Performance Evaluation of Filtering Techniques For Cancerous Lung Images

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----------ABSTRACT----------

Lung diseases in India are increasing year by year. Respiratory diseases like asthma, chronic obstructive Interstitial Lung Disease (ILD),pulmonary disease (COPD), pneumonia, tuberculosis (TB) and cancer are most common and major health problems. As per a report given by the WHO the deaths due to lung diseases in India are on a rise which accounts for 11% of the total deaths. As many as 142.09 in every 1 lakh, die of one form or other form of lung disease giving India the distinction of ranking first in lung disease deaths in the world. This paper presents a method for performance evaluation of various filters by calculating the SNR values for lung cancer X-ray images. LPF, HPF, Median, Wiener filter is applied on a set of cancerous lung X-ray images. The results obtained show that Wiener filter outperforms the other filters based on the SNR values.

Keywords*:* **High pass filter, Lung cancer, Low passfilter, Median filter, Signal to noise ratio(SNR), Wiener filter**

I. INTRODUCTION

Lungs are the important organs for respiration. They are spongy, air filled organs located on the either side of thorax (chest).It is covered by thin outer layer called pleura; this layer allows the lungs to expand and contract during breathing. Lung can be affected by various types of diseases one among of them are cancer. It is a condition where then cells starts dividing abnormally and uncontrollably which results in tumour. This tumour grows rapidly and spreads to other organs of the body. The two main types of lung cancer are small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC).Most common type of cancer is NSCLC. It is found in 80% of cancer patients. It can again be classified into squamous cells carcinoma, adinocarcinoma(AC) and large cell carcinoma(LCC). These tumors can be detected using X-ray, CT scan and MRI.

According to a survey conducted by American Cancer Society, lung cancer was the leading cause of deaths due to cancer . Over90,275 Indian people were affected by lung disease among them 83,235 people died. The survival rate of lung cancer was lowest compared to other types of cancer.

Filtering is the method of removal of noise or unwanted components. Here the filters performance is evaluated on cancerous lung images by calculating the signal to noise ratio. The filters we use here are low pass filter, high pass filter, median filter and wiener filter. Low pass filter is a filter that allows signals of low frequency and attenuates high frequency signals. High pass filter is a filter that allows signals of high frequency components and attenuates low frequency signals. Median filters is used in image processing so as to reduce “salt and pepper” noise. Wiener filter is used to reduce the amount of noise present in the signal by comparing it with the given noise.

Nooshin Hadavi, et al [1], proposed an approach to reduce the error rate by passing the obtained CT images to cellular learning automata lattice for making them detect the lung cancer. Ashwini Kumar Saini, et al [2], proposed this paper on lung cancer, types of noise in medical imaging and themethod for removal of noise.P. B. Sangamithraa, et al [3], proposed this paper as a classification of whether the given CT image is cancerous or normal image using EK-Mean Clustering. Rotem Golan, et al [4], proposed that using CADe in large number of lung nodule in which the variation of the appearance increases, hence challenging there detection using CADe. K. Punithavathy, et al [5], proposed a method to get overall accuracy of 92.67% by better classification and cancer detection. Jun Wei, et al [6], proposed the investigation of three different CI filter and their result shows the performance and effectiveness of the filter.

II. METHODOLOGY

In the proposed method, the acquired images that will undergo a pre-processing stage. The region of interest (ROI) is selected and then the ROI is undergone pre-processing, which consists of-

1. Image enhancement by Histogram Equalization.

The formula for Histogram Equalization is as follows:

$$\sum_{i=1}^{k} = m_i \quad (1)$$

Where, i be the total number of observations and k be the total number of bins, the histogram m_i.

2. Image filtering
   - Low pass filter
   - High pass filter
   - Median filter
   - Wiener filter

(a). Low pass filter: $y[i] = \frac{1}{M}\sum_{J=0}^{M-1} x[i+j]$ (2)

where x be the input signal, y is the output signal and M is the number of points in the average.

(b). High pass filter: $S_{ij}=x_{i,j}+\lambda F(x_{i,j})$ (3)

where $x_{i,j}$ is the original pixel value at the co-ordinate ij , F is the high pass filter, λ is the tuning parameter.

(c). Median filter: y(m,n)=median{x[i,j],(i,j) ε w} (4)

where w is defined by the user, centered around location [m,n] in the image.

(d). Wiener filter:

$$f_{ij}= \sum_{k=-n/2}^{\frac{n}{2}-1} \sum_{l=-n/2}^{\frac{n}{2}-1} (v_{kl}g_i + k, j+1) + e_{ij}$$

3. Calculation of SNR.

Theformula for SNR is as follows:

SNR=20*log10((ima-imi)/mse)

Where, ima be the maximum intensity of the pixel, imi be the minimum intensity of the pixel and mse be the mean square error.

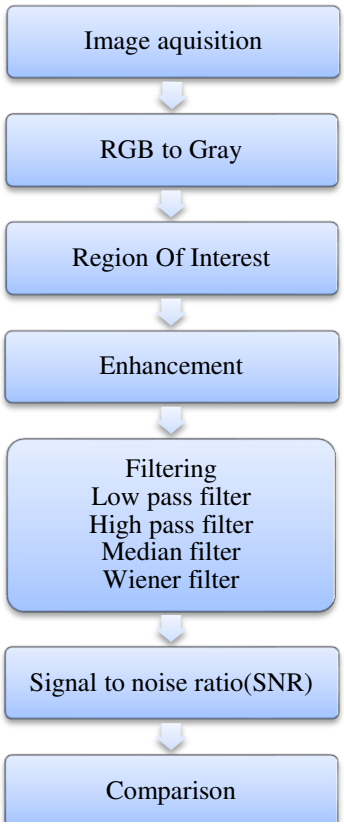

Figure 1: Flow Diagram

After finding the SNR, the values of various filters are obtained.

III. RESULTS

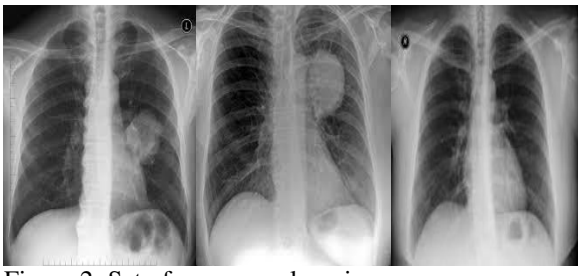

Figure 2: Set of cancerous lung images

Table1: SNR values of different lung images

Image -	Lung 1	Lung 2	Lung 3
LPF	14.1069	15.1019	16.3556
HPF	13.2022	15.0714	13.8639
Median	18.5580	20.9196	22.5059
Wiener	20.2826	21.3758	22.8863

Figure2 shows the set ofcancerous lung images. Table1 shows the SNR values of different lung images**.** From Table1 it is found that wiener filter performs more efficiently than any other filters.

IV. DISCUSSION

Three sets of cancerous lung images are taken for analysis. The region of interest (ROI) is selected in each image. Different filtering techniques like low pass filter(LPF), high pass filter(HPF), median filter and wiener filter are applied to the image for noise removal. Histogram equalisation is applied to enhance the images.SNR is calculated for the different filters.

Each image of the lung is passed through the four different filters mentioned above. When Lung 1 image is passed through the LPF the value obtained is 14.1069. The same image is passed through HPF the value obtained is 13.2022,when its passed through Median filter the value obtained is 18.5580 and when it's passed through Wiener filter the value obtained is 20.2826 which is the greatest amongst all .Similarly when image of Lung2 is passed through the four filters the values obtained when passed through the LPF is 15.1019. When the same image is passed through HPF the value obtained is 15.0714,when its passed through Median filter the value obtained is 20.9196 and when it's passed through Wiener filter the value obtained is 21.3758 which is the greatest amongst all in the case of lung2.Image of the lung3 is passed through the four filters. When Lung3 image is passed through the LPF the value obtained is 16.3556. The same image is passed through HPF the value obtained is 13.8639,when its passed through Median filter the value obtained is 22.5059 and when passed through Wiener filter the value obtained is 22.8863 which is the greatest amongst all in this case.

The results tabulated in table 1 show that Wiener filter performs more efficiently than the other three filters for removing noise from cancerous lung images.

V. CONCLUSION

The proposed system is tested on three sets of X-Ray cancer lung images. The results obtained show that SNR is maximum for wiener filter, therefore wiener filter is most effective in removing noise from cancerous lung images. However, more images of cancerous lung are to be tested for developing an expert system for computer aided diagnosis using other filtering techniques.

VI. ACKNOWLEDGMENT

The authors thank the Principal and Management of ACS College of Engineering, Mysore road, Bangalore for permitting and supporting us to carry out the research work.

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