

Analytical Study of Various Filters in Lung CT Images

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Abstract - Digital image processing plays a vital role in all form of medical fields. Particularly, it is also affiliated with the Medical Image Processing in the diagnosis of Lung Cancer and other diseases. In today's era Medical image processing has emerged in the diagnosis of various diseases predominantly for cancers. Removal of noises in medical images is a challenging task in such kind of image processing. In order to overcome those issues, filtering the image is a pivotal task to remove the noises and for better image enhancement. In this paper, suitable preprocessing methods are compared with various filters. The performance is valued on Peak Signal-to-Noise Ratio (PSNR) and Mean Squared Error (MSE). It is also observed that the wiener filter having better performance for images corrupted by white noise compared to other linear filters.

Key Words: Medical image processing. Wiener filter. Median filter. Average filter.

1. INTRODUCTION

Lung cancer is a disease of abnormal cells which grows into a tumor. In several types of Cancers, the rate of Lung Cancer is increasing step by step. Lung cancer kills more people every year than breast cancer, colon cancer, and prostate cancer[1]. The American Cancer Society calculates that nearly 180,000 new cases of lung cancer are found and lung cancer deaths occur nearly 170,000 per year. This shows that every day approximately 480 people are diagnosed with lung cancer and 460 people die due to this. The World Health Organization (WHO) had reported that over millions people die due to lung cancer. WHO has clearly states that lung cancer is one of the greatest problems faced by the world in the present centuries. Due to genetic damages in lung cell, it leads to turbulence cell proliferation. Lung cancer cells have the ability to affect the neighboring tissues and spreads to other parts of the body. If correct medical care is not given, lung cancer slowly kills that person. The lung cancer death increases day by day. Even after the diagnosis the cancer survival rate is less. So to detect lung cancer earlier, we use CAD.

In the interpretation of medical images Computer Aided Detection/Diagnosis (CAD), are methods in medical data set that helps to detect and diagnose the diseases. Moreover, CAD may reduce the inter-and intra-observer changeability

in image performance [2]. CAD systems helps physician to observe areas like nodules, tumors.

Preprocessing is a subcategory of image processing which is used to improve the accuracy and interpretability. Image pre-processing is a powerful and testing factor in the computer-aided diagnostic systems. In medical image, preprocessing the image is an essential part for segmenting the tumor so that segmentation and classification algorithms work correctly.

Accurate detection and segmentation of the tumor leads to exact classification of those tumors. The segmentation is clearly identified only when image is pre-processed as per image size and quality. As there are number of preprocessing methods are available and been introduced, the usage of Preprocessing is to enhance some quality and to remove unwanted features. In preprocessing techniques images are filtered for changing the pixel level, adding affects to the image, adjusting the brightness. To identify the best filters for image preprocessing. Comparison of different image filters are used with metrics analyzed.

In this paper- section II is about recent survey, section III describes methodology, section IV shows the result and section V conclusion

1.1 Literature survey

The paper[2] used various types of preprocessing techniques. In this paper the author discussed about different filters which are used to find PSNR and MSE values for finding the best filter.

The paper[3] proposed different filtering techniques for removing noises in color image and compared results for filtering techniques in image processing.

The paper[4] mentioned the preprocessing of MRI images which is investigated by considering various methods of digital image enhancement, image sharpening and image denoising.

1.2 Motivation and justification

As there are various preprocessing filters are available and been introduced, the purpose of using Preprocessing is to enhance some features and to remove unwanted features. To identify the best filters in segmentation of image processing, Comparison of different image filters are performed.

Based on the metrics the result is justified.

II. METHODOLOGY

The lung CT images having low noise when compared to scan image and MRI image. The main advantage of the computer tomography image having better clarity, low noise and distortion. So we can take the CT images for processing the lung image.

The overall model of my paper is given in diagram (Fig.1).

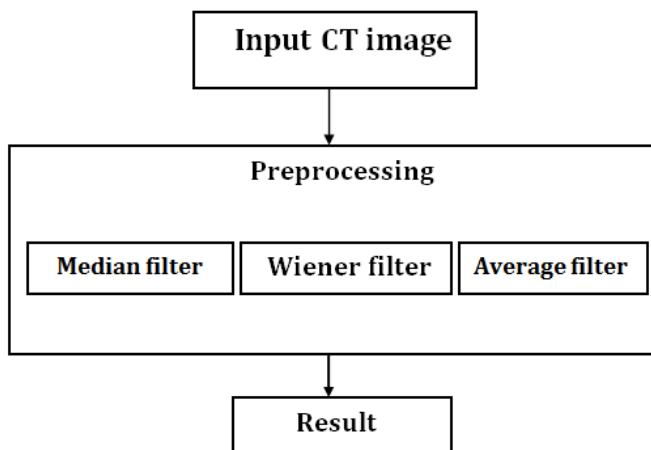


Fig 1.Outline of the paper

Median filter

The Median Filter is performed by taking the magnitude of all of the vectors within a mask and sorted according to the magnitudes. It is based upon moving a window over an image (as in a convolution) and computing the output pixel as the median value of the brightness within the input window. The Simple Median Filter has an advantage over the Mean filter since median of the data is taken instead of the mean of an image. The pixel with the median magnitude is then used to replace the pixel studied. The median of a set is more robust with respect to the presence of noise[5]. The median filter is given by

$$\text{Filter}(X_1, \dots, X_N) = \text{Median}(|X_1|^2, \dots, |X_N|^2)$$

Wiener filter

The goal of the Wiener filter is to filter out noise that has corrupted a signal. It is based on a statistical approach. Typical filters are designed for a desired frequency

response. However, the design of the Wiener filter takes a different approach. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the linear time-invariant filter whose output would come as close to the original signal as possible.

Wiener filters are characterized by the following:

1. Assumption: signal and (additive) noise are stationary linear stochastic processes with known spectral characteristics or known autocorrelation and cross-correlation
2. Requirement: the filter must be physically realizable/causal (this requirement can be dropped, resulting in a non-causal solution)
3. Performance criterion: minimum mean-square error (MMSE) The orthogonality principle implies that the Wiener filter in Fourier domain can be expressed as follows: [6]

$$W(f_1, f_2) = \frac{H^*(f_1, f_2) S_{xx}(f_1, f_2)}{|H(f_1, f_2)|^2 S_{xx}(f_1, f_2) + S_{nn}(f_1, f_2)}$$

Average filter

The idea of average filtering is simply to replace each pixel value in an image with the mean ('average') value of its neighbors, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean. Often a 3x3 square kernel is used, although larger kernels (e.g. 5x5 squares) can be used for more severe smoothing. (Note that a small kernel can be applied more than once in order to produce a similar but not identical effect as a single pass with a large kernel.)[5]

IV Experimental result

Similarity Measures:

For a long time, MSE & PSNR used to measure the degree of image distortion, because they can represent the overall gray value error in the entire image.

A. Mean Square Error (MSE):

Mean Square Error (MSE) can be estimated to quantify the difference between values implied by an estimate and the true quality being certificated. The average squared difference between the reference signal and distorted signal is called as the mean square error. Given a noise free (m,n) monochrome image I and its noisy approximation K, MSE is

defined as

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i,j) - K(i,j)]^2$$

Here, M and N are the no of rows and columns in the input image respectively. Hence, to evaluate PSNR firstly MSE value should be calculated.

B. Peak Signal to Noise Ratio (PSNR):

Peak signal to noise ratio is the difference between the maximum possible signal and the corrupting noise that affect the expressed as decibel scale. High value of PSNR indicates the high quality of image.

$$PSNR = 10 \log_{10} \frac{R^2}{MSE}$$

Here R is maximum fluctuation in input image data type. PSNR measures the peak error [7].The result of the metrics values are shown below tables.

Performance Evaluation.

Table1. Image quality parameters of image 1

Filter	MSE VALUES	PSNR values
Wiener filter	5544.15	10.73
Median filter	5618.56	10.67
Average filter	25748.8	04.06

Here, in the first image wiener filter shows the best result with 5544.15 MSE and PSNR10.73 values. Likewise the image2 are performed with metrics

Table2.Image quality parameters of image 2

Filter	MSE VALUES	PSNR values
Wiener filter	18.98	35.38
Median filter	45.66	31.57
Average filter	264.83	09.55

Here in the second wiener filter shows the best result with 18.98 MSE and PSNR has 35.38values.Same as image 3 are performed with metrics

Table 3.Image quality parameters of image 3

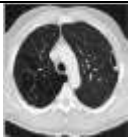
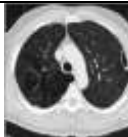
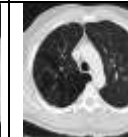
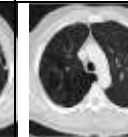


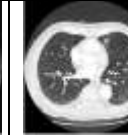
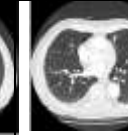



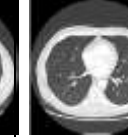
Filter	MSE VALUES	PSNR values
Wiener filter	7.59	39.36
Median filter	22.56	34.63
Average filter	588.06	10.47

Here, in the third image wiener filter shows the best result with 7.59 MSE and PSNR 39.36 values. Finally the three images are applied to three filters and find out the metrics values which are high in MSE and low in PSNR.

Performance Evaluation

The images are shown with the original image and three filters. The table is shown below (Table 4)

Table 4. Result of filtering images

	Original image	Average filter	Median filter	Wiener filter
Images1				
Images 2				
Images 3				

3. CONCLUSION

In this paper various filters were analyzed and experimented with the CT images. The main aim of preprocessing is to remove the noises and other artifacts from the medical images and to make better enhancement. In order to select the better filter the experimentation has been made with the various filters and the results are compared. The results show that the techniques used in this system were efficient enough to find the best filter using the performances metrics. So we select wiener filter for using the lung CT image preprocessing.

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BIOGRAPHIES


D.Yasmeeen received the B.sc degree in Computer Science from MS University in 2012 and M.sc degree in Computer Science from MS University in 2015. She is currently pursuing the M.phil degree in Computer Science. Her research interest mainly include domain of digital image processing.



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