Noise Reduction in Images using Enhanced Average Filter

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ABSTRACT
Noise Reduction is an important block in the image processing system. The main problem in image processing is to find the suitable method for reducing noise presented in the captured image.The extent of noise reduction is directly proportional to the quality of the image produced.In this paper, we introduce some basic noise types, traditional noise reduction methods and a proposed method to reduce the Gaussian, Salt and Pepper noise from the PGM images.The proposed methodology discussed here is specially developed to reduce impulse noises efficiently than average or median filter.There are various methods for enhancing the image that is degraded by noise like average filter, median filter and fuzzy filter.This paper is based on the enhanced average filter that gives better result than simple average filter.

General Terms:
Algorithms, Filters.

Keywords:
Noise Reduction, Images, PGM Images.

1. INTRODUCTION
Noise reduction is the process of reducing noise from a digital image. The main purpose of reducing noise is to enhance the quality of an image.All the noise reduction techniques are equivalent in a conceptual manner, no matter what image is being processed, however the approach for implementing these methods may vary with the pre knowledge of the properties of the images taken into account. In the spatial domain, filtering depends on location and its neighbors. In the frequency domain, filtering multiplies the whole image and the mask. Some filters operate in spatial domain, some filters are mathematically derived from the frequency domain to spatial domain, other filters are designed for special noise, combination of two or more filters, or derivation from other filters. Generallyimages are degraded with the noise when they are transmitted or during image acquisition process. Mostly, images are corrupted with an impulsive noise. This impulsive (bipolar) noise is called salt & pepper noise. Salt & Pepper noise is a special case of impulsive noise, where a certain percentage of individual pixels in digital image are randomly digitized into two extreme intensities, that is, the maximum and the minimum intensities [1]. The occurrence of salt &pepper noise can severely damage the information or data embedded in the original image. So, before subsequent image processing tasks such as edge detection or segmentation is carried out, this type of noise must be removed.

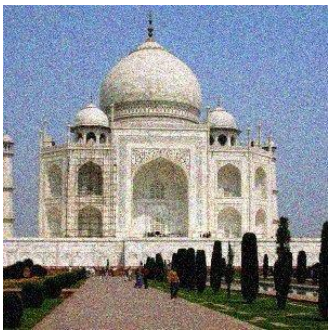

Fig 1.1 Image with noise

Fig 1.2 Original Image

The basic filters used for filtering are:

a. **Average Filter**
b. **MedianFilter**
c. **Fuzzy Filter**

This paper consists of only first two types of filtering methods of the above and a proposed enhanced average filter.

Some important terms related to filtering methods are described below:

1.1 PGM Images

PGM format is just similar to grayscale file format. These type of images are very easy to learn .It can easily be described in programming language. A PGM image is a grayscale image. Many pseudo PGM formats are used normally where everything is inherit except the meaning of each value of every pixels. In most of the applications, PGM images is the array of arbitrary integers.All the programs which they are thinking that they are processing a graylevel image, they get turned into something else.

The name "PGM" is an acronym derived from "Portable Gray Map."

The PGM images are a unique and different type of extensions used for the pictures. These types of images are being used in our project. Our project basically deals with only the gray scale pictures, gray scale pictures are nothing but black and white images, just for information. PGM format is a standard bit map based format contains 4 lines header,and the information is stored in unsigned char datatype with a 8 bit data per pixel or maximum 256 gray scale levels.

.The header of a PGM image file consists of:

- **a.** First line containing the **signature** of the image file and identifies the file as PGM
- **b.** Second line is the **comment line**
- **c.** Third line provides information about the **number and rows and columns** of data stored in the file, and
- **d.** Fourth line specifies**maximum gray level**contained in the image

1.2 Noises

1.2.1 Gaussian Noise

In Gaussian noise, the value of each pixel gets changes by a small amount from its original value. A histogram is a graphical representation of the data distribution. It represents the frequencies shown by the rectangles, having an area equal to the frequency of observations .The total area of the histogram is equal to the number of observations. The histogram shows a normal noise distribution. The Gaussian model is a good model because of the central limit theorem which states that the sum of all different noises represents Gaussian distribution.

1.2.2 Salt and Pepper Noise

The salt and pepper noise is a type of impulse noise. It is a noise which is seen mostly in images. It contains black pixels on white background and white pixels on black background[11].One important feature of this noise is the weight or value of the noisy pixel has no connection or relation with the color of the neighbor pixels. This type of noise generally affects a little rangeof image pixels. When this type of pixel is viewed, it looks like black and white dots. Sources of this type of noise are dust in the camera and overheated or defective elements.

2. METHODS

2.1 Average Filter

Average or mean filter is the most simple and the easiest method to implement the smoothing of images i.e.minimizing the extent of intensity variation among neighboring pixels. It is also used to minimize noise in images frequently. In this methodthe filtering concept is to replace the processing pixel element value in an image matrix with the average value of its neighborsincluding itself. Repeatedly it removes those pixel values which are not representing their surroundings. Average filter is somewhat equivalent to the convolution filter.This filter also relies on kernel to represent the shape and size of the vicinity to be sampled while mean is calculated. 3X3 square kernel is frequent in practice ,however in the cases where the demand of high smoothing comes one can use larger kernels like 5X5, 7X7 etc.

Average Filter reads the input image and sets the image header information for the output image. It applies the smoothing algorithm and sets the output image as input for the next iteration if it's not the last iteration and writes the output image after completion of all the iterations.

The mean algorithm works by adding all the surrounding or neighbor pixel values and takes the mean or average of those values. The resulting value is placed in the central pixel.

Code snippet for mean:

```
int tsum=inval;
for(int k=0;k<8;k++)
tsum=tsum+neighbour[k];
int outval=tsum/9;
imgout.setPixel(r,c,outval);
```

Computing the straightforward convolution of an image with this kernel carries out the mean filtering process.

5 + 3 + 6 + 2 + 1 + 9 + 8+ 4 + 7 = 45.

45 / 9 = 5.

Center value (previously 1) is replaced by the mean of all nine values (5).

2.2 Median Filter

The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, median filter is much better than mean filter as it preserves the important details of the image such as edges. The median filter works like a mean filter only. It considers each pixel of the image and checks whether that particular pixel is the representative of its nearby neighbors or not. Instead of replacing the value of the pixel with the mean of its neighbor pixel values. It replaces by the median of the neighbor pixel values[12].

The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. If the neighbors of the center pixel are in even number then the mean of the two middle pixel values are used.

Neighbor values-115,119,120,123,124,125,126,127,150

Average value-124

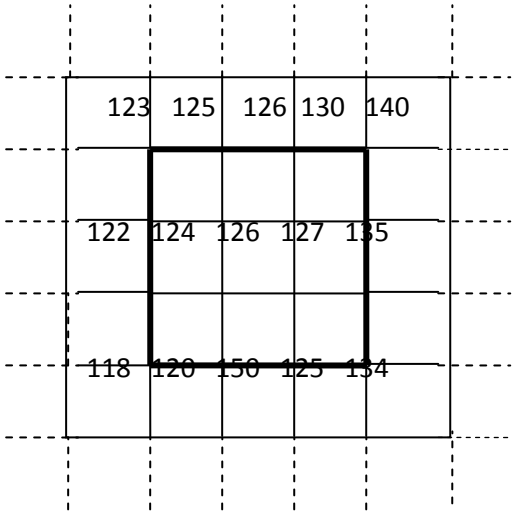

Fig-2 Calculating the median value of a pixel neighborhood. As can be seen the central pixel value of 150 is rather unrepresentative of the surrounding pixels and is replaced with the median value: 124.

2.3 Enhanced Average Filter

Average Filter discussed earlier is simple and very easy to implement. If the method of average filter is changed by certain measures, the result of average filter is improved up to a certain extent.

Here, we are modifying the average filter to reduce the noise associated with the given image.

3. Proposed Methodology

The pseudo code of the enhanced average filter is given below:

Unfiltered Values			Mean Filtered		
5	3	6	*	*	*
2	1	9	*	5	*
8	4	7	*	*	*

Fig-3 Unfiltered values and mean filter

- First, calculate the average of neighbors of the pixel to be processed.

Average=|_ (sum of neighbors)/ (no. of neighbors) _|

- Now find the value of MN and MX, where MN and MX are defined as:

MIN=abs (average - minimum value pixel in the neighbor)
MAX=abs (maximum value pixel in the neighbor - average)

MN=|_MIN/2_|

MX=|_MAX/2_|

- Then calculate the pixel value by using formula:

If (MX<MN)

Pixel value=AVG - MN

Elseif (MN<MX)

Pixel value=AVG + MX

Elseif (MN=MX)

Pixel value=AVG

Now replace the original value of pixel by the calculated pixel value.Here,

abs () : is used to calculate the **absolute** value.

|_ _|: is used to calculate the **floor** value.

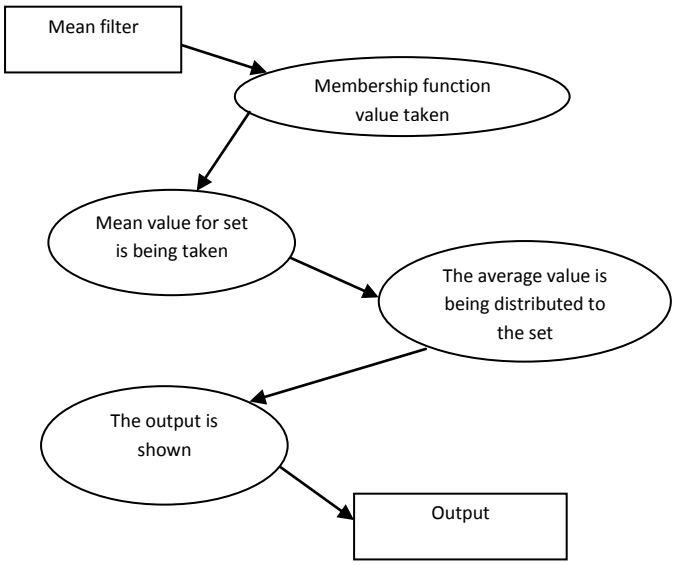

Fig-4 DFD of Methodology

4. ARCHITECTURE USED

This project is based on MVC architecture as java uses this architecture.

Model–view–controller (**MVC**) is a software pattern for implementing user interfaces. It divides a given software application into three interconnected parts, so as to separate internal representations of information from the ways that information is presented to or accepted from the user. The central component, the *model*, consists of application data, business rules, logic, and functions. A *view* can be any output representation of information, such as a chart or a diagram. Multiple views of the same information are possible, such as a bar chart for management and a tabular view for accountants. The third part, the *controller*, accepts input and converts it to commands for the model or view.

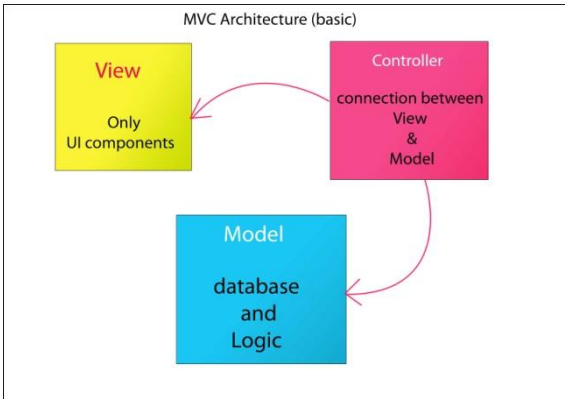

Fig-5 Architecture of MVC

5. FUTURE ENHANCEMENT

The future enhancement of this project can be that it can be integrated with the downloading systems that download the images from the internet and apply the filters with the consent of the user and provide a better image to the user. As some of the images can be distorted due to loss of certain packets in the network due to congestion or other common network related problems.

This project can also be updated and made a little more accurate with use of other complex technologies and methodologies and implemented for use of analyzing the satellite imagery. The various unwanted things that appear in the satellite imagery like the clouds, fog, rain, etc., can be removed and a clear image with the clear view of the edges of land and other natural features clearly visible.

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