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Study of Noise and Filtering Techinques in Medical Images

Bhausaheb Shinde*
Head, Department of Computer Science
R.B.Narayanrao Borawake College, Shrirampur
Affiliated to Pune University, Maharashtra, India
Shinde.bhausaheb@gmail.com

Dnyandeo Mhaske
Principal and Head
Department of Zoology
R.B.Narayanrao Borawake College, Shrirampur
Affiliated to Pune University, Maharashtra, India

Machindra Patare
Department of Zoology
R.B.Narayanrao Borawake College, Shrirampur
Affiliated to Pune University, Maharashtra, India

A.R. Dani
Head, Department of Computer Science
International Institute of Information Technology, Hinjwadi,
Pune, Maharashtra, India

Abstract: Abstract: Image enhancement techniques are used to improve an image, where "improve" is sometimes defined objectively. i.e increase the signal to noise ratio and sometimes subjectively i.e. make certain features easier to see by modifying the intensities. Main objective are a) Various techniques for noise removal. b) Periodic noise reduction by frequency domain filtering c) Detecting of noise by selecting the region of interest.

Keywords: ROI-Region Of Interest, MRI– Magnetic Resonance imaging, MF- Median Filtering, AF-Adaptive Filtering, Average Filtering

I. INTRODUCTION

A. Noise Removal:

Digital images are prone to a variety of types of noise. There are ways that noise can be introduced into an image, depending on how the image is created. For example:

a) If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise can also be result of damage to the film, or be introduced by the scanner itself.
b) If the image is acquired directly in a digital format, the mechanism for gathering the data can introduce noise.
c) Electronic transmission of image data can introduce noise [1].

There are various ways to remove or reduce noise in an image. Different methods are better for different kinds of noise. The methods available include:

i. Linear filtering
ii. Median filtering
iii. Adaptive filtering

a. Linear Filtering:

You can use linear filtering to remove certain types of noise. Certain filters, such as averaging or Gaussian filters, are appropriate for this purpose. For example averaging filter is useful for removing grain noise from a photograph. Because each pixel gets set to the average of the pixels in its neighborhood, local variations caused by grain are reduced.

b. Median Filtering:

Median filtering is similar to using an averaging filter, in that each pixel is set to an 'average' of the pixel values in the neighborhood of the corresponding input pixels.

However with median filtering, the value of an output pixel is determined by the median of the neighborhood pixels, rather than the mean. The median is much less sensitive than the mean to extreme values. Median filtering is therefore better able to remove this outlier without reducing the sharpness of the image [2].

The medfilt2 function implements median filtering. The example below compares using an averaging filter and medfilt2 to remove salt and pepper noise. This type of noise consists of random pixels being set to black or white (the extremes of the data range). In both cases the size of the neighborhood used for filtering is 3 by 3.

c. Max and Min filter:

The median filter is by far the order-statistics filter most used in image processing; it is by no mean the only one. Max filter, given by

$$\hat{f}(x, y) = \max_{(s, t)\in S_{xy}} \{g(s, t)\}$$

This filter is useful for finding the brightest points in an image. Also, because pepper noise has very low values, it is reduced by this filter as a result of the max selection process in the sub image S_{xy}.

The 0 th percentile filter is the min filter.

$$\hat{f}(x, y) = \min_{(s, t)\in S_{xy}} \{g(s, t)\}$$

This filter is useful for finding the darkest points in an image. Also, reduces salt noise as a result of the min operation.

d. Mid Point Filter:

The midpoint filter simply computes the midpoint between the maximum and minimum values in the area encompassed by the filter. This filter combines order statistics and averaging. This filter works best for random distributed noise like Gaussian or uniform noise[3]

e. Alpha-trimmed mean filter:

Suppose that we delete the d/2 lowest and d/2 highest gray-level values of g(s, t) in the neighborhoods Sxy. Let g_r (s, t) represent the remaining mn –d pixels. A filter formed by averaging these remaining pixels is called an alpha trimmed mean filter[3].

$$\hat{f}(x, y) = \frac{1}{mn - d} \sum g_r(s, t)$$

If we choose d = (mn -1)/2 the filter becomes median filter.

f. Adaptive Filtering:

The wiener2 function applies a Wiener filter which is a type of linear filter to an image adaptively, tailoring itself to local image variance. Where the variance is large, wiener2 performs little smoothing. Where the variance is small, wiener2 performs more smoothing. This approach often produces better result than linear filtering. The adaptive filter is more selective than a comparable linear filter, preserving edges and other high frequency parts of an image. In addition, there are no design tasks; the wiener2 function handles all preliminary computations, and implements the filter for an input image. Wiener2, however, does require more computations time than linear filtering. Wiener2 works best when the noise is constant-power ("white") additive noise, such as Gaussian noise.

g. Adaptive median filter:

Adaptive median filtering can handle impulse noise with probabilities. The adaptive median filter is that it seeks to preserve detail while smoothing non impluse noise, something that the traditional median filter does not do[4].

B. Periodic Noise Reduction by Frequency Domain Filtering:

We discuss the more specialized band reject, band pass and notch filter as tools for periodic noise reduction or removal.

a. Bandreject Filters:

Bandreject filters remove or attenuate a band of frequencies about the origin of the Fourier transform. One of the principal applications of band reject filtering is for noise removal in application where the general locations of the noise a component(s) in the frequency domain is approximately know

b. Bandpass Filters:

A bandpass filter performs the opposite operation of bandreject filter. Performing straight bandpass filtering on an image is not a common procedure because it generally removes too much image detail. Bandpass filtering is quite useful in isolating the effect on an image of selected frequency bands.[5]

c. Notch Filters:

A notch filter rejects or passes frequencies in predefined neighborhoods about a center frequency. Notch filter must appear in symmetric pairs about the origin in order to obtain meaningful result. The one exception to this rule is if the notch filter is located at the origin, in which case it appears by itself.

C. Mean Filters:

In this section we discuss briefly the noise reduction spatial filters introduced and develop several other filters whose performance is in many cases superior to the filters.[6]

a. Arithmetic Mean Filter:

This is the simplest of the mean filters. The arithmetic mean filtering process computes the average value of the corrupted image g (x, y) in the area defined by Sxy.

$$\hat{f}(x, y) = 1/mn \sum_{(s,t) \in Sxy} g(s, t)$$

This operation can be implemented using a convolution mask in which all coefficients have value 1/mn.

b. Geometric Mean Filter:

An image restored using a geometric mean filter is given by expression

$$\hat{f}(x, y) = \prod_{(s, t) \in Sxy} g(s, t)$$

Here, each restored pixel is given by the product of the pixel in the sub image window, raised to the power 1/mn.

c. Harmonic Mean Filter:

The harmonic mean filter works well for salt noise, but fails for pepper noise. It does well also with other types of noise like Gaussian noise.

d. Methodology:

a) Detecting of Noise:

The detecting of noise in image will take crucial role in digital image processing; the detection is done through selecting a region of interest. Noise parameters must be estimated directly from a given noisy image or set of images. The approach to select a region in an image with as featureless a background as possible, so that the variability of intensity values in the region will be due primarily to noise. To select a region of interest (ROI) in MATLAB we use the function roipoly, which generates a polygonal ROI. Use roipoly to select a polygonal region of interest within an image. Roipoly returns a binary image that you can use as a mask for masked filtering[7].

b) Selecting a Polygon:

We use the roipoly function to specify a polygonal region of interest. If we call roipoly with no input arguments, the cursor changes to crosshairs when it is over the image displayed in the current axes. You can then specify the vertices of the polygon by clicking points in the image with the mouse. When you are done selecting vertices, press Return; roipoly returns a binary image of the same size as the input image, containing 1's inside the specified polygon, and 0's everywhere else.[8].

The example below illustrates using the interactive syntax of roipoly to create a binary mask. In the figure, the border of the selected region that was created using a mouse.

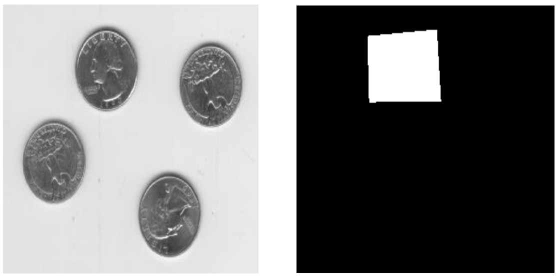
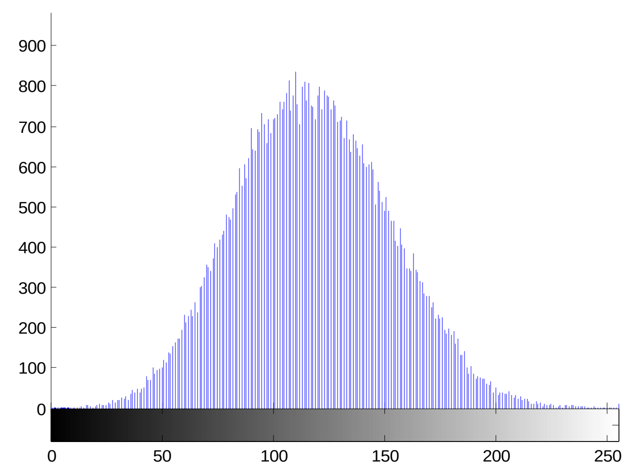
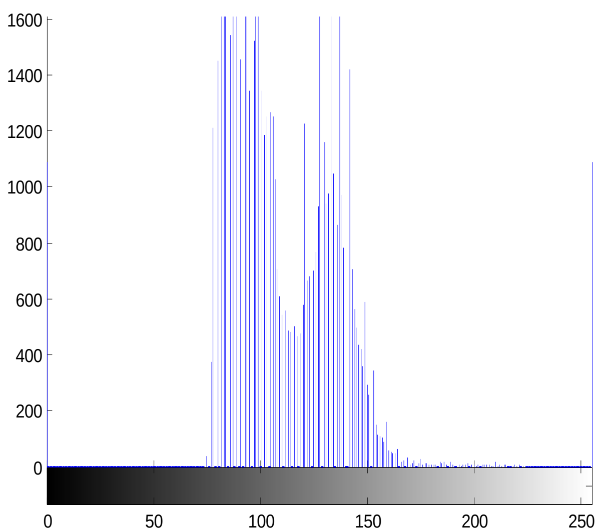


Figure 3.1.1 shows the original image and region of interest selected by using mouse.

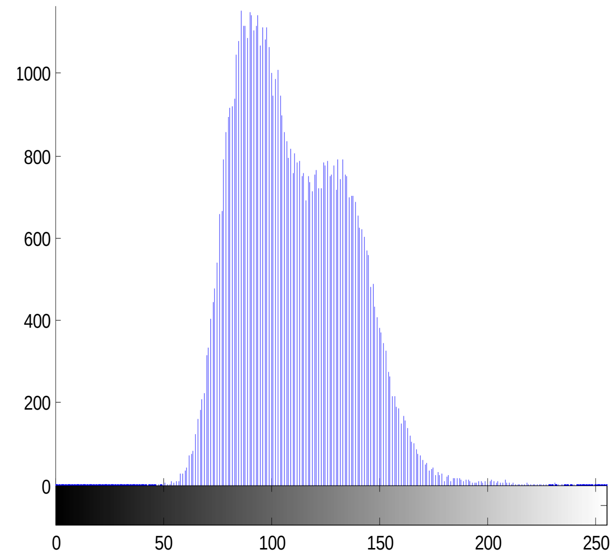
Once the region of interest selected find out the histogram of the same and match the histogram of different noise. Below figure shows noise pattern of various noise.[9]



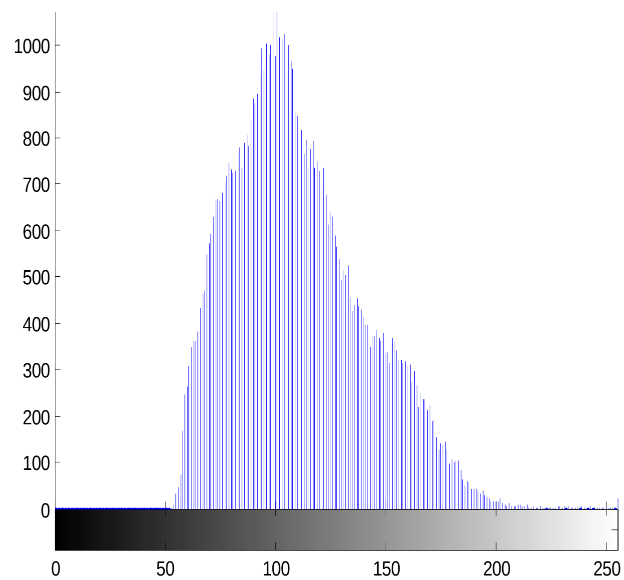
(a)Gaussian noise histogram



(b) salt & pepper noise histogram



(C) Poisson noise histogram



(d) Speckle noise

Figure. 3.2.1shows histogram for Gaussian, salt & pepper, Possion and speckle noise

II. DISCUSSION

As per discussed in chapter4 Different medical images like MRI, Cancer, x-ray and brain images have been studied. After finding the Gaussian noise in MRI image the various filtering techniques like Median filter, Adaptive filter and Average filter have been applied [10].

From the above discussion it is observed that Adaptive filter does better for noises and median filter does better for some noises. So we can say that there are no filtering techniques which will work better for all types of noises like gaussian noise, salt and pepper nosie, speckle nosie and Poisson noise.

III. CONCLUSION

In this work we have taken different medical images like MRI, Cancer, X-ray and Brain for detecting noises. We have detected various noises like Gaussian, Salt & Pepper, Speckle, and Poisson and also removed these noises from the above medical images by applying the various filtering techniques like Median Filtering, Adaptive Filtering and Average Filtering. The results are analyzed and compared with standard pattern of noises and also evaluated through the quality metrics like Mean, and Standard deviation.

This experimental analysis will improve the accuracy of MRI, Cancer, X-ray and Brain images for easy diagnosis. The results, which we have achieved, are more useful and they prove to be helpful for general medical practitioners to analyze the symptoms of the patients with ease.

IV.ACKNOWLEDGMENT

Shinde Bhausaheb: I have completed my M.C.S.(Master Of Computer Science), M.Phil. Also Register to Ph.D. I am working in R.B.N.B. College as Head of Computer Science Department having 12 years of expert as well as Lecturer experience

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