achieved from the various test samples. The average and standard deviation of the Sp index was used for performance estimation. The total number of the various hidden neuron in the method were obtained by basing it on the maximum performance values that were obtained from the test data set. The age values in the method were thereby normalizes to attain a zero

mean furthermore the train group to extreme values of +1 and -1. Parameters were used to normalize the age values test groups that were obtained from the various training groups. Resilient back-propagation (RPROP) was the training algorithm that was adopted and was operated in batch mode (27). This algorithm provides an optimal convergence time with a little computational expense and also there was a constant need for tweaking. The most function was the MSE and all the neurons that were employed, were performed by the hyperbolic tangent as their activation function. Alternative diagnostic methods were also evaluated for the purpose of comparing the results. All Artificial Neural Networks in the method were evaluated using the cross-validation approach (24).

The results for the method produced four models that consist of two for each diagnosis from the pre-test and the post test. All the highest average index values were selected for the results of the model. The table below depicts 'selected models' performance estimates for the diagnosis of tuberculosis consisting of data sets of 125 patients with pleural effusion - (CL - confidence Interval; SP - Sum Product Index; and ANN - Artificial Neural Network):

**Table 2: Performance Estimates of Selected Models**

| Technique | Approach | Hidden Neuron (n) | Sensitivity %(95%CI) | Specificity %(95%CI) | Accuracy %(95%CI) | SP |
|---|---|---|---|---|---|---|
| Fisher's | Pro - Test | - | 68.2 (66.6 - 69.8) | 90.2 (88.6 - 91.8) | 74.5 (73.6 - 75.4) | 78.8 (78.2 - 79.4) |
| Fisher's | Post - Test | - | 93.0 (92.4 - 93.6) | 94.9 (94.2 - 95.6) | 93.5 (93.1 - 93.9) | 93.9 (93.5 - 94.3) |
| ANN | Pre - Test | 15 | 94.5 (91.4 - 97.6) | 91.0 (85.2 - 96.8) | 93.5 (91.0 - 96.0) | 92.6 (89.5 - 95.7) |
| ANN | Post - Test | 18 | 99.3 (98.0 - 100.0) | 99.2 (97.3 - 100.0) | 99.3 (98.2 - 100.0) | 99.3 (98.1 - 100.0) |

During the pre-test all non-linear models were able to achieve an average of the SP index value that was greater than 90% and the neural model performance was greater than the performance achieved by any of the non-preprocessed data. Furthermore the Artificial Neural Networks were able to identify the diagnostics of 22 patients based only on clinical grounds (6). The results of the post-test in the model were compared to both the Fisher and the neural model. Thus the performance of the non-linear model SP index exceeded any result whether it was single or a combination test result.

Thus from the method the researchers were able to come to conclusion that Artificial Neural Networks were highly reliable for the diagnosis of pleural tuberculosis (28) that were based only on clinical grounds and the HIV status and also proved to be useful in remote condition that were lacking the access to sophisticated medical infrastructure. Furthermore suggestions were made by researchers to evaluate these tools as a substitute for diseases like thoracocentesis and pleural biopsy in laboratories that were well equipped.

The table below depicts the post test results of the variable performance estimates for the diagnosis of tuberculosis in a data set containing 135 patients with pleural effusion - (CL - Confidence Interval; SP - Sum Product Index; AFB - Acid Fast Bacilli; ADA - Adenosine Deaminase; ELISA - Enzyme Linked Immunosorbent Assay Serology; NAAT - Nucleic Acid Amplification Technique):

**Table 3: Post Test Results of the Variable Performance Estimates**

| Variable | Sensitivity %(95%CI) | Specificity %(95%CI) | Accuracy %(95%CI) | SP |
|---|---|---|---|---|
| Histopathological | 73.2 (66.7 - 79.7) | 100.0 (100.0 - 100.0) | 80.9 (76.3 - 85.5) | 85.9 (82.3 - 89.5) |
| Tissue Culture | 14.3 (9.9 - 18.7) | 100.0 (100.0 - 100.0) | 38.8 (35.6 - 42.0) | 40.0 (31.1 - 48.9) |
| Fluid Culture | 6.6 (3.3 - 9.9) | 100.0 (100.0 - 100.0) | 33.3 (31.0 - 35.6) | 23.1 (13.0 - 33.2) |
| AFB Smear | 0.5 (0.0 - 1.5) | 100.0 (100.0 - 100.0) | 28.9 (28.2 - 29.6) | 0.2 (0.0 - 4.3) |
| ADA | 79.9 (74.8 - 85.0) | 94.0 (89.2 - 98.8) | 83.9 (80.2 - 87.6) | 88.6 ( 83.2 - 90.0) |
| ELISA | 59.6 (52.1 - 67.1) | 98.2 ( 97.3 - 100.0) | 70.6 (65.3 - 75.9) | 77.2 (72.7 - 81.7) |
| NAAT | 66.9 (60.4 - 73.4) | 90.5 (84.0 - 97.0) | 73.6 (68.6 - 78.6) | 77.8 (72.9 - 82.7) |
| ADA + ELISA | 88.6 (84.4 - 92.8) | 91.8 (86.5 - 97.1) | 89.5 (86.2 - 92.8) | 90.0 (86.7 - 93.3) |
| ELISA + NAAT | 80.4 (75.7 - 85.1) | 87.2 (79.8 - 94.6) | 82.4 (78.0 - 86.8) | 83.6 (78.7 - 88.5) |
| ADA + NAAT | 85.4 (81.0 - 89.8) | 83.8 (75.5 - 92.1) | 84.9 (80.9 - 88.9) | 84.2 (79.3 - 89.1) |
| ADA + ELISA + NAAT | 92.6 (89.1 - 96.1) | 79.0 (70.3 - 87.7) | 88.7 (85.3 - 92.1) | 85.2 (90.3 - 90.1) |

Neural Networks have also been employed in the detection of tuberculosis in the lungs. A group of researchers published a paper that proved tuberculosis could be identified by a multilayer neural network (MLNN) (3). To achieve this two different structures were used, one with a single hidden layer and the other with two hidden layers. To realize the tuberculosis for comparison purposes, a general regression neural network was also performed (29, 30). The algorithm that was used to train the Multilayer Neural Network was Levenberg-Marquardt. In this method the data set for study was taken from a State hospital of patients' epicrisis reports.

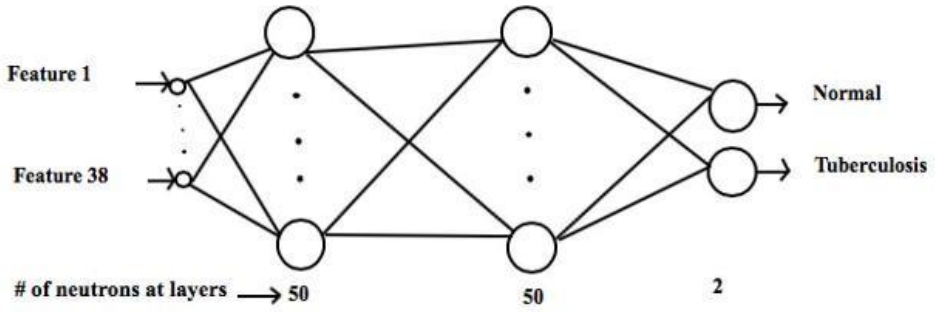


**Figure 7: Multilayer Neural Network with a Brief Description of the Working Model**

In the first stage of the diagnosis of tuberculosis by the neural network involves a multilayer neural network with one and two hidden layers. The neurons of the hidden layer that is 50 neurons for each hidden layer and non-linear sigmoid activation functions are used in the output layer. In the training of the neural network, back propagation with momentum (BPwM) and Levenberg-Marquardt (31) were used. In the method, a generalization to the problem is made from learning the training set of a problem. But once it starts to learn and memorize the training set, the generalization has been noticed to show decrease in its performance and cannot be improved by untrained test sets. Thus the k-fold cross-validation method can

be used to show good generalization by using neural networks. Thus in this 3-fold cross-validation the approaches are used to give an estimate of the performance.

The formula for the classification accuracies used in this method is as follows:

$$Classification Accuracy(N) = \frac{\sum_{x=1}^{|N|} assess(n_i)}{|N|}$$

$$n_i \in N$$

$$assess(n) = \begin{cases} 1 \ if \ classify(n) = nc \\ 0 \ otherwise \end{cases}$$

The results of the method proved that the classification of accuracies that were obtained were better than those obtained in the previous studies. Levenberg-Marquardt algorithm (31, 32) that was used for training was found to converge better than the back propagation with momentum.

Furthermore the results that were obtained from the multilayer neural network (3) with the two hidden layers were proved to be better that that with one hidden layer. Also the best results for the classification accuracy was found to be with the multilayer neural network with two hidden layers and also trained by Levenberg-Marquardt algorithm. The general regression neural network was also proved to be a good choice for the diagnosis in this method.

## 1.1 Summary

Researchers over the years have been able to prove that Artificial Neural Networks are capable of identifying and detecting the various problems involved in the field of medical science. One of the methods that were successful was the use of the Debauchee's wavelet and the output involved three images one of a normal lung, one with pleural effusion and another with pulmonary tuberculosis and was one of the best methods for feature extraction.

Another such method that helps in the field of medicine was that of the vessel detection by extraction of feature from a Hessian Matrix. The results proved to be far more successful than expected where the neural networks could be trained by distinctive large data sets and still be able to detect the affected region involved. Also, deep learning neural networks have gained an importance in terms of efficiency for pattern recognition and machine learning. Thus deep learning was used in the lung feature extraction by a number of researchers.

Furthermore other methods involving neural networks were that of the artificial neural networks to support the diagnosis of pleural tuberculosis and this was performed by a few researchers in the Federal University of Rio De Janeiro. The main aim was to evaluate the role of an article neural network and hence aid in the diagnosis of pleural Tuberculosis.

By this method they were able to come to a conclusion that artificial neural networks were highly reliable for the diagnosis of pleural tuberculosis by a multilayer perceptron topology. However another method involving a multilayer artificial neural network with the Levenberg-Marquardt algorithm proved to also produce satisfactory results in the diagnosis of tuberculosis. Many methods involving neural networks have been performed for the diagnosis of the affected lung region but weren't as successful when applied to the blood vessels lining the walls of the lung. Thus with the right algorithm employed, these neural networks could prove to be successful in this sphere.

# Chapter 2: Methods to Detect and Classify Computer Tomographic Images for Fibrosis of Lungs

Convolutional neural networks (CNNs) (33) have a generic link between feedforward neural networks and adaptive filters and also represent image processing in an interesting way. One or more layers of two dimensional filters with appropriate and possible non-linear activation function and/or down-sampling can be used to create two dimensional CNNs.The network error minimization methods of the convolutional neural networks can be used to optimize these networks and thus produce quite powerful image transformations. Convolutional neural networks have specific key properties (33, 34) of spatially local connection and translation invariance. Thus it can produce the desired output for the specified system and this is an interesting alternative if the distribution of input is spatial or temporary.

## 2.1 Image Processing Method Analysis

In this research, a description of the convolutional neural network architecture with its approach to a practical image processing application for the detection of lung fibrosis for computer tomographic images by pixel manipulation (35, 36) is presented. A convolutional neural network can be used to detect and characterize a lung image by manipulating it pixel by pixel. Although a number of methods that have been used such as the "Combining Markov Random Fields (37) and Convolutional Neural Networks for Image Synthesis" and similar methods, edge detection by pixel manipulation thus making the detection of fibrosis in computer tomographic images possible. Thus the method involves a deep learning method that helps in solving edge detection which has been a problem unsolved in image processing of lung images. These lung images are never constant hence it has been near to impossible to identify the exact extent of the fibrosis. Many methods that exist have a tendency to rely heavily by multiple image features computation and thus making the system complex and expensive in terms of computation.

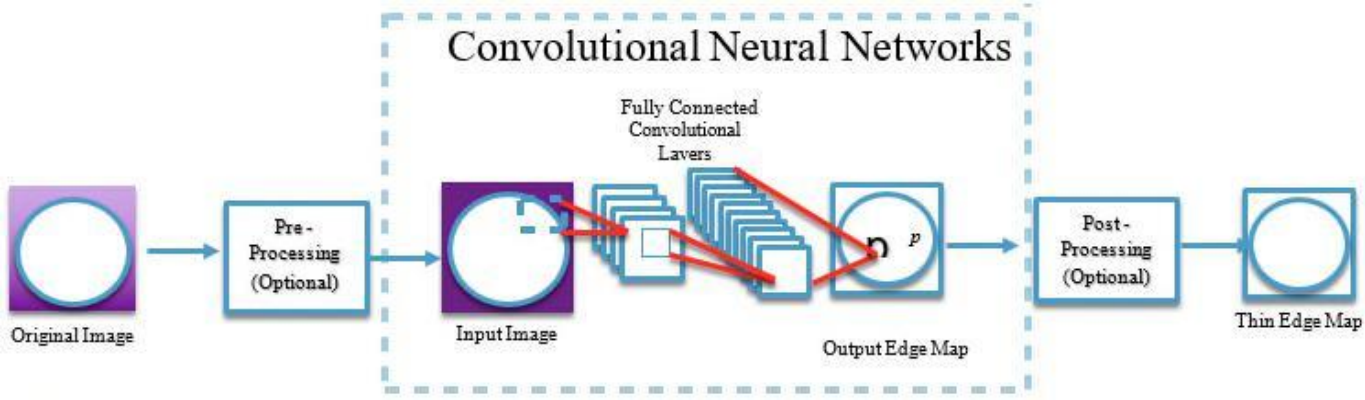


**Figure 8: Process of Deep Learning Convolutional Neural Network**

The Convolutional Neural Networks is trained in a way that the prediction of the edge detection is based purely on image fibrosis from a CT lung image. The training data set (38, 39)for the method involves that of computer tomographic images in the lung and pleural mode of the same patient. The reason being that these modes although of the same patient produces a huge difference when edge detection has been applied. Such networks are adopted so that the system is free from additional procedure involving feature extraction, thus making the method simple and further efficient without the loss of performance in edge detection. Once edge detection has been done, further more experiments on the network structures, combination of data, various other pre-processing and post-processing techniques (40) have also been performed so as to enhance and influence the performance. The task of identifying the boundary of an

object is done by edge detection techniques in image processing and has been widely used in areas of computer vision. The main aim was to provide an accurate, simple and fast algorithm that can increase the performance of the system and thereby the efficiency. Accurate results for lung images have not been accurate as the edges form in many diverse ways. Thereby a universally applicable edge detection algorithm cannot comply with the purpose of detecting fibrosis.

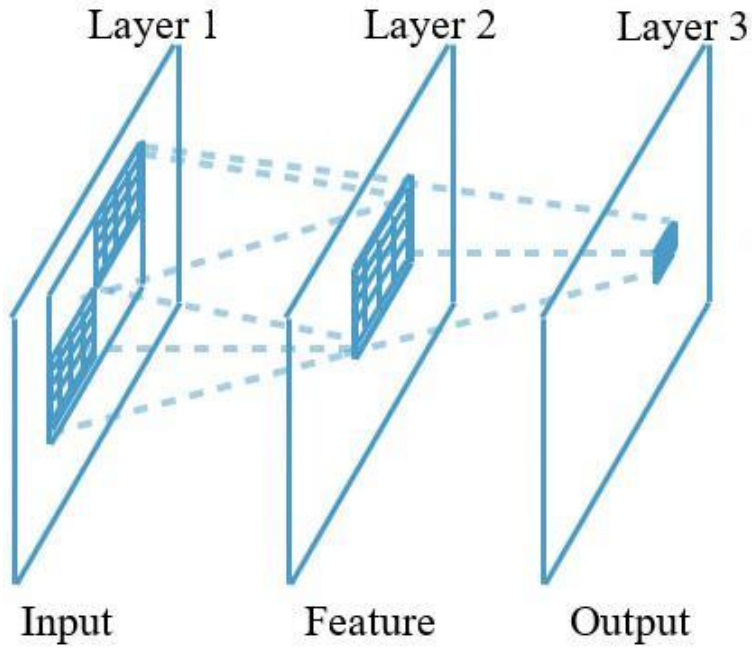


**Figure 9: Deep Convolutional Neural Network with a Single Neuron in Two Layers**

Most of the conventional edge detection algorithms mainly depend on the gradient computation which means pixels with large gradient magnitude and thus labelled as edges. various other techniques such as non-maximum suppression (41) have been implemented to produce an accurate result. But these methods are only based on a color assumption or change in intensity on the boundary between many images while it remained unchanged in a single lung image. Thus the correspondence between the boundary detected are learned from data rather than basing it on any man made assumptions. Traditional learning methods are not capable enough to learn a direct mapping from patches of certain images to prediction of an edge. In order to get an accurate representation, many have tried to compute gradient channels and multiple color or can even extract the similar features of the original CT image and this has effected the performance in terms of output to a huge extent. Thus by considering and further more introducing a deep convolutional neural network with pixel manipulation, the detection of fibrosis can be made easy, efficient and even accurate unlike the traditional learning structures. By implementing this we are free from extraction of features or even computation of multiple channels (42) and thus suggesting a very straight forward method in terms of the detection and output accuracy.

Thus the training algorithm for the back propagation or the conjugate gradient descent (43) tries to minimize the mean squared error by adjusting the weights and the bias.

**E(W,B) = 1/ (2|L|) Σ [lower limits (xi,ti)  L] Σ[upper limit: c, lower limit:k=1](N(xi; W,B)k − tik)2**

It also shows that the feed-forward when provided with enough nodes in the hidden layer with a large training data set can approximate the bases posterior probability.

$$P(\omega_j|x) = P(\omega_j)p(x|\omega_j)/$$
$$[p(x)],\ \text{where, } j = 1,\ldots,m$$

A feed-forward of an artificial neural network with one hidden layer can be used to identify such a mapping:

$$R(x; W,B)=w32T\ f(w21Tx - b2) - b3$$

The required output of the regression artificial neural network is the conditional mean.

$$E(y|x) = \int Rm\ yp(y|x)dy$$

A training set L with pairs of input and output values (x,y), is used to adjust the weights (43, 44) and bias terms such that the mean squared error between the predicted value and the desired value.

$$E(W,B) = 1/(2|L|)\ \Sigma\ [\text{lower limits } (x^i,t^i)\in L]\ \Sigma[\text{upper limit: } m, \text{ lower limit:} k=1](R(x^i; W,B)_k - y^i_k)^2$$

In this method the network should capture local patterns (44) from any inputed CT image in the convolutional layers and this makes it a suitable tool for solving the detection of fibrosis problem, because the edges are usually correlated locally and only specific patterns (45) are exhibited. Thus this research is developed based on these methods by further modifying them and creating a simple design. Its further more simplified by the removal of pooling layers (45). The entire data set used in the experiment is of sample images fro the the Belarus Tuberculosis Institute. Best performance can be achieved by using a simple three layered network that takes raw RGB color patch from a image as the input without any of the pre processing. By not suppressing the image and further more applying it to the whole system the performance can be improved.

## 2.2 Edge Detection Method Analysis

Once an image has been inputted into the network extra noise has to be removed by certain preprocessing techniques for accurate edge detection (46). The convolutional neural network scans the image and then makes the edge detection pixel by pixel and this is based on the image patch that is centered on it. The Convolutional Neural Networks can be characterized as follows:

- The translation invariance which means that the neural weights are fixed with respect to it's spatial translation
- It's local connectivity as in neural connections can only exist between spatially local regions
- The optional progressive decrease in spatial resolution such as the number of features can be gradually increased.

The above constraints thus make a convolutional network to operate similar to system with interconnected filters (46), and thereby profitable comparisons can be made by other filtering systems, since the neural weights of the convolutional neural network can work as a system of finite impulsive response (47) or even wavelet filters. Thus a trained network can be custom made with a trainable filter system for a certain mapping application.
Finally, morphological operations or even non-maximal suppression (46, 47) can be applied as a post process technique and this helps to increase the localization accuracy. The pre process technique used is a

smart algorithm that not only increases the system complexity but is straight forward and helps in noise removal. Further more the convolutional neural network serves more or less as a core component of the system. It takes the image patches and makes the predictions based on whether the identified central pixels are located on the edge of the CT image or not. Thus, any filter that fulfill the task of pixel comparison and identification can be employed in the system. The post processing that takes place in the system usually covers large amount of pixels that are considered to be inaccurate. Hence, a non-maximal suppression or morphological suppression method (48) is employed so as to render a thin edge that is mapped in the final output of the CT image.

Formula for the Laplacian of Gaussian filter:

**LoG(x,y) = - 1/π2[1 - ((x2 + y2)/22)] e ^ -x2 + y2)/22**

The advantage of using the laplacian of Gaussian (48) is that it requires few arithmetic operation than the other filters since the kernel size is smaller than the image and also the method can be pre-calculated in advance, therefore needing only a single convolution to take place during runtime. Hence the laplacian of gaussian method is employed.

## 2.3 Method Used for the Detection and Analysis of Fibrosis

Once the edge detection is done with a suitable edge detection algorithm, the extent of fibrosis is analyzed and detected by pixel manipulation.

### *2.3.1 Identification of Image Bit Depth and the Components of the Pixel Color*

The depth of the image can also be referred to as the bits per pixel. This is taken as an indicator of the amount of storage space required to store the respective computer tomographic image. The smallest unit of storage in the system is the bit value (49) in any storage medium and can simply be refereed by either 0 or 1.

The smallest unit of storage in C# is expressed in the form of a byte integral value (49) and it occupies 8 bits of storage. Hence, it is not possible in C# to further express any value as a bit. Thus, a functionality is provided in a .net framework that enables the concept of representing a value as a bit, and this occupies far more that a bit of the memory when it has been implemented.

Thus if a computer tomographic image is taken into consideration as a 32 bits per pixel, the for each of these contains pixels in the respective CT image of 32 bits additional storage is required. Thus, by knowing that a byte is a 8 bits logic implies (50) that the 32 bits are equal to the four bytes. This can be determined by dividing the 32 bits by that of 8. The image format for any CT image should be taken as 32 bits per pixel and further can be encoded as 4 bytes for each pixel of the image. Thereby 32 Bits per pixel requires 4 Bytes to represent that of a single pixel.

### *2.3.2 Representation of Data in Pixel Byte Format*

The 32 Bits per pixel that was equated to the 4 bytes per pixel is now used in turn as in each byte is used to represent a color component. Thus it should be capable of expressing a single color that is used to represent the respective pixel. Hence the image format will be referred to as 32 Bits per pixel ‘argb’ which means that the color components (50, 51) that are contained in the pixels are red, green, blue and the component of alpha.

This Alpha component will be used to indicate a particular pixel transparency (52). Again each color is represented by a value of a byte. A color component in the method can only contain a value with the range from 0 to 255, which means that the possible range of values can start from 0 and end till 255 and this is in terms of bytes. The value of a color in the method is in fact a representation of the intensity of color associated with that of a pixel from a single image. The highest possible intensity is indicated by a 0 and no intensity is represented by that of 255. When the Component of Alpha is thus set to 255 it is thereby an expression of no transparency (53) and when it equates to 0 is a representation of the associated pixel to complete transparency, and thereby negating the color values by the other remaining color components.

It should be noted that all images support transparency and this is similar to how certain image formats can be represented by a grayscale (54) or just a black or white pixels. The computer tomographic images that are expressed in terms of the red, blue, and the green color value and also has no component of Alpha can be image in the image format of 24 Bit RGB. Thus each pixels requirement for storage is 24 bits or 3 bytes is represented by the value of intensity of red, green and blue and further more limited to range of 0 to 255.

### *2.3.3 Manipulation of Individual Pixel Color Components*

It is possible to manipulate the value of each individual color component of a pixel from the respective image in C#. When the expressed value of a color component is updated there will be a change on the whole by the respective pixel that was expressed by the color value (55). This changes the intensity of the color components. For example let us consider that if the vale of a blue color component was doubled, the result would be the color having twice the intensity as before.
Thus, when the color components are manipulated, a color filter (56) is applied to an underlying image. Furthermore, by iterating the value of bytes and by performing any updates based on the conditional check also qualifies as a algorithm.

### *2.3.4 Retrieving a Byte Array from Color Components*

The outcome of the .net framework's memory in respect to it handling the infrastructure and also the usage of the Garbage Collector (57) is that it is more possible that the address of this memory is assigned to certain variable when it is instantiated and it could be changed during the scope of the variable. This needn't possibly reflect the same memory address when it is going out of scope. The garbage Collector is responsible to ensure that the variable's memory reference is updated. This should be ensured whenever an operation is performed by the Garbage Collector and further more results in the memory moving to a whole new address in the memory.

When an image's underlying data is expressed in the form of a byte array (57, 58) while accessing it, in order to signal the Garbage Collector of an addition memory existing, the method requires a new mechanism. This may not be updated when the values are shifted in the memory to a whole new address.

- A method must be provided to lock bits by the specific class and when the byte value representing the pixel data is invoked, it will not be moved in the memory by this Garbage Collector not until all the values represented are unlocked by the Unlock Bits method that is defined by that of the same class as that of the lock bits method.
- The method to Lock the bits that is defined, returns a value which contains all the data that is related to the lock operation.

- Thus when invoking the method to Unlock the bits it is also required to pass an object created that was returned when the method to Lock the Bits was invoked.

An overridden implementation is also provided by the method to lock the bits. This allows the method to call the code and specify only a certain or required part of a Bitmap to be locked in the respective memory. This is represented as a rectangle structure.

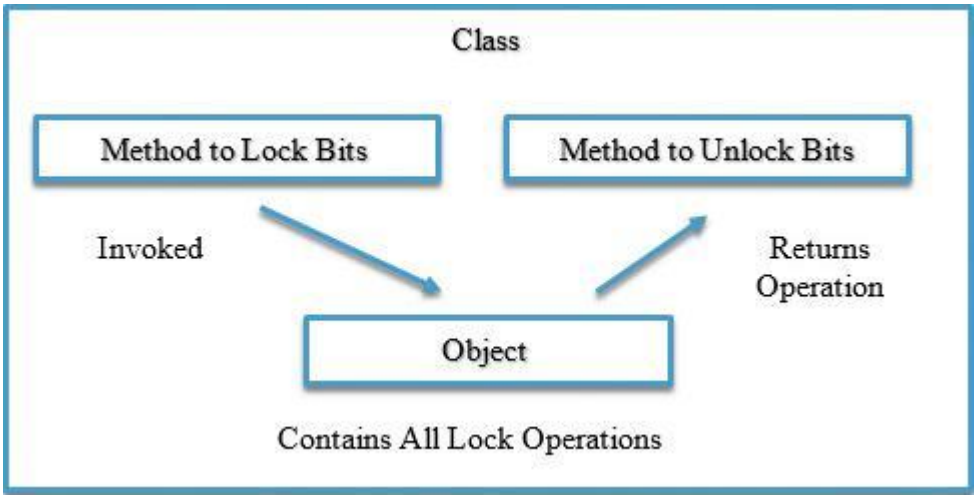


**Figure 10: Process of Retrieving the Byte Array**

In order to update the size of an entire bitmap, this method helps so in doing it and the rectangle structure will be equal (58) to the whole size of the bitmap. The object that was returned when the method to lock bits was invoked, a certain property will be defined. This helps to contain the address of the very first pixel of the bitmap that is the starting point of the data.

### *2.3.5 Filtration of Bitmap Color Components Algorithm*

The implementation involves that of two Bitmap images, as in a pleural mode image and lung mode image of the same patient, to be blended by considering one as a source image and the second as an overlay image. Thus an algorithm is created for this method and this should be defined as class containing public properties that affects how the synchronization (59) of the image is achieved.

- First an instance of an object is created for the specified class and thereby also setting certain values for the associated public properties at runtime as specified by the user. This class can thus be used and furthermore it is taken as a dynamic algorithm.
- This algorithm should further more contain the class definition and this should also contain six public properties.
- These six public properties in the class are used to identify whether or not a color component should be included in calculating the specific new value.
- In addition to this there six more properties that will help in denoting a factor so that it can apply a component of color as an input to the resulting component of color.
- A property should be defined for a certain color component. This is set to true so that the associated Level property will be applicable while calculating any new value of the color component.

- Also three properties of type enum are defined publicly in the same specified class for the color component. This value is responsible for determining the calculation between the color components of the source and the overlay image.
- Once each component of color has been applied to the associated factor of Level Property, the enum value defines the calculation.
- Finally the source and the overlay components could be either subtracted, averaged, added, larger or smaller value discarded.

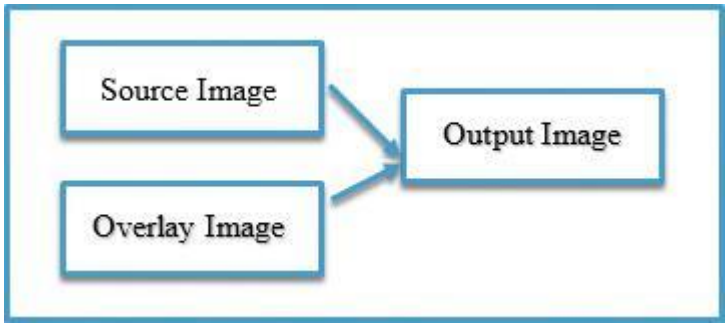


**Figure 11: Concept of the Color Component Filtration**

### *2.3.6 Blending Bitmap Images*

In this process a method is defined as an extension method to target (60) the class specified while retrieving a byte array. This method helps in creating a net memory for the bitmap of which the color values for the source and overlay bitmap image are calculated and thus defined by an object parameter that was defined in the bitmap color component process.

- It starts off by the creation of a 2 byte array that is intended to have the source and overlay bitmap image pixel data contained in it. This is expressed in a 32 bit argb (alpha, red, green and blue) image format.
- This is further locked in the memory by the lock bits method as mentioned in the retrieving image process.
- Now before the value of the bitmap byte are copied, a byte array has to be declared.
- The bitmap bytes are further more copied to the declared byte array.
- The bitmap's size of the byte data can be thereby determined by multiplying the Stride (60, 61) by the height of the bitmap and hence an instance can be obtained from the retrieve color components when invoking the bits in the lock bit method.
- The associated object of the class will contain information about the lock operation and hence it needs to be implied as a parameter while unlocking the bits.
- The Stride of the bitmap refers to the scan width of the bitmap image and this stride property can be described as the overall amount of color components that is found within a row of pixels from this bitmap image.
- This property should always be rounded to boundary of four bytes. This can be done by making a deduction that the property modules would always equal to a 0.
- This is achieved by multiplying the stride property with that of the Height property.

- This Height is also represented as the number of scan lines and is equal to the height of the bitmap image in pixels from the object that has been derived.

Multiplying the two properties can be simple considered as multiplying the height, width and depth of the image.

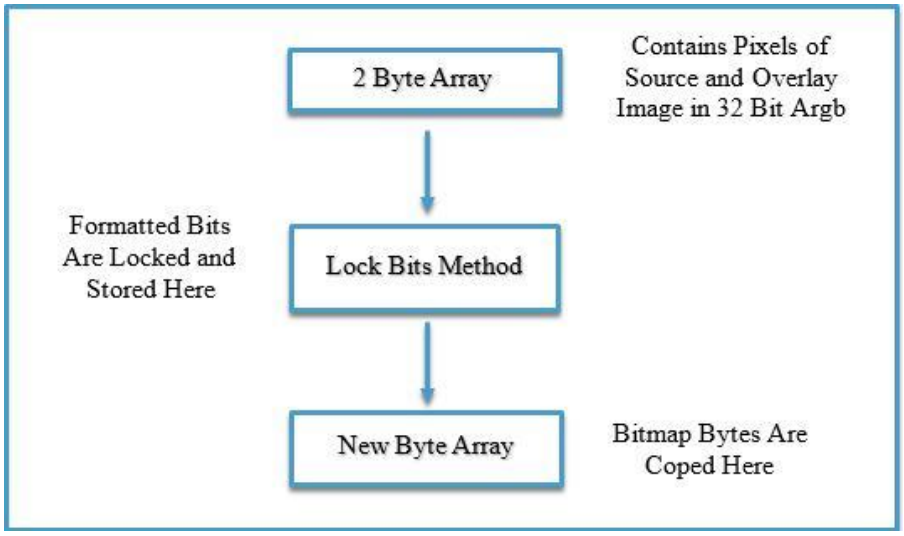


**Figure 12: Process of Creating a Memory for the Bitmap**

When an array of two bytes has been obtained from source and overlay bitmap image, iteration between the two arrays takes place simultaneously. This calculation is based on values that have been define from the respective object (62) that is defined in the class. The more possible failure is when it comes to bitmap manipulation and not remembering the right order of the color components.

Now the pixel format is in 32 Bits per pixel argb. The reference state (63, 64) now of the argh is alpha, red, green and blue when the actual order of a pixel is blue, green, red and alpha. This ordering of the color components usually develops some unintended consequences. In the defined object, if the color components are disabled then the new color component will be set to zero. During the byte array iteration, each color component that is associated with the enum type values (65) also performs set of calculations which are also defined by the object of the same defined object. Calculations are invoked by a method that is defined to calculate the enum type blend values. After all the calculations have been completed a new object is created. The updated pixel is copied after the bitmap object that is created is locked in the memory. Just before returning the bitmap which contains the value of the color components (66) it should be unlocked.

### *2.3.7 Calculation of Blend Values*

The method that is created to blend the enum type values is used to perform a number of calculations for each color component (66) and this is based on the Blend type that is specified only by the specified object. It is very important to check if the method returns a value and thus ensuring that the new color component values is within the range from 0 to 255. Any value that exceeds the highest limit that is more than 255, the value should be assigned to 255 and if the value is less than 0, that is a negative value, it should be assigned to a 0.

### 2.3.8 Conversion of the 32 Bit Per Pixel ARGB Format

In order to convert the format an extension method is defined so as to target (67) the string class. In addition to the conversion of these image formats, this method could also be implemented to resize (66, 67) the respective computer tomographic images. The method is invoked only when the user has specified the source and overlay image and also therein to produce a better filtering. This requires the overlay image to also be of the same size. The images that are inputted as source images are never resized. The overlay images are only resized so as to match the size of the inputted source image.

- The computer tomographic images can only be resized if the required size is known and the inputted overlay image is not if the same size as the required size.
- A situation in which the size is not known can only occur if an over image is inputted before the source image.
- Thus, when the the source image has been changed, the overlay image may be recreated from the respective file system and then further resized if needed.

Furthermore, if the image is not to the 32BppArgb format, then the method that is created (67) will further invoke another method. This method implements the GDI drawing by using the class Graphics that has been defined in order to resize the image.

## 2.4 Summary

The research on the whole combines three algorithms which are for image processing, edge detection and image convolution. The inputted image is processed to produce the required bits per pixel using the single convolution and horizontal or vertical convolution. Once the bitmap is distinguishable by pixels format for each color component, then it is applied to a edge detection method such as the laplacian of gaussian 5*5 method of type 1. This not only helps to distinguish the boundaries of the bitmap images but also helps to remove the noise by smoothening the image by using the gaussian blur function. Finally, two bitmap CT images are inputted of two modes, one of which is the pleural mode and the other is the lung mode. Once edge detection has been applied to both inputted images, pixel manipulation is done by retrieving the byte array of the color components and hence the extent of fibrosis can be known and the output that is produced will be more accurate and also efficient in terms when used in the field of medical science.

# Chapter 3: Requirement Specification and Software for the Detection of Lung Fibrosis

The coding language used to develop the algorithm is c# and is developed on a Windows Platform for the detection of fibrosis.

## 3.1 Requirements and Services

Neural networks in the field of Medical science has been improving by the day but the detection of fibrosis could be made more possible with a proper detection algorithm along with pixel manipulation. For the algorithm we will be using computer tomographic images to detect fibrosis. Image processing methods have usually found to be successful by using MATLAB, but here since we need to detect the edge and finally perform pixel manipulation to produce accurate results, the entire program is implemented in .net Visual Studio.

In order to proceed with the proposed algorithm, computer tomographic bitmap lung images of patients suffering from various diseases caused by fibrosis with a proper pixel format is required. This is to be ensured cause while leaning these images through a convolutional neural network, the results produced would be more accurate and also efficient. The output results could be saved in order to use them for medical purposes as in to find the extent of fibrosis for a particular patient. A number of edge detection methods have been implied in various fields of science and have proven to be successful. Some of the very few methods are the Laplacian, Laplacian of Gaussian, Sobel, Prewitt and Kirsch. The edge detection method that is implemented in this method is Laplacian of Gaussian 5 * 5 edge detection method because unlike the other edge detection filters, this method can be used to filter any results that vary comparatively when any grayscale or color image is compared.

The Laplacian of Gaussian edge detection method consists of two types and this helps in implementing a Gaussian Blur Matrix that is comparatively large in size and thus produces image results of a high degree and also with less noise. Further more the output thus produced helps in pixel manipulation and also helps to produce an accurate result in the detection of fibrosis.

Thus for the algorithm to be produced successfully, bitmap CT images along with the implementation of the laplacian of Gaussian 5 * 5 method and the pixel manipulation algorithm that is created helps to produce more accurate results.

## 3.2 Class and Methods Hierarchy

The programming language C# is used because it is proven to produce some of the most accurate outcomes in terms of Image Processing. The program on the whole is divided into three parts.

- Image Processing using deep learning method
- Edge Detection method
- Pixel Manipulation method.

### *3.2.1 Image Processing Class Hierarchy*

In this process we define a class ImageProcessing.cs. In this class we define three public methods and one private method. The methods are as follows:

- Private method to get a gray scale bitmap image
- Public method to load images in the respective bit format
- Public method for pixel recognition
- Public method for identifying the regions.

#### 3.2.1.1 Private Method to Get a Gray Scale Bitmap Image

Here, the height and width of the class of the image is taken as variables. The image processing helps to achieve the Gray Scale of the bitmap image. The method is defined as follows:

**private static byte[][] GetGrayscaleImageData(Bitmap image)**

Once the height and width of the image has been achieved, the bits are locked in the memory when the object created is invoked. The bitmap image will be read only if it is in a particular format.

```
BitmapData bitmapData = image.LockBits(new Rectangle(new Point(0,
        0), image.Size), ImageLockMode.ReadOnly, image.PixelFormat);
```

Here, a bitmapData object is created in which the bits of the image are stored.

```
byte* OriginalRowPtr = (byte*)bitmapData.Scan0
            + i * bitmapData.Stride;
```

The Stride property of the object bitmapData is used to identify the total number of color components found in a row of pixels from a Bitmap image. This also helps to round the property to a boundary of four bytes.

**image.UnlockBits(bitmapData);**

The object bitmapData needs to be passed while even invoking the unlockBits and finally returns a value with the image data.

#### 3.2.1.2 Public Method to Load Images in the Respective Bit Format

This method helps in taking the image values and loading them into the process. It is defined as follows:

```
public static byte[][][] GetGrayscaleImagesData(string[] filenames,
    ref int imagesNumber, ref int imageHeight, ref int imageWidth)
```

Here, the height, width and the length of the image is taken as variables and assigned to a new object named the firstBitmap.

To identify the first image from a loop of bitmap images a for loop is created by adding a pointer to the starting set of bitmap images inputted. Now the first inputted image is converted to a gray scale image by calling the GetGrayscaleImageData.

**imagesData[i] = GetGrayscaleImageData(new Bitmap(filenames[i]));**

This helps to convert the loaded image to the gray scale image format and it returns the image that can be passed when necessary.

#### 3.2.1.3 Public Method for Pixel Recognition

This method of the image processing helps to convert the given bitmap image to a 32 bit format bitmap image. It can be defined as follows:

**public static Bitmap GetBitmapFrom32Matrix(byte[][] matrix, int height, int width)**

This helps to represent the height an width in a byte array format. First a net object is created called resultBitmap.

**Bitmap resultBitmap = new Bitmap(width, height, PixelFormat.Format24bppRgb);**

This also helps to convert the inputted pixels into 24 bits per pixel with height and width variables. The converted pixels are now stored in memory of the lock bits method and can be invoked when necessary.

**byte* BitmapRowPtr = (byte*)UpdatingData.Scan0 + i * UpdatingData.Stride;**

Scan0 contains the address in memory of the Bitmap's first pixel as in starting point of a Bitmap's underlying data.

#### 3.2.1.4 Public Method for Identifying the Regions

The method helps to identify the bitmap image regions from the byte array input with the height and width variables. It can be defined as follows:

**public static Bitmap GetBitmapFromRegions(int[][] regionsMatrix, int height, int width, int bodyRegionIndex, ColorFactory cFactory)**

Furthermore filtration can be applies to the pixels that were received by the previous methods. The pixels got is segmented and the byte count is applied to 4 to cut the area out for filtration.

```
byte* BitmapRowPtr = (byte*)UpdatingData.Scan0 + i *
            UpdatingData.Stride; for (int j = 0; j < width; j++)
            {
               int ColorPosition = j * BytesCount;
               segmentIndex = regionsMatrix[i][j];
               if (segmentIndex == -1)
```

This helps to cut out areas for filtration and the result is passed. Now,The highest possible intensity is indicated by a 0 and no intensity is represented by that of 255. Here, we represent any value that exceeds the highest limit that is more than 255 be assigned to 255 and values that are less than 0, be assigned to a 0.

```
if (segmentIndex == bodyRegionIndex)
                {
                   BitmapRowPtr[ColorPosition] = 255;
                   BitmapRowPtr[ColorPosition + 1] = 255;
                   BitmapRowPtr[ColorPosition + 2] = 255;
                }
                else
                {
                   BitmapRowPtr[ColorPosition] = 0;
                   BitmapRowPtr[ColorPosition + 1] = 0;
                   BitmapRowPtr[ColorPosition + 2] = 0;
```

Now the values are stored in the lock bits memory and invoked when the unlock bits function is called and the resulting bitmap is passed for edge detection. Thus the image is successfully processed through the algorithm and the image is represented in the respective image format for edge detection.

### *3.2.2 Edge Detection Class Hierarchy*

The whole of the edge detection process consists of the following classes:

- ExtBitmap.cs
- Matrix.cs
- Mainform.cs

#### 3.2.2.1 ExtBitmap.cs

This class is responsible for performing the Image convolution such as Single Matrix Convolution. Further more the method defined helps in horizontal and vertical Matrix Convolution which helps in the edge detection. It consists of four methods:

- Public Method for Image Canvas Conversion
- Private Method for Image Convolution
- Public Method for Convolution Filter
- Public Method For Laplacian of Gaussian 5 * 5 Type 1

**Public Method for Image Canvas Conversion**

In this method the width and height of the source bitmap is taken as variables and assigned to a integer variable. It checks for two conditions if the width is greater than the height or equal to it. It is defined as follows:

```
public static Bitmap CopyToSquareCanvas(this Bitmap sourceBitmap, int canvasWidthLenght)
```

This method helps in taking the inputted image and convert it to a square canvas for further matrix conversion. This image is converted into a graphic form and assigned to a variable graphicsResult. The image is then set to three types which are the composition Quality, interpolation mode of the cubic and the pixel mode. The three are set to be in high quality so that the inputting source image would be in the required quality.

```
graphicsResult.DrawImage(sourceBitmap,
                         new Rectangle(0, 0,
                            bitmapResult.Width,
                         bitmapResult.Height), new Rectangle(0, 0,
                            sourceBitmap.Width, sourceBitmap.Height),
                            GraphicsUnit.Pixel);
```

The width and the height of the image is set to 0 so that it begins from the starting point and finally the output is given to a new variable which is the bitmapResult.

**Private Method for Single Matrix Convolution**

This method is an extension method that is aims at using the bitmap class. Therefore it is intended to apply a user defined matrix and thus convert the image further to a grayscale. It is defined as follows:

```
private static Bitmap ConvolutionFilter(Bitmap sourceBitmap,
                                        double[,] filterMatrix,
                                           double factor =
                                               1, int bias = 0,
                                        bool grayscale = false)
```

Here the method takes the inputted bitmap image and checked if the image has already been converted to a grayscale format or not. A new object is created ‘sourceData’ to which all the converted bits are locked and stored and also converted to a 32 bit pixel format.

```
BitmapData sourceData = sourceBitmap.LockBits(new Rectangle(0,
                                0, sourceBitmap.Width, sourceBitmap.Height),
                                        ImageLockMode.ReadOnly,
                                    PixelFormat.Format32bppArgb);
```

Further more the stride of the bitmap image is multiplied into the the height of the image and assigned to a byte array. If the image is found to be in the grayscale format, the Argb of the image is thus calculated and assigned to an incremental array and set to 255.

```
resultBuffer[byteOffset] = (byte)(blue);
                resultBuffer[byteOffset + 1] = (byte)(green);
                resultBuffer[byteOffset + 2] = (byte)(red);
                resultBuffer[byteOffset + 3] = 255;
```

Once the color is calculated the result is stored in the memory of an instance such as resultBitmap when lock bit is invoked and when the unlock function is called the new lock operation stored in the memory is sent as output that can be processed.

**Public Method for Vertical and Horizontal Convolution Filter**

This method is defined so as to accept two matrices which is need for the algorithm to produce more accurate results. It is defined as follows:

```
public static Bitmap ConvolutionFilter(this Bitmap sourceBitmap,
                                       double[,] xFilterMatrix,
                                       double[,] yFilterMatrix,
                                           double factor = 1,
                                               int bias = 0, bool
                                        grayscale = false)
```

This method is similar in function as the single matrix convolution method where the pixel format is converted to a 32 bit argh format and bits are stored to and instance of an object. It is invoked also when the unlock function is called. Further more the stride of the bitmap image is also multiplied with height of the bitmap image. Once the images are inputted, the grayscale format is checked and assigned to an array buffer respectively, after which the rub values are calculated and also assigned to incremental buffer. The value from the buffer is used to calculate each individual color component by assigning it to a integer filterOffset.

In addition to this, the square root of the color components are calculated to find the total color component pixel value and is defined as follows:

```
blueTotal = Math.Sqrt((blueX * blueX) + (blueY * blueY));
greenTotal = Math.Sqrt((greenX * greenX) + (greenY *
greenY)); redTotal = Math.Sqrt((redX * redX) + (redY * redY));
```

Now, the values are assigned to a buffer offset incremental array and is finally set to the high intensity color component value which is 255. The output result is also stored in the object instance and invoked while unlocking the bits.

**Public Method for Laplacian of Gaussian 5 * 5 of Type 1**

This method is a common variation of the Laplacian filter and is intended to deal with noise intensity of other filters. This is achieved by the use of a Gaussian blur which removes the house by smoothening the image. Thus a high degree of gaussian blur results high degree of the image smoothening produced. It is defined as follows:

```
public static Bitmap Laplacian5x5OfGaussian5x5Filter1(this Bitmap sourceBitmap)
```

In this method, the object resultBitmap calls the ConvolutionFilter function and the color component values of the inputted image are calculated.

```
Bitmap resultBitmap = ExtBitmap.ConvolutionFilter(sourceBitmap,
                      Matrix.Gaussian5x5Type1, 1.0 / 159.0, 0, true);
```

#### 3.2.2.2 Matrix.cs

The class Matrix.cs helps in the matrix representation of the pixels. It consists of the following method that helps to convert the inputed 32 bit argb pixel format in a matrix for accurate output.

- Public method for laplacian of gaussian matrix representation of Type 1

**Public Method for Laplacian of Gaussian Matrix Representation of Type 1**

This method represents laplacian of gaussian by repressing the pixels in a matrix format and thus helps in smoothening the image by removing the noise. The laplacian 5 * 5 matrix is defined as follows:

```
public static double[,] Laplacian5x5
    { get
        { return new double[,]
          { { -1, -1, -1, -1, -1, },
          { -1, -1, -1, -1, -1, }, {
          -1, -1, 24, -1, -1, }, { -
                1, -1, -1, -1, -1, },
           { -1, -1, -1, -1, -1 }, };
    } }
```

Here, we use Kirchoff's matrix to implant the laplacian 5 * 5. Similarly the Gaussian 5 * 5 matrix is defined as follows:

```
public static double[,] Gaussian5x5Type1
    { get
        { return new double[,]
           { { 2, 04, 05, 04, 2 },
           { 4, 09, 12, 09, 4 }, {
          5, 12, 15, 12, 5 }, { 4,
                  09, 12, 09, 4 },
           { 2, 04, 05, 04, 2 }, };
    } }
```

This method samples the gaussian kernel by taking a mid point of the pixels and then normalizing it. Here it can be seen that the value at the centre is the largest and decreases symmetrically as the distance decreases from that of the centre.

#### 3.2.2.3 Mainform.cs

This class is connected to main user interface and connects all classes to thus produce the final output. It consists of the following properties:

- Public method for bitmap initiation
- Private method for the functioning of the button load click
- Private method for the functioning of the save button click
- Private method for applying the filter.

**Public Method for Bitmap Initiation**

In this method intiates a form creation where all the inputted bitmap images are set to null that is the original image, the preview image and the final result bitmap image. It is defined as follows:

```
private Bitmap originalBitmap = null;
    private Bitmap previewBitmap = null;
    private Bitmap resultBitmap = null;
```

Here, original bitmap represents the original inputted image, the preview bitmap is the image that is constantly changing and the result is the final output image.

```
cmbEdgeDetection.SelectedIndex = 0;
```

The selected value for the edge detection is also initiated to a 0 so as to produce an accurate output with perfect bitmap edge detection**.**

**Private Method for the Functioning of the Button Load Click**

This method gives the functioning when the load button on the user interface for the source image is clicked. It is defined as follows:

```
private void BtnLoadSourceImageClickEventHandler(object sender, EventArgs e)
```

In the same way the functioning of the load button for the overlay image is defined as follows:

```
private void BtnOverlayImageClickEventHandler(object sender, EventArgs e)
```

The button on click, is able to select images from a list of bitmap images with extension .png and .jpg. It helps to connect the code with a list of existing files on the users system.

```
StreamReader streamReader = new StreamReader(ofd.FileName);
        originalBitmap = (Bitmap)Bitmap.FromStream(streamReader.BaseStream);
        streamReader.Close();
```

Finally the selected image is first converted to the required bit format and then copied to the square canvas for matrix conversion for further image process.

```
previewBitmap = originalBitmap.CopyToSquareCanvas(picPreview.Width);
        picPreview.Image = previewBitmap;
```

In order to enable the overlay of images, these inputted images are given to a comparison method by calling the function.

```
RenderOverlayBitmap();
```

The overlay bitmap method is defined as a private method which is as follows:

```
private void RenderOverlayBitmap()
```

Here the inputted image is null value and then all the color components of the inputted image are extracted for the filteration process to take place and the image is returned.

**if (picSource.Image == null || picOverlay.Image == null || ignoreControlEvents == true)**

**Private Method for the Functioning of the Save Button Click**

When the save button on the user interface is clicked, this method helps to save the image on the system. It is defined as follows:

**private void btnSaveNewImage_Click(object sender, EventArgs e)**

The method takes the output image and on clicking the save button helps to save the selected file to a respective file path. It also filters the images to the respective file format to be saved.

```
SaveFileDialog sfd = new SaveFileDialog();
        sfd.Title = "Specify a file name and file path";
        sfd.Filter = "Png Images(*.png)|*.png|Jpeg Images(*.jpg)|*.jpg";
        sfd.Filter += "|Bitmap Images(*.bmp)|*.bmp";
```

**Private Method for Applying the Filter**

In this method, the selected bitmap can be used with the given gaussian filter to reduce the noise in the image. It is defined as follows:

**private void ApplyFilter(bool preview)**

Here, it takes the respective inputted bitmap image and applies the laplacian of gaussian 5*5 filter and the outputted image can further be used for pixel manipulation in accurate fibrosis detection.

```
if (selectedSource != null)
 { bitmapResult = selectedSource.Laplacian5x5OfGaussian3x3Filter();
  }else (cmbEdgeDetection.SelectedItem.ToString() == "Laplacian 5x5 of Gaussian 5x5 - 1")
```

After the filter is applied the noise from the output is comparatively reduced and this makes the inputted image more easier for edge detection and further more for pixel manipulation.

### *3.2.3 Pixel Manipulation Class Hierarchy*

The pixel manipulation process helps to filter the inputted image to be adjusted to a fine degree, after which the image can be manipulated pixel by pixel and finally the extracted bitmap images can be blended to produce the image with an accurate detection of fibrosis. It consists of two classes one of which includes the main output class that is defined in the edge detection process. The methods are as follows:

- PixelManipulation.cs
- Mainform.cs

#### 3.2.3.1 PixelManipulation.cs

This class provides all the methods to perform pixel manipulation and finally blending values of the color components for lung fibrosis detection. The methods are as follows:

- Public method for bitmap image blending
- Private method for calculating the inputted bitmap image color component value
- Public method for bitmap image format conversion
- Public method to input a filtered bitmap image
- Public method for object Serialization And Deserialization
- Public method for calculating the enum value.

**Public Method for Bitmap Image Blending**

This method takes the inputted bitmap image and the final formatted image and produces a comparison with applying a certain filter. It is an extension method that targets the main bitmap class. This method helps to create a new memory by an instance of an object BitmapFilterData. It is defined as follows:

**public static Bitmap BlendImage(this Bitmap baseImage, Bitmap overlayImage, BitmapFilterData filterData)**

Now, it begins by creating a two byte array that contains both the source and the overlay pixel data that is expressed in 32 bit Argb format and thus locked in a memory by invoking the lock bits.

**BitmapData baseImageData = baseImage.LockBits(new Rectangle(0, 0, baseImage.Width, baseImage.Height), System.Drawing.Imaging.ImageLockMode.ReadWrite, System.Drawing.Imaging.PixelFormat.Format32bppArgb);**

After which the bytes of the bitmap is determined by now multiplying the stride into the height. Further more the unlock bits operation is invoked so as to obtain all lock operation stored in the memory. As mentioned earlier the stride refer to the scan width of the image and must be rounded to four bytes.

**byte[] overlayImageBuffer = new byte[overlayImageData.Stride * overlayImageData.Height];**

After the arrays have been received from both the source and the overlay image, the method then iterates the arrays simultaneously.

**for (int k = 0; k < baseImageBuffer.Length && k < overlayImageBuffer.Length; k += 4)**

Here the loop increment by a value of four every time it is executed and execution is performed in terms of pixels and each pixel is an bitmap that has been encoded and consists of 4 bytes in 32 bit argb format. Here the loop constantly calculates the values of the color components. The color components are calculated in the argb order.

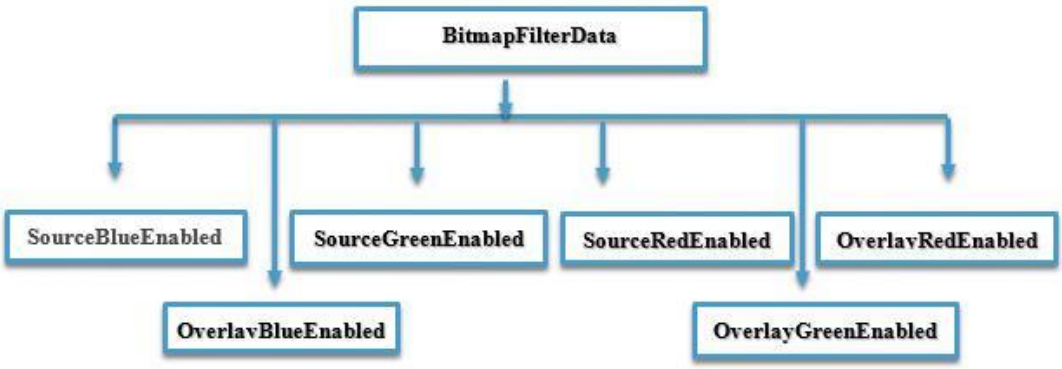


**Figure 13: The six properties of the BitmapDataFilter**

**BitmapData resultImageData = bitmapResult.LockBits(new Rectangle(0, 0, bitmapResult.Width, bitmapResult.Height), System.Drawing.Imaging.ImageLockMode.WriteOnly, System.Drawing.Imaging.PixelFormat.Format32bppArgb);**

Once calculation have been performed the color component values are locked in the image memory and must be invoked with while unlocking.


**Figure 14: Related Additional Six Properties to Enhance the Color Component**

## Private Method for Calculating the Inputted Bitmap Image Color Component Value

This method helps to calculate the color components of the sha bitmap image and further more the blend values. It is defined as:

**private static byte CalculateColorComponentBlendValue(float source, float overlay, ColorComponentBlendType blendType)**

Here, the calculations are performed based on the blend type value for each color component that is specified by the respective defined object.

```
if (resultValue > 255)
        { resultByte = 255;
        }
        else if (resultValue <
        0) { resultByte = 0;
        } else
        { resultByte = (byte)resultValue;
         } return resultByte; }
```

This is to ensure that value of the color component returned falls within the range of 0 and 255. If the resultValue is greater than 255 it is assigned to 255 and if it is lesser than 0 it is assigned to 0.

## Public Method for Bitmap Image Format Conversion

This method is also defined as extension method that points to a target class. It helps to convert the image to a 32 bit argb format and also can be used to resize the inputted bitmap image. It is defined as follows:

**public static Bitmap LoadArgbBitmap(this string filePath, Size? imageDimensions = null)**

The image is resized if the image size is known and also if it also it the same required size. The case of the image size is not known can only take place if the overlay image is inputted first. The resize of the file takes place by first reading the size of the inputted source image from which the overlay image that is inputted from the file system can be resized.

```
StreamReader streamReader = new StreamReader(filePath);
        Bitmap fileBmp = (Bitmap)Bitmap.FromStream(streamReader.BaseStream);
        streamReader.Close();
```

The images thus inputted into the system and is checked if it has to be resized or not. Now, the image is checked if it is in the 32 bit argb format. If not, the image height and width along with the image bitmap format is taken into consideration and passed to GetArgbCopy method.

```
if (fileBmp.PixelFormat != PixelFormat.Format32bppArgb || fileBmp.Width != width || fileBmp.Height != height)
        { fileBmp = GetArgbCopy(fileBmp, width, height);
        } return fileBmp;
```

The GetArgbCopy method is called whenever format conversion has to be done and is defined in a private method as follows:

**private static Bitmap GetArgbCopy(Bitmap sourceImage, int width, int height)**

Once the method is called, its takes the inputted bitmap image's format, width and height and thereby image conversion is performed by creating a new object instance and further more implementing the GDI drawing by defining the graphics class.

```
Bitmap bmpNew = new Bitmap(width, height, PixelFormat.Format32bppArgb);
using (Graphics graphics = Graphics.FromImage(bmpNew))
```

Thus, the image is resized to to required size and also changed to the required bitmap format for further accurate detection of fibrosis.

## Public Method to Input a Filtered Bitmap Image

This method is defined so as to take the inputted bitmap image that have a filter already applied to it and all noise has been removed. It is defined as:

**public static Bitmap GetBitmap(this PictureBox pictureBox)**

This is done by taking the inputted bitmap image that is assigned to the particular picture box and given a value of null and further assign it to a new variable with the filtered image and bitmap is returned.

```
Bitmap bitmapPicturebox = null;
 bitmapPicturebox = new Bitmap(pictureBox.Image);
```

**Public Method for Object Serialization and Deserialization**

Two methods are defined to implement the blending of the filtered bitmap source and overlay images. It is as follows:

*Method for Serialization*

**public static string XmlSerialize(BitmapFilterData filterData)**

*Method for Deserialization*

**public static BitmapFilterData XmlDeserialize(string xmlString)**

The methods implement the algorithm by using the defined object and assigning the public properties that are defined to a certain value as specified by the user at runtime. These methods enabled a call to the serialize function of the specified object to a string variable that will contain the xml representation of the object.

*Serialization*

```
string xmlString = xmlSettings.Encoding.GetString(memoryStream.ToArray());
```

*Deserialization*

```
filterData = (BitmapFilterData)xmlSerializer.Deserialize(memoryStream);
```

The serialize method performs the function of converting the pixel bytes of the bitmap to a sting variable and the deserialize function is called to undo it and produce the image in its given format.

**Public Method for Calculating the Enum Value**

The class of this method defines three public properties of type enum. The value that is determined from this type is obtained from the color components of the source and the overlay bitmap. Thus the ColorComponentBlendType value determines the property level after modifation is performed. It is defined as follows:

**public enum ColorComponentBlendType**

Now any mathematical function such as add, subtract, average, ascend or descend can be performed on the color components derived from the source and overlay bitmap image and this is derived from three public properties.


**Figure 15: Three Public Properties for Calculating the Type to be Performed Component**

**Mainform.cs**

This is the already existing class for the user interface where the open and the save button was defined. It consists of two private methods that help in the pixel manipulation.

- Private method for filter application confirmation
- Private method to save the filtered image.

**Private Method for Filter Application Confirmation**

This method is done so as to check if the inputted image has already been applied to the filter. It is defined as:

**private void NeighbourCountValueChangedEventHandler(object sender, EventArgs e)**

It calls the previous method and applies a boolean value 'true' to it so as run the previous method.

**ApplyFilter(true);**

Here is where the filter and also serialization and the deserialization is applied.

**Private Method to Save the Filtered Image**

This method helps to save the filtered image after filtration has been applied. It ids defined as follows:

**private void btnSaveFilter_Click(object sender, EventArgs e)**

The filtered image is saved to the existing file system in order to access it when needed.

```
SaveFileDialog sfd = new SaveFileDialog();
 sfd.Title = "Specify a file name and file path";
 sfd.Filter = "Image Filter
 Files(*.xbmp)|*.xbmp"; sfd.AddExtension = true;
```

## 3.3 User Interface

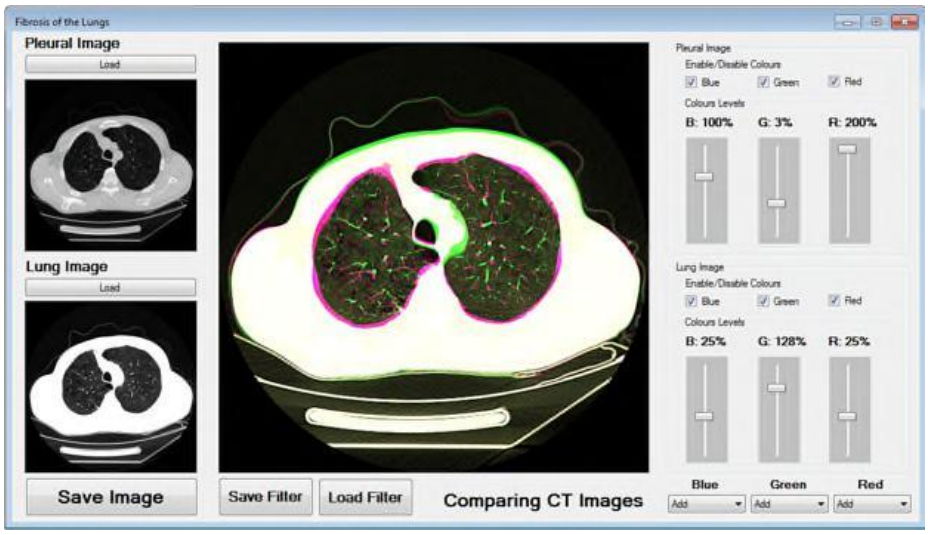


**Figure 16: Fibrosis of the Lungs**

The user interface contains a load button for the source and the overlay image which calls the load button method and loads the image from the system files. The output image can also be saved to the system files by the save image button which makes a call to the save button method. The laplacian of gaussian 5*5 filter can be applied by the load filter button which makes a call to the apply filter method. The save filter button helps to save the respective filtered image.

## 3.4 Summary

In this chapter, mainly emphasizes on the software that was used in the detection of fibrosis. It also includes all the classes and methods involved in process and also the final user interface, which have been explained in detailed. The programming language that was employed to do is c#.

# Chapter 4: Experiments and Modeling for Detection of Fibrosis

The algorithm and methods that have been formulated to detect fibrosis has been put under the test and analyzed to see if the results match the output that is required. Thus in this section, a number of computer tomographic images of patients suffering from fibrosis and the output is further analyzed. Hence a number of experiments need to be performed to check and see if the images that have been inputted were processed and thus help in the detection of fibrosis.

## 4.1 Evaluation Method and Data Set

A number of sample computer tomographic images of the lungs in pleural mode and lung mode of 15 patients diagnosed with fibrosis by a well profound biological center were selected for evaluation and training in the proposed algorithm. The sample CT images are dived into three subsets which are used for training, validation and testing. The system should be trained by following the guidelines strictly with the given data set and the entire result is evaluated based on specified algorithm.

While selecting the data sets, we should be very specific in the selection of computer tomographic images as in patients suffering from fibrosis should be only taken as input data set. Also, sample images from well known clinical data set should only be taken into consideration since it the image is in a required format and further more the pixilation of the images is appropriate to be taken as the required data set.

### *4.1.1 Preparing the Training Data Set*

Before the process of training the network begins, the image patches that correspond to the respective aspects that is acceptable by the neural networks are prepare by the following ways.
First a pre processing technique algorithm that was specified to remove noise is applied to the inputted data set. Thus a patch of the image is picked and thus corresponds to the required variables and further more sent to the neural network for training. A normal problem while training the data set would be the number of negative samples identified, which are the patches that do not belong to any edge in the respective processed samples and thus we balance it by selecting all positive samples from the inputted data set and thus train the network.

## 4.2 Edge Detection Analysis

In order to identify which edge detection was suitable for the algorithm a number of filters were tested with the respective computer tomographic images for the detection of fibrosis. The following filters were applied and tested.

### *4.2.1 Laplacian 3 * 3*

The laplacian 3 * 3 filter was applied on the lung and pleural mode computer tomographic images.It is known that this filter is a second type derivative of the edge detecting operator, hence it is more sensitive to the involved noise than the sobel and prewitt filters. Thus when the filter is been used on the images for the detection of fibrosis, althoughthe ouput is of a fine edge detection it is impossible to identify the region of fibrosis because this filter removes most of the noise involved in the image leaving it with an output that cannot be used to detect accurate regions of fibrosis.

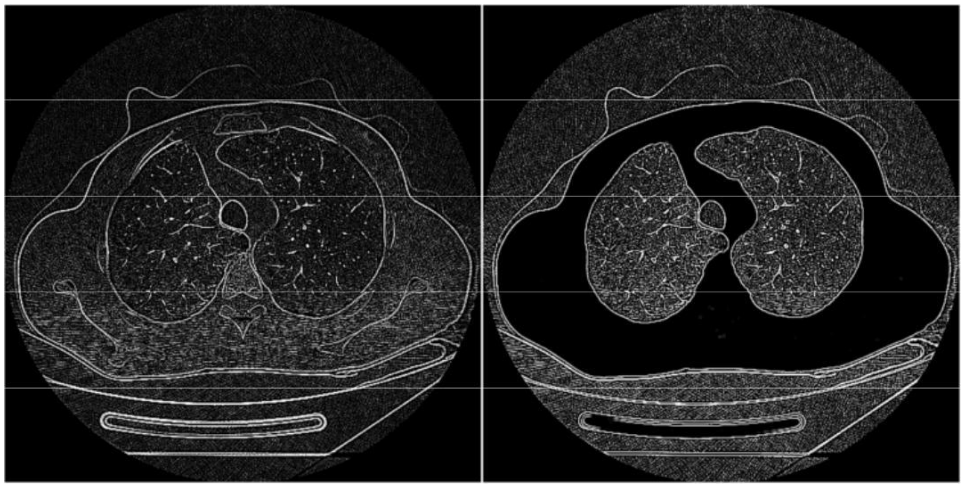

**Figure 17: Laplacian 3 x 3 Lung Edge Detection in Pleural and Lung Mode**

From the image, we can observe that a clear edge detection is produced without much of the involved noise almost making the computer tomographic samples to appear flawless and hence making it even more impossible for fibrosis detection.

### *4.2.2 Laplacian 5 * 5*

The laplacian 5 * 5 filter when applied to a computer tomographic images of the pleural and lung mode of a particular patient suffering from fibrosis, the edge detetection is produced but with a prefound difference when compared to the both the color and further more any grayscale lung image. On the contrary to the laplacian 3 * 3 filter, comparatively more noise is produced with fine edge detection.

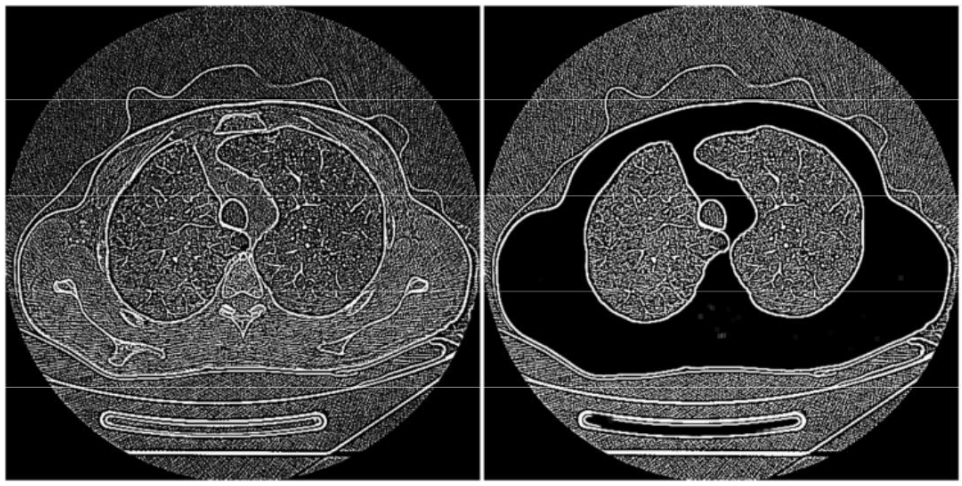

**Figure 18: Laplacian 5 x 5 Lung Edge Detection in Pleural and Lung Mode**

From the above image we notice the noise produced in the respective output is more when compared to the laplacian 5 * 5. This although enhances the edge detection, the filter being sensitive to noise makes it also impossoble for fibrosis detection.

### 4.2.3 Laplacian of Gaussian

The laplacian of Gaussian filter is a a very common variation as known of the defined laplacian filter and when applied was intended to produce results that counter the previous two methods sensitivities. Thus when applied to the plueural and lung mode images, instead of producing and optimized image with little or required noise for the fibrosis detection, the results were varied in terms that two modes could not be used in further comparison or processing producing poor results.

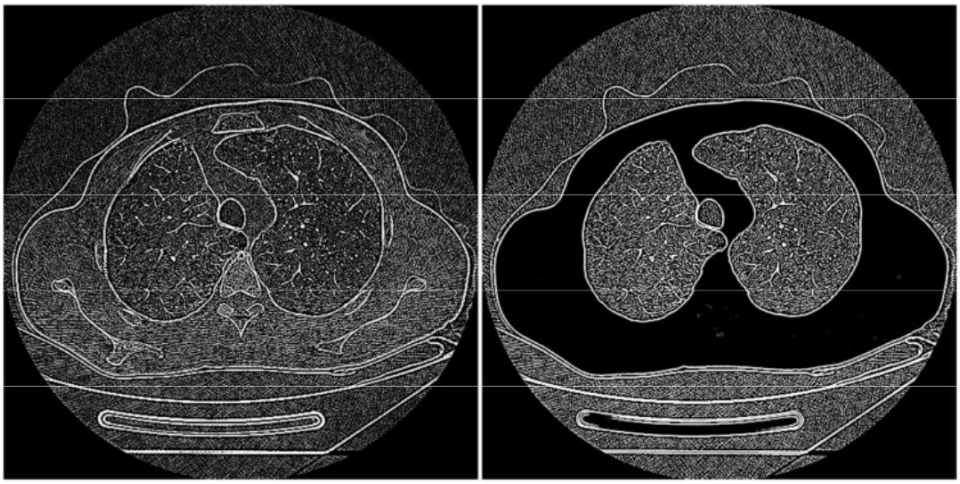

**Figure 19: Laplacian of Gaussian Lung Edge Detection in Pleural and Lung Mode**

The image depicts the two modes of the same lung image with a difference in output making it difficult to process further.

### 4.2.4 Laplacian 3 * 3 of Gaussian 3 * 3

The laplacian of Gaussian 3 * 3 is also a variation of the laplacian and Gaussian method that is intended to produce the required output for fibrosis detection. This filter can only produced results based on the image inputted. Hence any image that requires extreme analysis would not be able to be processed and thus produce an optimized output.

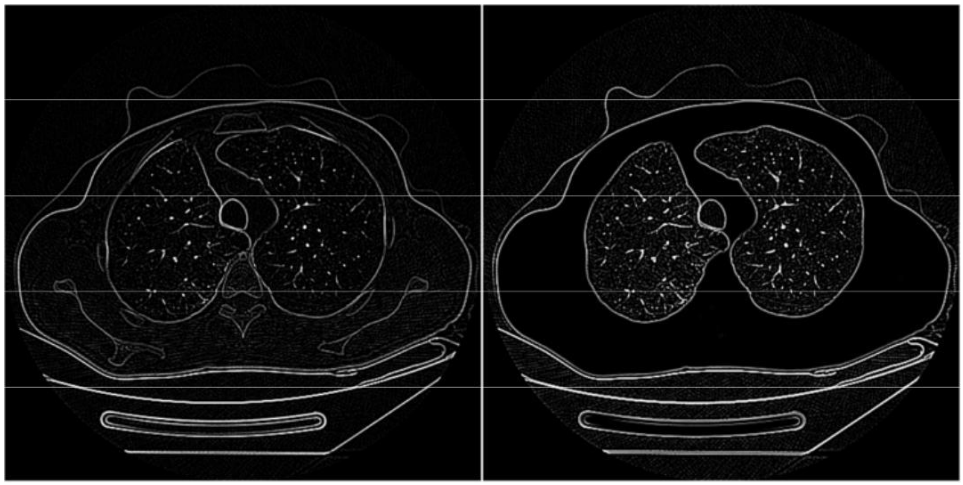

**Figure 20: Laplacian 3 x 3 of Gaussian 3 x 3 Lung Edge Detection in Pleural and Lung Mode**

The image shows a depiction of the pleural and lung mode of the same patient with an outputted result of no proper edge detection making this impossible for the detection of fibrosis.

### 4.2.5 Laplacian 3 * 3 of Gaussian 5 * 5 - Type 1

This filter is another type of variation of the laplacian 3 * 3 and the Gaussian 5 * 5 which when applied to the computer tomographic lung images of the same patient in the pleural and lung mode, the function of the Gaussian Blur make the the outputted image weak for analysis and cannot be used in comparison for fibrosis detection.

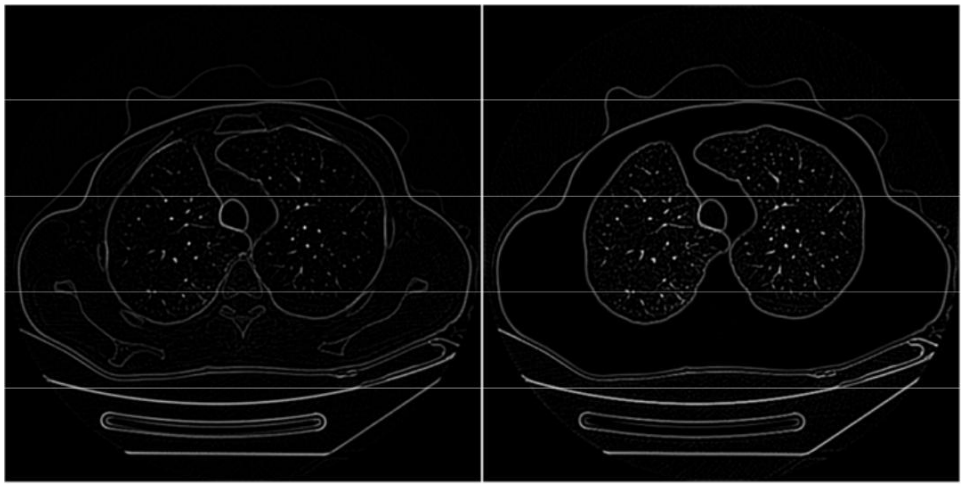

**Figure 21: Laplacian 3 x 3 of Gaussian 5 x 5 of Type 1 Lung Edge Detection in Pleural and Lung Mode**

The image depicts the two modes after the application of the laplacian 3 *3 of Gaussian 5 * 5 filter with weak output analysis.

### 4.2.6 Laplacian 3 * 3 of Gaussian 5 * 5 - Type 2

This filter is a modification of the type 1 filter that is the previous defined method, which when applied to the images of the same patient in two different modes also produces an optimized image of the Gaussian Blur. It show an improvement when compared to the laplacian 3 * 3 of Gaussian 5 * 5 in type one but still has weak edge detection which cannot also be used in the analysis and detection of fibrosis.

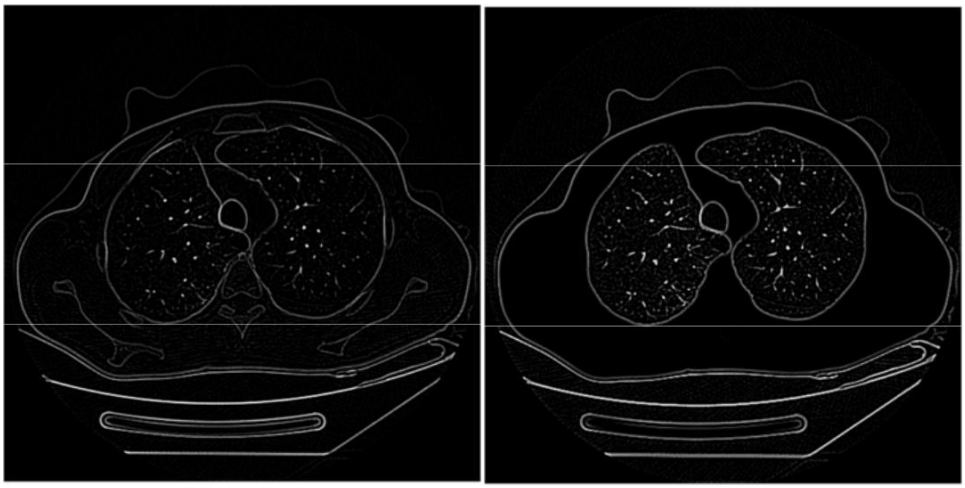

**Figure 22: Laplacian 3 x 3 of Gaussian 5 x 5 of Type 2 Lung Edge Detection in Pleural and Lung Mode**

The image depicts an improvement from the previous filter of type 1 but also has weak edge detection which when used in pixel manipulation cannot be used to get the optimized required output.

### 4.2.7 Laplacian 5 * 5 of Gaussian 3 * 3

This filter is a variation of the laplacian 5 * 5 and the Gaussian 3 * 3 filter which when applied to the computer tomograohic images if the patient also in the pleural and the lung mode produces a result with good optimized edge detection but increase in the noise . Also there is a infinite difference between the two modes making it impossible for the detection of fibrosis.

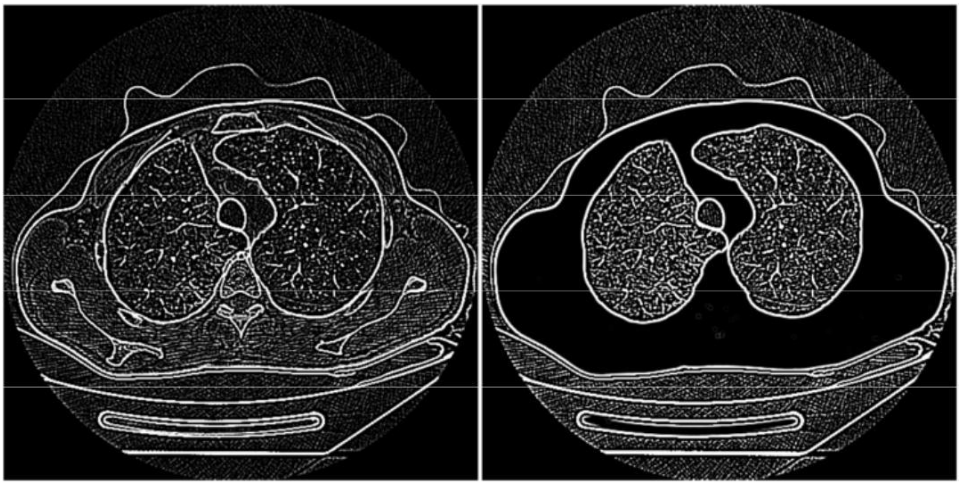

**Figure 23: Laplacian 5 x 5 of Gaussian 3 x 3 Lung Edge Detection in Pleural and Lung Mode**

The image above shows a depiction of the two applied modes with good edge detection and increase in noise with a comparative difference in output. Hence with the impossibilities in the produced output it cannot be applied in the fibrosis detection.

### 4.2.8 Laplacian 5 * 5 of Gaussian 5 * 5 - Type 1

This filter is a variation of the laplacian 5 * 5 and the Gaussian 5 * 5 filter which when applied to the computer tomographiclung images of the same patient in the two respective modes produces a comparatively high degree of smoothing. The reults thus produced are with an optimized detection with the required amout of noise for the detection of fibrosis.

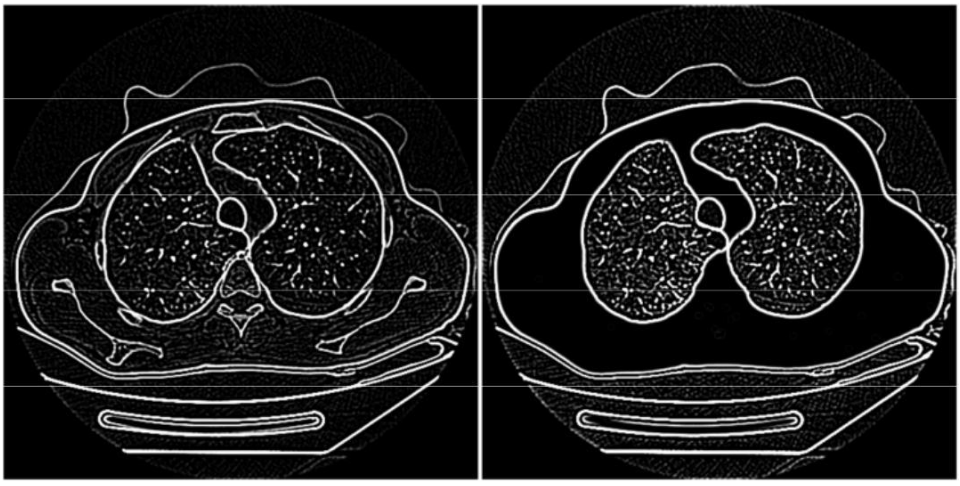

**Figure 24: Laplacian 5 x 5 of Gaussian 5 x 5 of Type 1 Lung Edge Detection in Pleural and Lung Mode**

From the image it can be seen that the two outputed images after the filter has been applied displays a boundary with good edge detection when the wo image are compared and also comparative ampunt of noise which will help to produce good optimize results in the detection of fibrosis.

### *4.2.9 Laplacian 5 * 5 of Gaussian 5 * 5 - Type 2*

During the implementation of Laplacian Gaussian filter, the gaussian blur is define by a 5 x 5 matrix of Laplacian along with a 5 x 5 matrix of gaussian. This method actually provides accurate results. But when trying to detect for an image with abnormalities or many particles inside the lung, the inner cavity of the lung appears to be faded. The output image goven below shows the noisey inner part of the lungs.

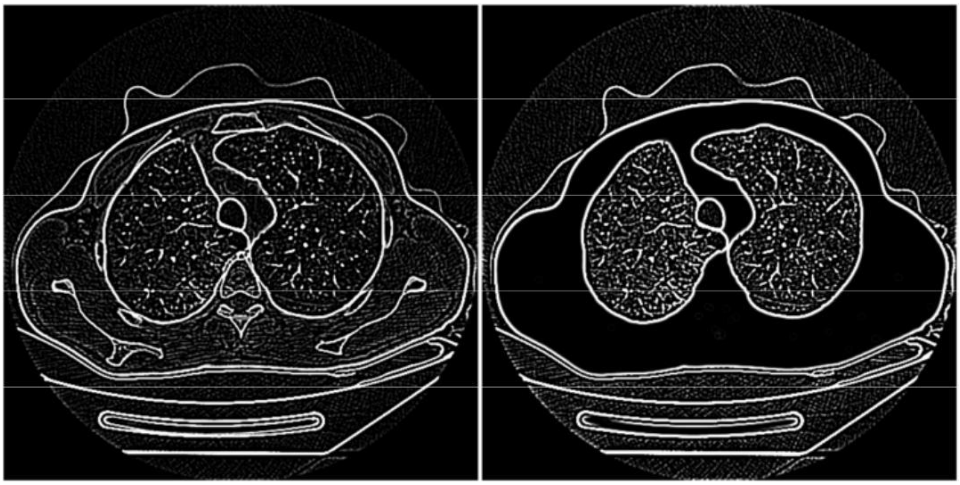

**Figure 25: Laplacian 5 x 5 of Gaussian 5 x 5 of Type 2 Lung Edge Detection in Pleural and Lung Mode**

### *4.2.10 Sobel 3 * 3*

Sobel uses a discrete differentiator along with increasing the gradient intensity of the image during border detection. This results is lung border detection and also detection of mass or plasma found inside the lungs, thus making fibrosis unclear. The detection of Lung border using Sobel is shown below.

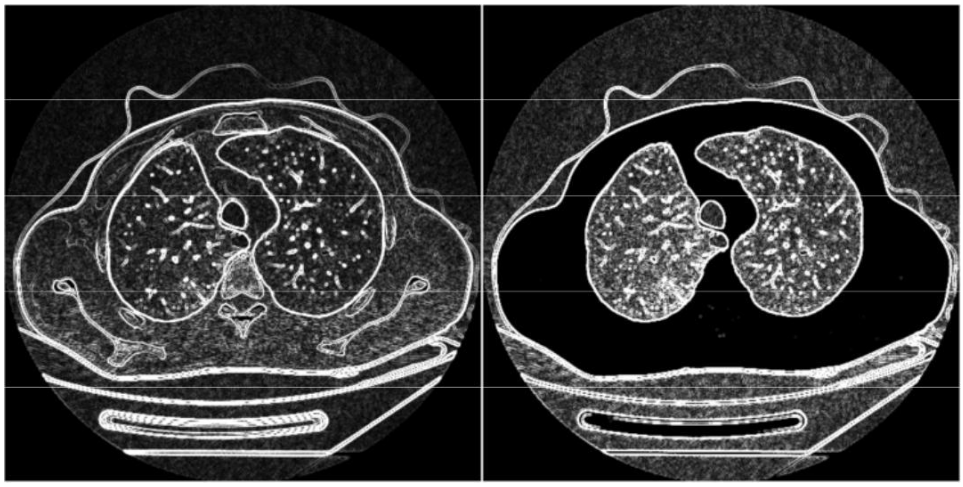

**Figure 26: Sobel 3 x 3 Lung Edge Detection in Pleural and Lung Mode**

### 4.2.11 Prewitt

Prewitt operator usually uses discrete differentiation to identify all image borders and process them. This method detects the fibrosis border of the lungs discretely and it is vey defined. The only problem revolving around this method is that to much noise or other lungs features are also detected along with fibrosis which will not allow us to identify the fuzziness associated with fibrosis thus making the method inefficient. The output image that us detected using this method is seen below.

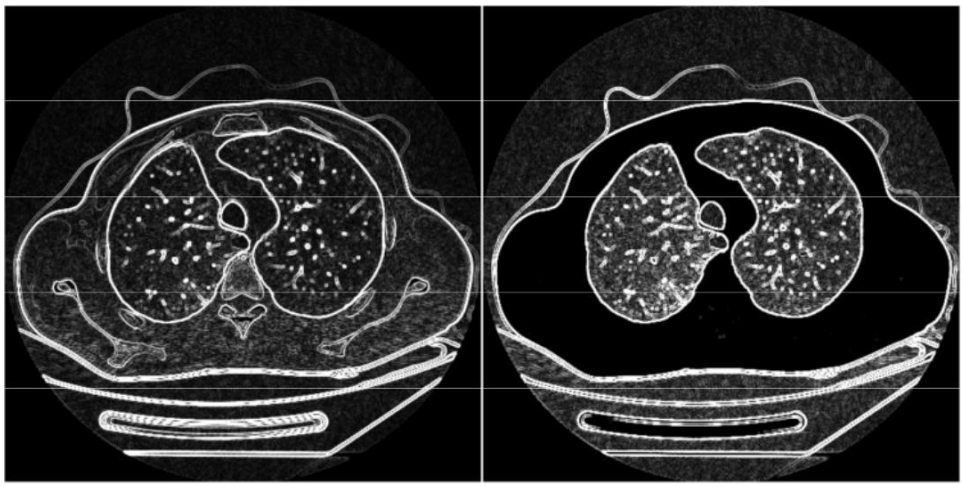

**Figure 27: Prewitt Lung Edge Detection in Pleural and Lung Mode**

### 4.2.12 Kirsch

Kirsch detection usually takes place using Compass edge detection. Thus detection of lung borders using this method results in a very noise and distorted image as Kirsch tries to provide all details during detection. Furthermore the contrast of this image is very high, which in turn would not help in detecting the fibrosis layer. The output that was obtained from Kirsch Edge detection is show below.

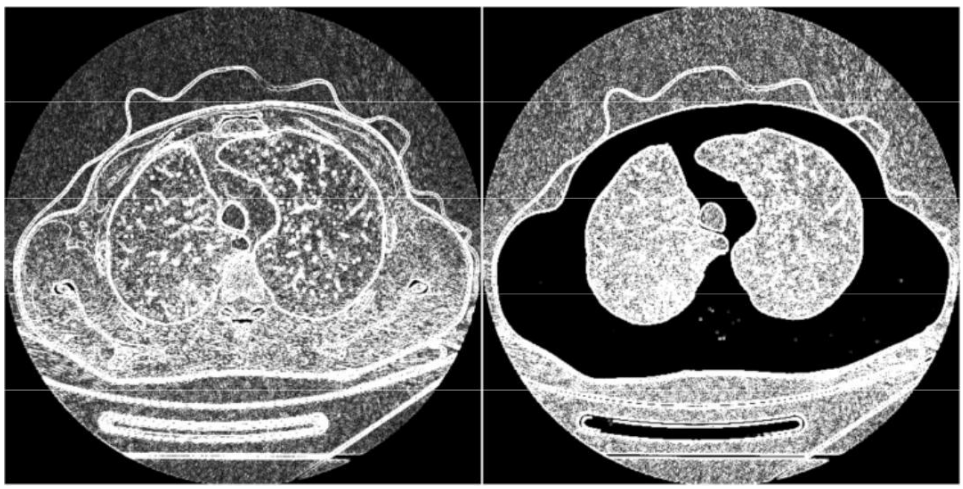

**Figure 28: Kirsch Lung Edge Detection in Pleural and Lung Mode**

Thus from the above edge detection analysis, the laplacian of gaussian 5* 5 of type 1 proved to be efficient for the proposed algorithm in the detection of fibrosis. Hence after analyzing and testing using various filters, this filter produced results were satisfactory for further processing. Although other filters

have been proven to be successful in various edge detection methods, to identify the extent to which the patient has been effected the laplacian of gaussian 5* 5 of type 1 was the most efficient.

Thus from the above edge detection analysis, the laplacian of gaussian 5* 5 of type 1 proved to be efficient for the proposed algorithm in the detection of fibrosis. Hence after analyzing and testing using various filters, this filter produced results were satisfactory for further processing. Although other filters have been proven to be successful in various edge detection methods, to identify the extent to which the patient has been effected the laplacian of gaussian 5* 5 of type 1 was the most efficient.

## 4.3 Performance Analysis

The overall performance of the system in the detection of fibrosis is analyzed and tested and the results were found to be efficient. In the performance analysis, an number of computer tomographic images of the lung in the pleural mode and lung mode are taken into consideration. In order to understand the performance analysis, it is important to understand the different modes of the lungs and hence further more the efficiency of the pleural mode and the lung mode. The different possible modes of the lung computer tomographic images are as follows.

- Lung Mode
- Pleural Mode
- Whole Mode
- Soft Mode
- Bone Mode

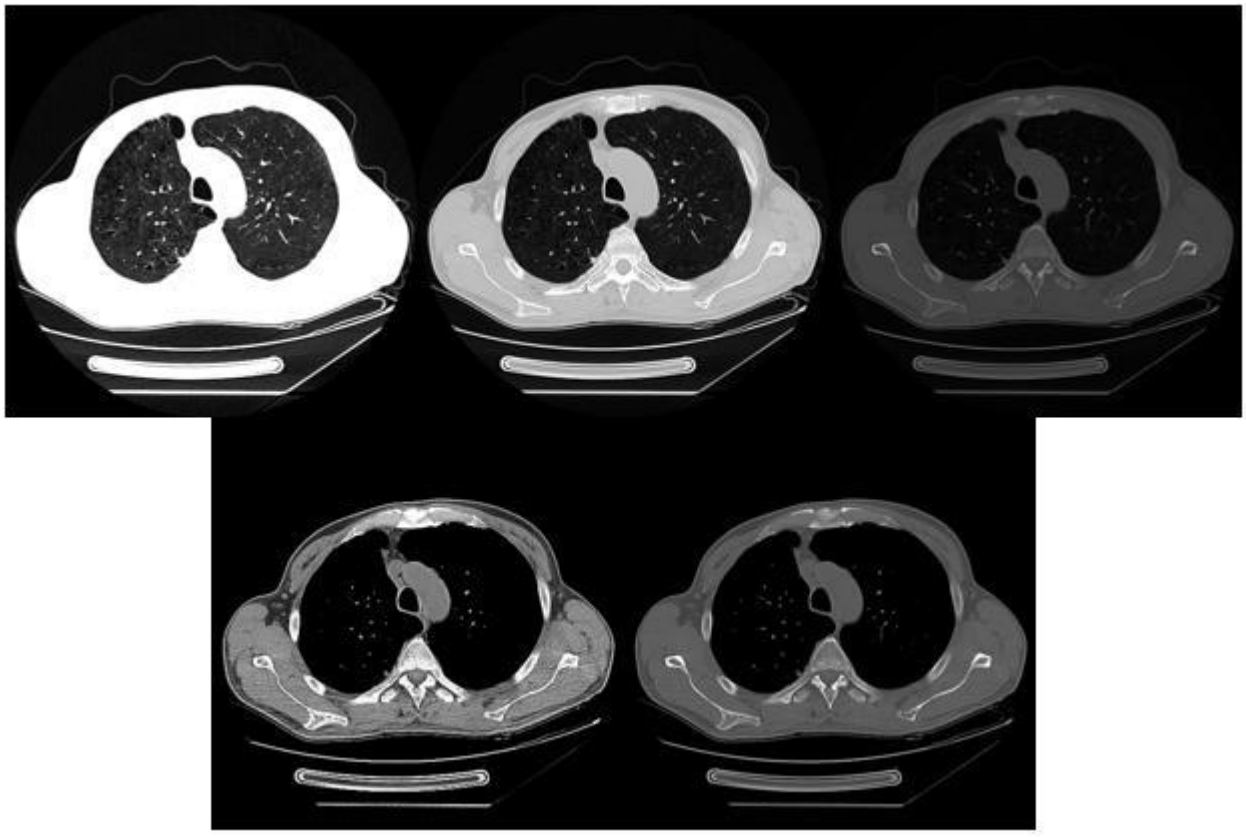

**Figure 29: CT Image in Various Mode (From Left to Right), Lung, Pleural, Whole, Soft, Bone**

### 4.3.1 Comparison of Computer Tomographic Image Modes

For the performance analysis a number of modes were used in comparison and tested which are as follows:

#### 4.3.1.1 Lung Mode and Whole Mode

The lung mode and the whole mode when take into comparison as depicted does not produce a clear output of the fibrosis detection after the respective edge filter. It also can be noticed that the image is depicted with two indefinite boundaries proving that it cannot produce accurate results.

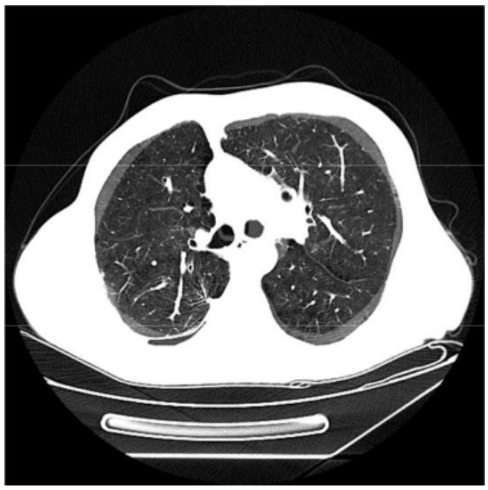

**Figure 30: Comparison between Lung and Whole Mode CT Images**

#### 4.3.1.2 Lung Mode and Bone Mode

The lung mode and the bone mode when compared does not really produce a good optimized result as the two modes by itself are alo similar and hence making it impossible for fibrosis analysis. The image below shows the two modes in comparison with a look alike output and no accuracy in the detection of fibrosis.

**Figure 31: Comparison between Lung and Bone Mode CT Images**

#### 4.3.1.3 Lung Mode and Pleural Mode

The lung mode and pleural mode of the same patient is taken into comparison. The two modes are comparatively different as in the pleural mode is a softer depiction of the lung mode. Hence when the required edge is applied to these two modes and then taken into a comparison, the extent of the fibrosis from the detected edge can be significantly recognized. The outputted image also makes it easier and possible for analysis and further more producing safe and accurate results in fibrosis detection.

**Figure 32: Comparison between Lung and Pleural Mode CT Images**

#### 4.3.1.4 Pleural Mode and Whole Mode

Whole mode gives a generic view of the lung, hence using this mode along with any other mode might not result in fibrosis being highlighted. However, comparison of whole mode with pleural was performed during testing and the results displayed below.

**Figure 33: Comparison between Pleural and Whole Mode CT Images**

#### *4.3.1.5 Pleural Mode and Bone Mode*

Sine bone mode shows bone tissues and plural mode tends to show the pleural liquids associated with the lung, both do not have a clear fibrosis layer. When comparing these two modes, though fibrosis is detected, it appears very light and does not serve our purpose. Increasing contrast may help the image. But this may increase the overall overhead associated with the software.

**Figure 34: Comparison between Pleural and Bone Mode CT Images**

#### *4.3.1.6 Whole Mode and Bone Mode*

While comparing the output edge detector of whole and bone mode, since the contrast of both modes is very low, detection of fibrosis cannot be seen at all. Therefore, using these two modes is not helpful in solving the objective of our project. However edge detected images of both modes were taken and tested and the output can be seen below.

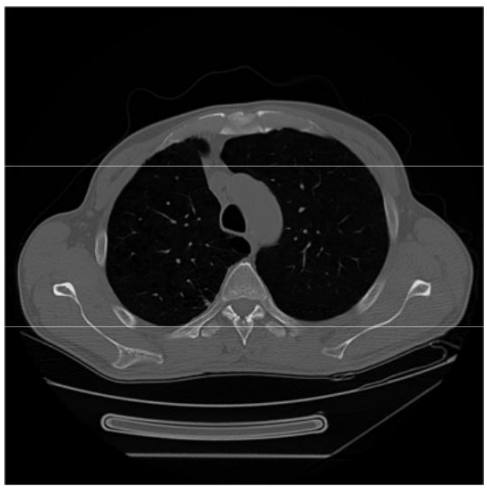

**Figure 35: Comparison between Bone and Whole Mode CT Images**

### 4.3.2 Output Analysis with the Tested Computer Tomographic Images

From the CT image analysis, the pleural and the lung mode show a variance in the edge detection produced when compared at the same stage of the patient under diagnosis. This is because when the pleural mode of the lung image has been analyzed and tested after edge detection has been applied, the results produced are very efficient as most of the extent of fibrosis in the lung image can be identified, whereas the lung mode displays the same state of the lung image in a more refined state.

Now the two images are inputted to test if the extent of the fibrosis can truly be identified with the above applied algorithm. In order to do so, a pleural and lung mode image should be inputted in the source and the overlay slot respectively. Each of the inputted images are then passed through the laplacian of gaussian 5*5 filter and the outputted image is that of the two images in comparison with each other after the manipulation of pixels. The output was thus proven to be efficient with a good detection of lung fibrosis.

### 4.3.3 Application of Color Filter

Once the edge detection ha been completed the image is further tested with a proper color filter application. This helps to depict a clear fibrosis detection with the difference of the actual lung image and the extent to which the patient has been affected.

The complete test is the continued and tested with the computer tomographic lung images of 15 patients. With every test, the performance of the algorithm was proven to almost close to accurate showing the exact extent of fibrosis.

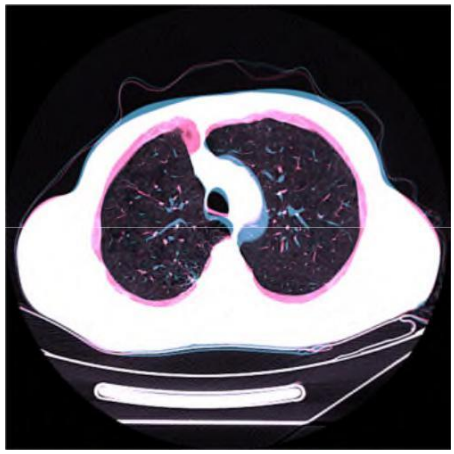

**Figure 36: Lung Image with Fibrosis Detected**

## 4.4 Summary

Thus in this chapter the methods that were used for the complete detection of fibrosis have been successfully implemented with a brief description of the implemented working process. A number of attempts with different edge detection filters and modes of the computer tomographic lung images have been taken into consideration with images of attempts taken in executing it. The Laplacian 5*5 of Gaussian 5*5 proved to produce the required optimized edge detection output. Further more the pleural and lung mode were found to be suitable in the detection of fibrosis showing a distinct extent of the fibrosis during analysis. Thus the detection of fibrosis was proved to be successfully with every attempt that was analyzed and tested.

# Chapter 5:Finance Management Resource Efficiency and Saving

The main objective of financial management which either decides the profit or loss of the project or management it is related to. This profit or growth is usually related to its expansion or diminution (68) in the existing market or the new market. It is mainly used in decision making, controlling subsystems of an enterprise. The following decisions are made as a result of financial management:

- The management of the working project and its implications which arise due to international competition within its area of expertise.
- Control of capital investment of the project which involve careful evaluation, selection and management of project related entities.
- How financing of the project can be dealt with if it happens to exist for a longer term period.
- Understanding the scope and effects of capital markets for the project.
- Understanding the strategic planning processes which in turn help to manage the long and short-term financial activities of the project.

The management of risk in the different aspects of the financial activities related to the project undertaken has to also be addressed. SWOT Analysis (74) helps us to identify both the strengths and weaknesses of the project at hand. SWOT is specially a powerful tool and it helps to uncover opportunities that are not yet exploited. By understanding weaknesses that are related to the project, we could eliminate them which if not taken care of can cause major problems in the future. SWOT also helps us understand our competitive market and helps us create a strategy that places us above the rest of the competitors so that we occupy a successful place in the market.

Another important step is the analysis of competitors in the market which is achieved with the help of market segmentation which in turn helps us identify potential consumers in the market. It is the process of subdividing a large homogeneous market (77) into small identifiable segments with similar demands, characteristics and needs. The main objective is developing a marketing mix that matches the expectations of target customers for a particular segment. In this method, the total demand is broken into segments and then tested according to its target audience. The are four basic factors which affect market segmentation and are addressed below:

- Clear identification of each segment.
- The size of each segment.
- The accessibility of each segment based on its promotional efforts.
- Whether each segment coincides with company's policies and resources.

Finances can be managed in the following manner by considering its aspects (69) in each an every sphere related to finance:

- Financial Planning - It helps in determining the requirements for the financial concern of business and also helps in promoting the enterprise.
- Funds Acquisition - Acquiring maximum funds at minimum costs.
- Proper Use of Funds - Proper allocation of funds to improve the operational efficiency of the business and also helps in reducing the capital cost which in turn helps in increasing the value of the firm.
- Financial Decision - Taking financial decisions with respect to business concerns which usually have a direct affect on the entire business growth

| | |
|---|---|
| | as there is a direct relationship with various department functions like market production and personnel, etc. |
| • Improving the Profit | - Profit can be improved with the help of strong control devices, for example, devices such as ratio analysis, budgetary control, cost volume analysis, etc. |
| • Increasing the Value of the Firm | - Wealth of business and investors can be improved by maximizing the profitability of the product. And producing higher profitability leads. |
| • Promoting Savings | - Higher profitability is earned and wealth has to be maximized which in turn helps in promoting and mobilizing corporate savings. |

Financial management plays an important role in business and corporate finances and these sectors cannot function without it. Financial requirement of the business differs from firm to firm (70) and the nature of the requirements on the basis of terms or period of financial requirements, it may be long term and short-term financial requirements.

If the project requires further probing into the future, analysis has to be made to make sure this is possible. This is done with the help of QuaD technology (76) which helps in analyzing future perspectives of the project. It is a flexible quality management system which helps in providing future traceability of production data. It helps in identifying all quality aspects which in turn helps us to maintain the quality of the project from its birth to its retirement. It also helps in fault analysis (71) and also provides real time information clearly and precisely with the help of advanced reporting. This in turn gives us a real time analysis report of all the information required to diagnose or resolve future process problems at the earliest and also helps in improving the quality and productivity of the product. Due to constructive analysis even for future development, this method helps in reducing the cost of the production of the project and also reduces future fixing costs.

The main task of thesis is to create software that models the economics (70) of the project mathematically and also helps to monitor the functioning of the project which in turn will simplify work that has to be carried out by companies and customers.

With the existence of a main function, for instance, a function to send emails, to initiate direct calls (72) to a program, to main work history of clients , to select the language of the client and also to create reminders will help in significantly improving the convenience with which the project is used. Assessment of product resource criteria is one of the most important aspects in learning about the projects growth and this method helps in understanding this. Analyzing (72, 73) the efficiency of resources from the standpoint of economic criteria helps in attracting more users which in turn increases the competitiveness of the product. This analysis also helps in reducing the price of the product.

Therefore financial management forms the lifeblood of the product or an organization. The concern of every business deals with the fact of enough funds and resources to carry on with th project. Business growth can be achieved only if finances are managed efficiently. If finances are neglected (74) at anytime, it could lead to drastic measures.

## 5.1 Market Trends and Audience of Pulmonary Fibrosis System

In the recent years, idiopathic pulmonary fibrosis has been noticed to be at a higher degree, which has fueled the demand for idiopathic pulmonary fibrosis therapeutics (73, 74) and also for diagnosis of these fibrosis areas. The introduction of novel medicines and advancement in treatment methods of the disease has further supplemented the overall growth of the market and also supplemented therapeutics to a higher level. But there is no automatic method recently discovered for the diagnosis of Fibrosis. Though there is no absolute cure for idiopathic pulmonary fibrosis available as of now quick diagnosis is very essential. Failure to provide a complete cure and analysis of the disease are considered as major setbacks to the market.

Greater focus on the detection of idiopathic pulmonary fibrosis has led to the development of this new software. This software makes it easy for doctors to identify the problem lung area and also help patients diagnose faster. In addition, increasing research and development programs (75) for introduction of new therapies to successfully diagnose and cure fibrosis have been in expected to favor the market.

### *5.1.1 Fibrosis Based on Region Wise Analysis*

On the basis of region, the extent of severity of fibrosis, and the urgency of diagnosis by both the doctors and the patients, market segmentation graph has been created. There exist six key regions where the extent of fibrosis is high when compared to the rest of the world. They include North America, Latin America, Western Europe, Eastern Europe, Asia Pacific (APAC), and the Middle East & Africa. Of these countries Europe and North America are considered as the two largest regions which are identified to buy highest amount of therapeutics for fibrosis. Hence diagnosis of the disease (75) should also be high. Other countries like the US, Canada, Germany, France and Britain have also accounted for a healthy demand of idiopathic pulmonary fibrosis therapeutics attributed to the increasing number of fibrosis patients occurring in these countries. Since the number of patient with fibrosis in these countries is high, diagnosis of fibrosis is also high.

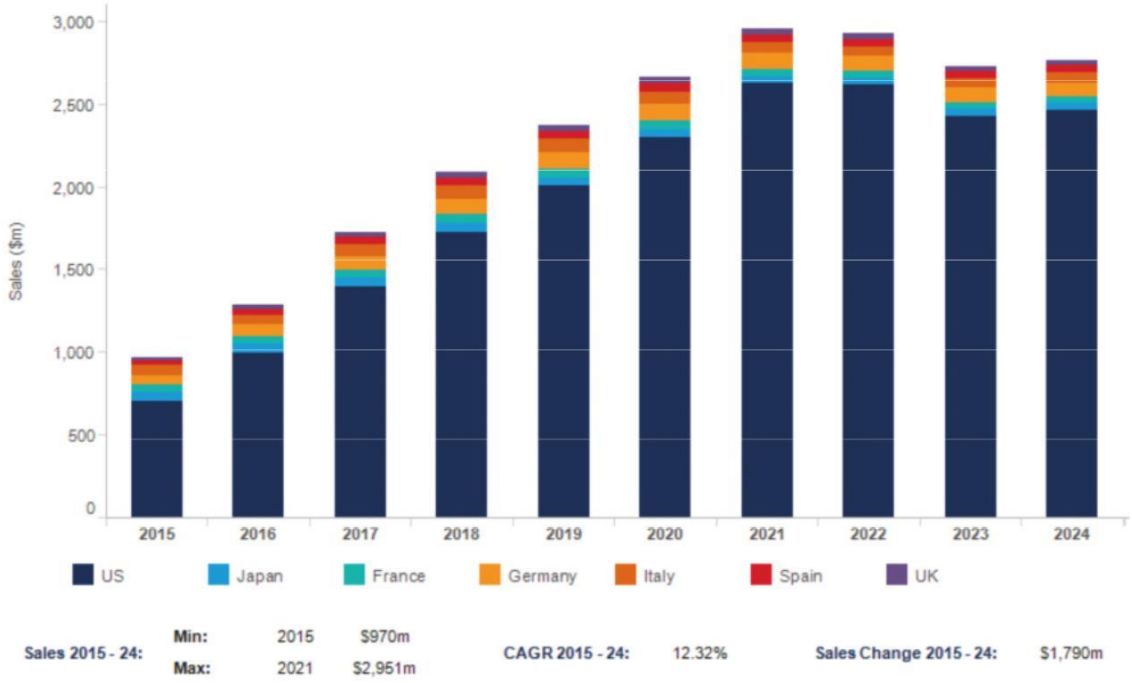


**Figure 37: Graph showing the requirement of diagnosis for fibrosis**

The report is created which helps in handing out a comprehensive evaluation of the market with fibrosis. In-depth qualitative insights, historical data, and verifiable projections about market size (76) are also offered in this report. The values that are provided in the report have been derived the knowledge of market size and also the number of patients and the urgency for diagnosis and treatment. This research report not only provides a repository for the analysis of fibrosis but also information about every facet in the market. The report is not limited only to regional markets, technology, types, and applications but to markets around the world.

The following table shows the number of patients that were expected and are expected to have fibrosis and hence require a diagnosis. This segmentation is provided for 6 countries from the year 2016 to 2024. The countries include the US, Japan, and five major EU countries which include France, Germany, Italy, Spain, and the UK.

**Table 5.1: The Number of Patients Expected to be Diagnosed with Fibrosis**

| Country | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|
| **US** | 38818 | 51,058 | 60,332 | 64,008 | 65,638 | 67,128 | 68,638 | 70,219 | 71,841 | 73,484 |
| **Japan** | 3416 | 3,789 | 4,238 | 4,520 | 4,566 | 4,580 | 4,590 | 4,604 | 4,618 | 4,632 |
| **France** | 3580 | 4,122 | 4,721 | 5,084 | 5,193 | 5,268 | 5,339 | 5,406 | 5,478 | 5,549 |
| **Germany** | 4783 | 5,448 | 6,282 | 6,874 | 7,024 | 7,109 | 7,188 | 7,269 | 7,348 | 7,426 |
| **Italy** | 4697 | 5,318 | 6,039 | 6,503 | 6,621 | 6,689 | 6,757 | 6,825 | 6,898 | 6,975 |
| **Spain** | 2638 | 3,049 | 3,551 | 3,903 | 4,012 | 4,083 | 4,154 | 4,229 | 4,308 | 4,391 |
| **UK** | 1723 | 2,040 | 2,427 | 2,697 | 2,761 | 2,797 | 2,832 | 2,868 | 2,905 | 2,945 |
| **Total** | 59,656 | 74,824 | 87,592 | 93,589 | 95,815 | 97,654 | 99,498 | 101,421 | 103,396 | 105,401 |

The above table can be represented in the form of a segmentation table considering the total number of patients requiring diagnosis and setting the time frame from 2015 – 2017, 2018 -2021 and 2022 – 2024 as follows.

**Table 5.2: Map of Service Market Segmentation Representing the Number of Patients Diagnosed with Fibrosis Within the Given Time Period**

| Time Frame | Number of Patients to be Diagnosed with Fibrosis | | |
|---|---|---|---|
| | < 90000 | 90000 – 100000 | >100000 |
| 2015 - 2017 | | | |
| 2018 - 2021 | | | |
| 2022 - 2024 | | | |

Based on the data provided above, it can be clearly seen that the number of patients requiring diagnosis of fibrosis increases as the year increases. Calculating the number of fibrosis patients from six different countries, we are able to see that between 2015 and 2017, less than 90000 people were diagnosed with fibrosis.

In the future, the number of patients to be diagnosed with fibrosis increases and falls somewhere between 90000 and 100000 and this estimation is predicted for the time period starting from 2018 till 2021.

From the year 2022 till 2024, it has been predicted that more than 100000 people will be diagnosed with fibrosis. In this case, the need for automatic and faster detection of fibrosis becomes an essential

commodity in hospitals and the future of this software is predicted to serve its purpose with a huge profit that could be obtained from it.

## 5.2 Analysis of Technical Solutions from Resource Energy and Resource Saving

In order to analyze the competitiveness of the project, accuracy and productiveness of each operation should be measured. The performance and the productiveness of the product could be calculated with the help of certain benchmarks. These benchmarks (76) help in identifying technical and economic aspects and also the software development that was involved with the product. On the bases of these benchmarks, results of the product under performance were calculated and are presented in the scorecard table given below.

**Table 5.3 - Evaluation Card for Comparing Competitive Technical Solutions**

| Criteria for evaluation | | Criterion Weight | Scores | | | Competitiveness | | |
|---|---|---|---|---|---|---|---|---|
| | | | $S_f$ | $S_{k1}$ | $S_{k2}$ | $C_f$ | $C_{k1}$ | $C_{k2}$ |
| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Technical Criteria for Assessing Resource Efficiency** | | | | | | | | |
| 1 | Improving user productivity | 0.05 | 4 | 4 | 5 | 0.2 | 0.2 | 0.25 |
| 2 | Easy to use (meets consumer requirements) | 0.1 | 4 | 5 | 4 | 0.4 | 0.5 | 0.4 |
| 3 | Interface quality | 0.05 | 5 | 3 | 4 | 0.25 | 0.15 | 0.2 |
| 4 | Reliability | 0.2 | 5 | 4 | 5 | 1 | 0.8 | 1 |
| 5 | Easy operation | 0.1 | 5 | 4 | 4 | 0.5 | 0.4 | 0.5 |
| **Economic Criteria of an** | | **Efficiency Assessment** | | | | | | |
| 1 | Product competitiveness | 0.05 | 4 | 4 | 3 | 0.2 | 0.25 | 0.15 |
| 2 | The level of penetration of the market | 0.03 | 5 | 4 | 5 | 0.15 | 0.12 | 0.15 |
| 3 | Price | 0.2 | 4 | 3 | 5 | 0.8 | 0.6 | 1 |
| 4 | Estimated lifetime | 0.04 | 3 | 3 | 4 | 0.12 | 0.12 | 0.16 |
| 5 | After-sales service | 0.1 | 5 | 4 | 5 | 1 | 0.8 | 1 |
| 6 | Financing of scientific development | 0.05 | 3 | 5 | 5 | 0.15 | 0.25 | 0.25 |
| 7 | Time to Market | 0.03 | 4 | 4 | 5 | 0.12 | 0.12 | 0.15 |
| | **Total** | **1** | | | | 4.89 | 4.31 | 5.21 |

The software created is a real -time structural health monitoring system and was analyzed with the help of Tieto-Oskari Oy which helps in measuring, informing, collecting and saving the data (76, 77) provided by this model. The system can also be connected to the existing property automation system or remote monitoring service. Real-time monitoring helps to prevent big material and personal losses, and to schedule the maintenance and repair works ideally without disturbing the productive use of the software.

By analyzing the data provided by the evaluation table, it can be proved that the product being developed for fibrosis has many competitive advantages. It has a set of convenient, simple and understandable

functions that could be even performed by untrained personnel which in turn is very important for the users of such applications. The framework is very understandable and the area of fibrosis to be detected can even be identified by the patient diagnosed with fibrosis. The software also provides color to the area affected with fibrosis.

## 5.3 SWOT Analysis for Lung Fibrosis

SWOT Analysis as the name suggests refers to the strengths, weaknesses, opportunities and threats (78) of the research project. This framework can be credited by Albert Humphrey who tested this approach in 1960s and 1970s at the Stanford Research Institute (SRI). Thus SWOT analysis has been adopted by organizations of all types as an aid to making decisions. The four elements that are abbreviated from the name can be explained as follows.

- Strengths - This represents the internal attributes and resources that support a successful outcome.
- Weaknesses - This denotes the internal attributes resources that work against a successful outcome.
- Opportunities - This represents all external factors the project can capitalize on or use to its advantage.
- Threats - External factors that could jeopardize the project.

Once all the SWOT factors (77, 78) have been identified, decision makers should be able to better ascertain if the project or goal is worth pursuing and what is required to make it successful. Often expressed in a two-by-two matrix, the analysis aims to help an organization match its resources to the competitive environment in which it operates. Further more, SWOT analysis are used as inputs to the creative generation of possible strategies, by asking and answering the following four questions numerous times:

- How can we Use each Strength?
- How can we Stop each Weakness?
- How can we Exploit each Opportunity?
- How can we Defend against each Threat?

In order to provide a better understanding of the current state of research project, and also any potential strategies to achieve the stated objective, a SWOT Analysis can be undertaken. Consequently, the main objective is to apply this method of planning early in the life cycle of project with the intent that concepts described here can be used to strengthen and guide this emerging discipline (78). In practice, once an objective has been established, a multidisciplinary team representing a broad range of perspectives should carry out SWOT analysis; which is typically presented in the form of a matrix with the four factors.
Thus the main objective of this paper has been to provide an early attempt at formally defining lung fibrosis with that of CT images. Further more it helps in outlining a key objective of this new field, and identifying a number of Strengths, Weakness, Opportunities and Threats (SWOT) that project faces, with the intent that items described here can be used to strengthen and guide this promising new field. Thus a way is proposed to achieve this by developing a document where the practitioners can turn to for understanding and direction.

### *5.3.1 SWOT Matrix*

The following sections represent a number of SWOT (78) identified as we considered the past, present and future of research project. They are by no means the only possible items, and in several cases depending on one's perspective individual items could exist in more than one category.

**Table 5.4 - SWOT Matrix Table**

| | | **Strengths** | | **Weaknesses** | |
|---|---|---|---|---|---|
| | | S1. | Simple and intuitive interface. | W1. | No ability to create reminders. |
| | | S2. | Excellent data filtering | W2. | Lack of using language choice. |
| | | S3. | Interest in improving application, investors availability. | W3. | A bit expensive. |
| | | S4. | Professional developers. | | |
| **Opportunities** | | | | | |
| O1. | Attracting demand for the product. | 1.1. | Detecting the border of an image is a kin to the way humans conceptually organize the landscape to comprehend it. | 1.1. | Under the guise of 'flexibility' current commercial object-based software provides overly complicated options. |
| O2. | Rising cost of competitive development. | 1.2. | Using image-objects as basic units reduces computational classifier load by orders of magnitude, and at the same time enables the user to take advantage of more complex techniques. | 1.2. | There are numerous challenges involved in processing very large datasets. Detecting an inner fibrosis layer of an image of several tens of mega-pixels is a formidable task. |
| O3. | Extension of the functional. | 1.3. | Image objects exhibit useful features for fibrosis detection(e.g. shape, texture, context relations with other objects) that single pixels lack. | 1.3. | Fibrosis is a well defined problem problem, in the sense it has a unique solution. |
| | | 1.4. | Image-objects can be more readily integrated in vector GIS than pixel-wise classified raster maps. | | |

| **Threats** | | | | | |
|---|---|---|---|---|---|
| T1. | Lack of demand. | 1.1. | Sample and easy-to-use functionality helps to overcome the threat of lack of demand and declining popularity. | 1.1. | Lack of data filtering function in the application can lead to a decrease in demand. |
| T2. | Decrease of such applications popularity. | 1.2. | Professional developers, the availability of investment and interest .In the promotion of applications allow us to compete in the market. | 1.2. | The lack of automatics reminders can be a problem in case of new competitive developments. |
| T3. | Appearance of new competitive developments. | 1.3. | Methods have been successfully applied to many different problems, not only computer languages, and they can be easily adapted to this research. | | |

## 5.4 Quad Technology

For an assessment of prospects of the created decision in the market, the Quad technology (79) (Quality Advisor) is used. This technology allows us to define prospects of product development by means of allocation and an assessment of indicators of quality and commercial potential of the projects.

To assess the quality of the development, the selected indicators are the most important and decisive for the software of classification. If such factors as reliability and functionality are important to any user application, the quality of the interface and ease-to-use are particular importance for the software of classification, mainly due to the features of the user's interaction with information systems.

**Table 5.5: Scorecard of Comparing Competitive Technical Solutions**

| **Criteria for Evaluation** | | **Criteria Weight** | **Score** | **Maximum Scores** | **Relative Value (3/4)** | **Average Value (5x2)** |
|---|---|---|---|---|---|---|
| 1 | | 2 | 3 | 4 | 5 | 6 |
| **Indicators for Assessing the Quality of Development** | | | | | | |
| 1 | Reliability | 0.1 | 80 | 100 | 0.8 | 0.08 |
| 2 | Easy to use | 0.05 | 90 | 100 | 0.9 | 0.045 |
| 3 | Interface quality | 0.05 | 60 | 100 | 0.6 | 0.033 |
| 4 | Functional Capabilities | 0.15 | 80 | 100 | 0.8 | 0.12 |
| 5 | Additional Features | 0.05 | 90 | 100 | 0.9 | 0.045 |

| Indicators for Assessing the Commercial Potential of Development | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Competitiveness | 0.1 | 100 | 100 | 1 | 0.1 |
| 2 | Market entry level | 0.15 | 70 | 100 | 0.7 | 0.105 |
| 3 | Prospects of the market | 0.2 | 90 | 100 | 0.9 | 0.18 |
| 4 | Price | 0.15 | 80 | 100 | 0.8 | 0.12 |
| | **Total** | 1 | | | | 0.828/82.8% |

From the results scorecard shows that the weighted average value of the quality and availability of scientific development is 82.8%, which corresponds to prospective development by Quad technology.

## 5.5 FAST Analysis

The object of FAST Analysis (80) is software classification. The main function of the developed application is to give the users of fibrosis an opportunity to monitor and identify the inner fibrosis layer. In addition to the main features, the application has a user interface, simplifying the work process, as well as a number of additional functions.

The main internal functions provided by the application, are: adding, editing, filtering data, and work with automatic reminders.

As an additional function application provides opportunities to work in multiple languages and initialization calls.

Table below show all the processes used in the application description of the functions and their ranks. In the future, this classification can also be used for optimization of a development project (80) t, as to improve the efficiency of the process by reducing the value of the property and the preservation of the required quality. It is necessary, first of all, to pay attention to the additional functions. If in case of savings we will not use this function as it will not have a great effect on the functionality of the entire project.

**Table 5.6: Classification of the Functions Performed by the Project of Study**

| Process name | Function | Rank of function | | |
|---|---|---|---|---|
| | | Main | Basic | Additional |
| Technologies for Fibrosis | Giving users the ability to identify fibrosis layers. | X | | |
| Adding and Editing Color to Fibrosis Layer | Allowing users to create, edit color to detect fibrosis more clearly. | | X | |
| Filtering Data | Allowing the user to filter data. | | X | |
| Managing the Application in Different Languages | Allowing the user to select convenient for using language. | | | X |
| Automatic Reminders | Giving the users the ability to create appointments, notes, with | | X | |

| Process name | Function | Rank of function | | |
|---|---|---|---|---|
| | | Main | Basic | Additional |
| | the reminder possibility. | | | |
| Call Initialization | Allowing the user to call any existing numbers via the internet. | | | X |

For an assessment of the importance of these functions, the method of arrangement of priorities is used. Settlement and expert determination of the importance of each function is the basis for this method. The first step in assessing the significance of the functions is to build the adjacency matrix (table 5.6)

**Table 5.7: The Adjacency Matrix**

| | Function1 | Function1 | Function1 | Function1 | Function1 | Function1 |
|---|---|---|---|---|---|---|
| Function1 | = | > | > | > | > | > |
| Function2 | < | = | = | > | > | > |
| Function3 | < | = | = | > | > | > |
| Function4 | < | < | < | = | > | > |
| Function5 | < | < | < | > | = | |
| Function6 | < | < | < | < | < | = |

The second stage of assessing the significance of the functions is to convert the adjacency matrix into a matrix of quantitative relations functions (table 5.7)

**Table 5.8: Matrix Quantitative Relations Functions**

| | Function1 | Function1 | Function1 | Function1 | Function1 | Function1 | Total | |
|---|---|---|---|---|---|---|---|---|
| Function1 | 1 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 8.5 | 0.22 |
| Function2 | 0.5 | 1 | 1 | 1.5 | 1.5 | 1.5 | 7 | 0.19 |
| Function3 | 0.5 | 1 | 1 | 1.5 | 1.5 | 1.5 | 7 | 0.19 |
| Function4 | 0.5 | 0.5 | 0.5 | 1 | 1.5 | 1.5 | 5.5 | 0.15 |
| Function5 | 0.5 | 0.5 | 0.5 | 1.5 | 1 | | 5.5 | 0.15 |
| Function6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 3.5 | 0.1 |
| Amount | | | | | | | 37 | 1 |

From the result of FAST analysis, the least significant in the application is a function of a 6 initialization call. This result is explained by the fact that this feature is optional and it extends the functionality of the application. Compared with the basic functions of our application, the significance is lower. However, the introduction of the call initialization function justified the involvement of a significant number of users. Therefore, in the presence of human, time and material resources to add all, the initialization function can lead to increased profits by attracting users. In the case of a lack of necessary resources, introduction of a new function will be unjustified and also expensive for the customer.

Thus from all the information obtained from all the analysis performed, the results of financial management, resource efficiency and resource conservation in accordance with our research project are presented in the table 5.8.

**Table 5.9: Results of the Analysis and Evaluation of the Project**

| | Type of Analysis | Obtained Result |
|---|---|---|
| 1. | Identification of potential consumers of research results. | Potential patients who require diagnosis of fibrosis. |
| 2. | Analysis of competitive technical solutions. | Coefficient of fibrosis is 4.89, 4.31 and 5.21. |
| 3. | SWOT-analysis. | There were defined by<br>Coefficient development:<br>• The introduction of data filtering and automatic reminders.<br>• Increase in the amount of available languages. |
| 4. | Analysis of prospects for the development of QuaD technology. | The weighted average value of the quality and availability of scientific development is 82.8%, which corresponds to prospective development by QuaD technology. |
| 5. | FAST-analysis. | The least significant function in the application is call initialization, because it is optional and only extends the functionality of the application. |

## 5.6 Summary

Good financial management leads to a transparency of figures and supports a real understanding of the numbers in the development of any product. It makes it much easier to find savings, to show others how profitable you're the use of the product is. The stronger the financial management, the greater is the opportunity to maximize profits in the short term and to grow your capital value in the long term and also it becomes easier to raise finance at a lower cost.

In the explanation of financial management related to the detection of fibrosis, all economic aspects of the software obtained positive results thus proving that the software is good to be brought into the market as it will yield profit.

# Chapter 6: Social Responsibility

In the medical field, the social responsibility is to provide the highest quality of service to all classes of population. Thus if any rules or norms of the work ethic (81) has not been met it can be taken into argument out of all meaning. Therefore, in order for any medical facility to provide the highest quality of medical care it should include various measures for its continuous improvement on a regular basis. Sometimes the premise of the social responsibility is based on the grounds that people of medical profession have no greater moral responsibility to the public than people in other walks of life as in all people have an equal moral responsibility in society. Responsibility to the society (81, 82) in regard to work ethic is often taken for granted where people of all fields ignore basic principles and work ethics that can cause serious damage to the person and also to any equipment involved. Ignorance of these ethics may result in irreversible problems not only to all people in the field of medical science but also to the technically qualified people involved.

Thus this chapter focuses on the rules and norms of work at the computers and by identifying the main hazard whether or not that the conditions are favorable for health and also in the development process of the developer. Computers affect our vision (82), posture, and overall health. Thus if we can properly work out and observe all measures in order to provide healthy and safe working conditions, then it is possible to avoid a lot of unhealthy circumstances during work. We also focus on the safety of the patient in any circumstance of the research. Detection of fibrosis involves the use of computer tomographic images and hence the patient to be under diagnosis should be handled with extreme care, keeping all the concerning harmful factors in mind while performing the required tests for the research.

We further more discuss about the safety measures involving environmental safety, fire safety and also safety in any emergency situation and thus protection against dangerous and harmful factors.

## 6.1 Occupational Hazards

The harmful and dangerous factors that can have an impact on a person in due course of work (82, 83) are some of the occupational hazards that every person must take into consideration. Some of the factors are as follows:

| Dangerous Factors |
|---|
| • Direct contact with electrical live parts. |
| • In contact with the dead parts, appearing under voltage. |
| • In contact with floor and walls, appearing under voltage. |

| Harmful Factors |
|---|
| • Eyestrain and muscular skeletal system overload. |
| • Mental strain. |
| • Emotional stress. |
| • Monotony of work. |

### 6.1.1 Microclimate Requirements

Microclimate usually refers to the climate of a very small or restricted area (83) and this is especially in particular when it differs from the climate of the surrounding area. The climatic conditions of a particular area should be ensured so as to avoid damage to any physical equipment due to overload or even damage to the people in the particular area such as suffocation and the like.

There are three factors that determine this microclimate of a particular area is as follows:

- Indoor Air Temperature
- Relative Humidity
- Velocity

The combination of these three factors provides comfortable working environment (83) which is necessary to ensure the safety of the people involved. In the respective workplace there should be particular optimal parameters relative to the microclimate and this should be in accordance to that sanitary norms and rules as mentioned earlier. Thereby, according to the research the air temperature along with the humidity must not exceed 22-24 degree Celsius (83) and in the warm season it should not exceed 20 - 25 degree Celsius. In addition to this the relative humidity not be more than 40 - 60 percentage with a velocity of 0.1 m/s. Thus in order to maintain a particular microclimate within this particular conditions, the usage of a heating or air condoning system is used respective to the climate in that particular area.

Thus all the above parameters were met for the required microclimate while developing and executing the project and hence met all sanitary norms and rules. The above requirements are needed also while the program is executed in a medical field.

### 6.1.2 Office Requirements to Noise Levels

Noise in the production is one of the most common hazards that are caused and this causes a lot of inconvenience in the working environment. It is mainly due to the working equipment, the converters of the tension working by the various illuminants (83, 84) of daylight and also noise from the outside. Noise in the form of action can be in various forms and can also affect the person in the following ways.

- It complicates the legibility of speech of the concerning person affected by this factor.
- It causes a decrease in the working capacity as in the person finds it difficult to cope with the noise.
- It increases the fatigue of a person to a varied extent.
- Irreversible changes are also caused in the hearing of the concerning person.It can also cause a drastic change in the human body because of damage in the central nervous system.
- The person can sometimes get psychologically affected and is seen by the person’s lack in attention.
- The memory of the person being always surrounded by noise of some kind in a working environment often results in worsened memory of the person.
- The number of errors performed by the person is also increased in his work performance.

The noise level that is acceptable in any workplace for the personal computer users should not go beyond the Sanitary Norms and Rules (84) specified value and should not constitute more than a 50 dBA. Rustling of equipment sometimes caused by alphanumeric printers and other types of printers always exceeds the specified value and hence has to be performed in a place that does not affect the workplace

environment or the people in the particular working organization. Therefor in order to reduce the noise and vibration caused by certain equipment and devices in the workplace, they must be installed in certain special foundations and also with shock absorbing pads that are described in the respective regulations. Further more it is also possible to reduce the noise level that is caused by various factors in location of a personal computer. This can be done by the use of sound absorbing materials that has a maximum absorption with a coefficient that lie in frequency range between 63 - 8000 Hertz (84). This is the specification that is authorized and confirmed by the special acoustic calculations. In addition to the acoustic walls there should also be hung in the fold of the walls at a distance of 15 - 20 cm from that of the fence. The curtains used here should also be twice the width the window.

The office in which the research was carried out met all the above specified norms and work ethics according the Sanitary Norms and Rules where all noise levels were as per the needed requirements

### *6.1.3 Lightening Requirements*

While working, it is necessary for us to experience nominal working conditions and thus illumination (84) of the working area plays a very important factor for an individual to experience comfort at the workplace. Lighting in one of the most important factors that an employer must pay attention to, as very poor lighting may result in employees experiencing tiredness, increase in metal stress and also fatigue which is caused due to dimness of the surroundings and in contrast to this the light emitting from the computer appears very bright. This can even result in loss of eyesight in an individual.

Lighting can be divided into three categories depending on the source from which the light emits.
Based on the source, light can be classified into:

- Natural
- Artificial
- Combined

Natural light is obtained from the sun and also relates to any light that is diffused naturally. It usually varies depending on the time of the day, month of the year, location and region in which it is emitted. Artificial lighting is obtained from electrical sources. When there is insufficient supply (84) of natural light, artificial light is used. A use of both natural and artificial light, results in combined light source. The Coefficient of Natural illumination (CNI) should be 3.5% in the case of upper or combined lighting and should be 1.2% in the case of side lighting.
Light illumination on a computer screen should be around 300 – 500 lx in a working environment and this light should not create flares on the screen surface. In this case, light emitted from the screen should be more than 300 lx. In the case of artificial lighting, luminescent lamps should be used.

General lighting should radiate in the form of solid or broken lines from the lamps and these lamps should be placed parallel to the line of sight of the user. The ripple ratio of illumination should be not more than 10%. Brightness of these should radiate at an angle between 50 and 90 degrees to the vertical. The protective angle of these lamps should be at least 40 degrees.

### *6.1.4 Safety Measures*

Safety Measures for the various dangerous factors (84, 85) should be taken into consideration before performing any task. In the case of software engineering the most dangerous factor could be an electrical factor. Software engineers usually work with a personal computer and this includes various components

such as the display, processor, hey board and also an external output device. The power supply should be taken into into consideration since all the equipment's power supply is done by an alternating current voltage of about 220 volts. Thus, any personal computer can be energized as result of any failure, damages or any isolation breakdown. Further more depending on the room condition any danger involving electric shock can be increased or decreased.

Now by the classification of the Electrical Installation Code (EIC), the rooms involved with the above procedures it should be divided into the following:

- Rooms without any sort of increased danger.
- Rooms with increased danger.
- Especially dangerous rooms.

The work was thus proceeded in a room without any high risk (85) since it is not characterized by the presence of any conditions such as high humidity (relative humidity is said to exceed 75% for a prolonged amount of time), high temperature (35 degree celsius), conductive flooring and dust, simultaneous touches for connections to metal ground parts and also metal casing of all electrical equipment. Voltage of 220 volts can be a threat to life, hence for electrical safety the following steps need to be ensured while working indoors.

- All electrical networks must be protected to avoid any short circuiting. In order to do so, one must have high speed protection devices and thus ensuring there to be potentiality of response time for disconnection and selection. This can further more be ensured by the use of circuit breakers and fuses.
- All current carrying parts have to be isolated in order to prevent human interference accidentally or even on purpose. It is forbidden to use cables and wires with the following disadvantages.

Only qualified electricians can carry out the work of repair, installation, dismantling and then assembly of the required product involved and also adjustment of the electro technological equipment. Every single person involved needs to know the measures that need to be taken in the case of any medical help in the case of any potential damage caused by electric current to either human or the surrounding environment. Thus in order to ensure this every room also needs to be well equipped with the right first aid kit that can render to immediate first medical aid to the person or surrounding in danger.

A number of calamities take place due to the potential damage (81, 83) caused by electric current most often because of device handling negligence. The concerning person may either be ignorant at malfunctions of electro installations and naive to damages caused by the same. Any person involved in such situations need to know the following ways of when they should immediately disconnect a device.

- When there is an emergence of threat to life and health of the concerning person.
- When there is an emergence of smell which indicates that there is some burning isolation of plastic.
- When there is smoke or fire in the building.
- When there is sudden emergence of a spark with the involved devices.
- When the power cables or the switching devices have a visible damage detected.

Therefore, at any emergence of fire or ignition, it is absolutely necessary to disconnect the electric devices from the power supply (84) and in the case of an absolute emergency it is necessary to disconnect the

supply network by any automatic package switch or even a power breaker on the power board. Thus further more to call a fire brigade and to start extinguishing the fire with any available means. It is also necessary to remember that all installation under a voltage, at the time of fire extinguishing, only carbon dioxide or power fire extinguishers should be used. In any case it is also necessary to call a qualified electrician and to disconnect any power supply to the affected room at a strong ignition and further more use any foamy fire extinguisher and water to put out the fire completely.

### *6.1.5 Patient's Safety Requirements*

Here the patient's safety (81, 85) is taken into consideration through the progress of the research. Since computer tomographic images are used in the identification of fibrosis it is very necessary to check the impact it has on the patient under scrutiny. This could be due to faulty equipment or wrong diagnosis by the software created due to sudden malfunction. Thus the patient can be affected by some external means while studying the problem and can pose a serious threat to the life of the patient under supervision. The types of errors and harm can be thus classified regarding domain, or where they occurred across the spectrum of health care providers and settings. The root causes of harm are identified in the following terms:

- Latent Failure - Removed from the practitioner and involving decisions that affect the organizational policies, procedures, allocation of resources.
- Active Failure - Direct contact with the patient.
- Organizational System Failure - Indirect failures involving management, organizational culture, protocols/processes, transfer of knowledge, and external factors.
- Technical Failure - Indirect failure of facilities or external resources.

Every possible failure has to be taken into consideration every time a test is being performed on a patient. This helps to thus reduce the harm or danger (83) that could be caused to the patient. Hence with intense care while taking the scan of the patient, which is possible only with the help of the right specialists, who should make sure that all equipment is intact and also functioning well, and thus not putting the patient's life at risk. It is also important because any wrong detection of the disease could also lead to death of the patient. Thus taking into account the above possibilities of an error or danger to the patient's life the patient's health should be ensured and should not cause any serious threat to the patient under study.

## 6.2 Environmental Protection

Violation of any type can cause serious damage to the environment. Hence, it is necessary to make an effort not to cause to much of an impact on the environment and also thus to reduce the level of consequences that could be caused. According to the act. 11 (82) it states about "The rights and duties of citizens in the field of environmental protection" and also the Federal law of the Russian Federation of January 10, 2002 No. 7-F3 states about "About environmental protection". Each citizen has the right to have a suitable environment to live in and thus can also create an impact on any negative activity caused by any economic or any other activity. This can be either due to emergency situation of natural and techno geneic which is based on reliable information about a status of environment and also the person should be asked to compensate if any harm is created to the environment.

This research was performed by a computer that uses a rather small quantity of electric power, almost no noise, electro magnetic fields and ionizing radiations are in limits of admissible norms and therefore the

working place in an office where the project was executed does not render any negative impact on the environment or nature. The only main waste that was involved is that of solid waste such as paper, boxes, disk and diskettes. This garbage is taken out out the particular territory and stacked under that of home waste from which it was processed further.

## 6.3 Fire Safety

Fire safety is nothing but measures to prevent fires (86) and explosion by a single complex of organizational, technical, operation and also maintenance. Thus prevention is based on the exclusion of conditions that are necessary for combustion and further more the implementation of safety principles. Any fire in the workplace (86) can cause damage of the affected material and can be a threat to health and life if anyone is affected by it in the particular affected surrounding. Fire can be especially dangerous cause it can damage all computers, hardware, tools and documents. Most important it can also create a fire in the surrounding area if it is not stopped in time. The following are some of the factors that could start a fire in a workplace.

- Sudden short circuiting in an electrical wiring.
- Ignition of devices in the computing equipment.
- Fire safety infringement causing a breakout of fire on the furniture and floor in the workplace.
- Ignition of artificial lighting devices.

Thus the room in which the research project was developed, 220 volts of electricity is used to supply all computer equipment and also lighting. If there is any misuse of equipment or even a short circuit of an electric chain there can be an ignition and thus could be a threaten to life, destruction of equipment, documents and other available equipments. At times, ventilation can also be a cause of the ignition to take place. Some of the sources of ignition are as follows:

- Various electronic schemes of the personal computers.
- Devices applied for maintenance.
- Any power supplying device.
- Faulty air conditioners..
- Violations causing super heated elements.
- Electric sparks and arches.
- Fire combustible materials.

Any room with strong combustible materials belongs to the category B that is the room is on the highest degree of fire and explosion hazards. Protection and prevention (86, 87) against the fire is compulsory and a complex obligation for organizational and technical actions that are directed on the safety of the people. There should be a condition established for proper fire extinguishing and also on the restriction of fire. Some of the organizational activities involves fire instructing, training the people on safety regulations and finally make manuals, posters and evacuation plans. Furthermore, operating activities for the prevention involves the following:

- The workplace user’s compliance with operational standards of equipment.
- Providing free approach to the equipment.

- Upkeep insulation of live conductors.

In any corridor of the workplace there must be a OP5 power representation with a fire extinguisher (87) and a de-energizer for the entire office space. The evacuation plan must be displayed on all doors in the case of a fire breakout. In order to localize small fires without the need of a firefighter, every building should consist of a firefighter trunks, means for internal water to extinguish the fire, various other fire extinguishers, dry sand, asbestos, blanket and the like. Further more in order to extinguish the fire in the early stages, extinguishers should be used to a great extent. The fire extinguishers used can be divided into the following groups:

| | | |
|---|---|---|
| Foam Type Fire Extinguishers | - | This can be used to extinguish burning liquids, different materials, structural elements and equipment, except electrical equipment under voltage. |
| Gas Type Fire Extinguishers | - | This can be used for extinguishing liquid and solids, as well as electrical installations under voltage. |
| Carbon Dioxide Type Fire Extinguishers | - | The merit of this extinguisher is high extinguishing efficiency, safety of electronics, dielectric properties of carbon dioxide, which allows the use of these fire extinguishers, even when you can not disconnect the electrical installation immediately. |

Furthermore, if ignition takes place in an electric circuit (81, 85), in order to eliminate it, carbon dioxide fire extinguishers can be used or even a power OP5 can be used. If the fire breakout is uncontrollable it is necessary to evacuate the building immediately.

### *6.3.1 Safety from Fire and Explosives*

The most probable and destructive types of emergencies is that caused by fire or even more some sort of explosion in the workplace. Fire prevention (86) is only based on the exclusion of the condition that are necessary for combustion and further more the use of safety principles. Indoor fires are especially dangerous as it posses a threat to human life and health and it is also a threat to everything in the room such as computers and the equipment, tool, documents and also spread of fire to nearby areas. Sources that could start a flame indoors are as follows:

- Faulty electric equipment, failure in a an electrical writing, electrical sockets and switches.
- Faulty electric devices.
- Heating of location by electric heaters with open heating elements.
- Short circuit in an electrical writing.
- Contact with building lightning.
- Non-compliance with measures of fire safety and smoking indoors also can lead to a fire.

In any modern operating system, the electrical components are dense. In close proximity to each other are arranged all the connecting cables, patch cables (82, 83) and electric components. Hence when there is a flow of electric current, a certain amount of heat is used to raise the temperature to about 80 - 1000 degree celsius. It is also possible to melt the insulation, and as a result of short circuiting it is accompanied by sparks and finally leads to unacceptable overload of circuit elements. Thereby in order to remove the excess of heat in a personal computer it is very necessary to use an internal ventilator (87). It is necessary to observe the following technical fire prevention precautions:

- Wherever it is possible to reduce the amount of easily flammable substances, have it replaced with the analogs resistant to burning.
- To remove possible sources of ignition.
- To have a mandatory fire extinguishing mean (fire extinguishers).
- To carry out the fire warning indoors.
- To contain electric equipment in a good condition and whenever possible to apply the means to prevent the origin of a fire.
- To have proper exits for people during the time of a fire emergency.

## 6.4 Workplace Requirements

In the working environment involved in this research a number of adverse effects could take place. Hence in order to avoid these effects on any person involved with the personal computer ( 83, 85) by many harmful factors a number of hygienic requirements are developed to ensure the safety of the person in the work place.

### *6.4.1 Workplace Organization Requirements*

The requirements needed at a workplace in an organization (84) should also be in accordance to the sanitary norms and rules as mentioned above on a personal computer and have to carry out respectively based on this specification. They are as follows:

- All personal computers in any workplace should be in contact with a window opening aperture so that the light falls sideways and this should be more preferably to the left. This is to ensure that there is proper lighting in the workplace of an organization as per the norms and work ethics.
- The corners of any room should be avoided as in arrangement should be done only facing windows. Thus the respective distance from the wall to a personal computer must be a minimum a 1m.
- It is always better to set the personal computer in a way such that when looking away from the screen, it should always be possible to visualize any distant object present in the room. This has proven to be one of the most effective ways to unload any visual system.
- While taking into consideration the general set up of a number of computers in a single room of a workspace in an organization one has to make sure that the distance between the wall and the screen of the computer to be at least a minimum of 2m. Also the distance from the side of the wall to every adjacent computer should be not less than 1.2m.
- Every room in the workspace that have personal computer should always be equipped with any sort of window screen adjustable like blinds, curtains, external peaks, etc.
- The monitor, keyboard and the case of the computer have to face the person operating it directly as per the work ethic norms. Further more the distance between the operator and the monitor should be close to a 60 - 70 cm and the angle must be a 20 degree from the monitor to the level of eyes of the person operating.
- The space for feet has to be a minimum height of 600 mm, a minimum width of 500 mm and finally a minimum depth of about 450mm. Also, the support for the feet should also follow a

specific requirement of a width that is not less than 300 mm with a slightly adjustable tilt angle of about 0 - 20 degree must be provided.

- All the chairs that have been equipped in the working place needs to have a soft seat and suitable back rest making it comfortable for the user in the respective workplace. People are of various heights and weights and therefore it must be ensured that the seats are adjustable by height and also hold a convenient support around the waist.
- The position of the monitor relative to that of the body should comply to perpendicular from the viewing direction or at an angle of 75 degrees.
- The operator's hand should always maintain a correct posture and position in order to prevent the violation according to that in the loco motor system and also to the syndrome of constant loadings.

### *6.4.2 Leisure and Work Organization Requirements*

According to the type of employment, the modes of work and rest while working with the personal computer should be organized. The different types of work can be divided into three types:

- Group A - Involves work by reading information from the screen of the personal computer with the preliminary inquiry.
- Group B - Involves work with the input of information.
- Group C - Involves all types of creative work using dialogue mode with a computer.

For optimum working capacity support and also saving health (82, 87) of many professional users, small intervals should be organized between every shift. These small regulated intervals should depend on the duration of the work shift, it's type and also the category of work involved. In order to prevent the development of fatigue, the following measures should be ensured.

- During any regulated interval there should be proper ventilation in the room.
- During regulated intervals to perform some athletic excursuses for 3 - 4 minutes.
- Exercises should be conducted every now and then and for the eyes every 20 - 25 minutes.

## 6.5 Summary

Safety of the person is an important factor and needs to be considered when it comes to any working environment due to the enormous amount of dangerous factors that could take place knowingly and unknowingly. Hence every individual involved in the work process should be well aware of the possible harms that could take place and what are the immediate steps to be taken in order to prevent it from becoming an enormous disaster. It is also necessary to know the entire rules and regulations for the building layout to avoid such situation from happening. Since the entire project revolves around the computer tomographic images for the detection of fibrosis, the patients health should be taken into consideration and by following every safety measure regarding it with intense care. Further more, every individual involved in the research has proven to comply by the rules and speculations required for a safe environment.

# Conclusion

The main aim of this thesis is to create a software that detects fibrosis in the lungs and highlight the region of fibrosis, which was carried out successfully.

To solve this task, first previously used methods for the process of image detection and image learning were analysed and the advantages and disadvantages of using various technologies were discussed.

In the execution of this thesis, first the border of the lungs is detected in two modes, that is the lung mode and the pleural mode. The next step was tocompare the boundaries of both modes to identify the region of fibrosis. This region is highlighted in the original image using color filters that use the color components Red, Green and Blue.

The language used for the execution of this task is C# as this language is very efficient in image processing and image learning techniques, thus making detection of fibrosis faster and involves lesser overhead.

Once the creation of the software was completed, a financial and economic analysis of the software was analysed which involved a segmentation market table to analyse the audience for the software, a SWOT matrix table to analyse the advantages and disadvantages related to the software creates, a FAST analysis and QuaD analysis to calculate the efficiency of the software and also the future of the software. Based on the results obtained, a financial report was created and the software seems to be financially sound.

Finally, the safety involved with using the product was detected and analysed in every aspect of environment and human safety. The result proved that the product created is very safe to use.

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