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COMPARATIVE STUDY OF IMAGE ENHANCEMENT USING MEDIAN AND HIGH PASS FILTERING METHODS

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Abstract- Image Enhancement is one of the important aspects of image processing to improve the interpretability of the information present in images for human viewers. Filter techniques are mainly used for smoothness and sharpening of images and extracting the useful information for the analysis for image processing. In this paper a comparative study of filters such as median filter and spatial domain high-pass filter is discussed. Median filter is useful tools in order to reduce random occurrence of black and white pixels in image termed as salt-and-pepper noise while high-pass filtering is used to perform image sharpening. Results is simulated on matlab 7.0.1 environment which shows that the median filter is an effective tool to minimize salt-and-pepper noise while other will enhance the image through image sharpening.
Keywords- Spatial Domain, Transform Domain, Median Filter, High-boost Filtering, Unsharp Masking, MATLAB.

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Introduction

The objective of image enhancement is to improve the quality of image as perceived by a human beings through an enhancement algorithms. Image enhancement can be performed both in the spatial domain as well as in time domain. In spatial domain method median filter is used which works on pixel values of the images. The high-pass filter will works on high-frequency components of images. An enhancement algorithm is one that yields a better-quality image for the purpose of some particular application which can done by either suppressing the noise or increasing the image contrast. Image enhancement algorithms are employed to emphasize, sharpen or smoothen the image features for display and analysis. Enhancement methods are application specific and are frequently developed empirically. Image enhancement techniques emphasize specific image features to improve the visual perception of an image. Image-enhancement techniques can be classified into two broad categories as:

Spatial domain method

Spatial domain techniques deals with the manipulation of pixels values.

Transform domain method

The transform domain method operates on the Fourier transform of an image and then transform it back to the spatial domain.
Organization of paper is as follows: Median filter and calculation of median value is discussed in section-II , Spatial domain high pass filter is discussed in section-III, Section-IV and V shows the outputs of proposed median filter and spatial domain high-pass filter using MATLAB, finally section-VI gives the conclusion and result of the proposed scheme.

Median Filter

Median filters are statistical non-linear filters[3] that are often described in the spatial domain. A median filter smoothens the image by utilizing the median of the neighborhood. Median filter performs the following tasks to find each pixel value in the processed image:

- All pixels in the neighborhood of the pixel in the original image which are identified by the mask are stored in the ascending (or) descending order.
- The median of the stored value is computed and is chosen as the pixel value for the processed image.

Calculation of Median Value

Median value is calculated by eliminating the pixel values which are very different from their neighboring pixels. By eliminating the effect of such odd pixels, the values are assigned to the pixels that are representative of the values of the typical neighboring pixels in the original image. The median value of the marked pixel is computed as follows:

Let the 3x3 mask data is:

$$\begin{pmatrix} 1 & 5 & 7 \\ 2 & 4 & 6 \\ 3 & 2 & 1 \end{pmatrix}$$

Step 1: First, the pixel values are arranged in ascending order as-

1 1 2 2 3 4 5 6 7

Step 2: The median value of the ordered pixel is computed as follows:

~~1~~ ~~1~~ ~~2~~ ~~2~~ 3 ~~4~~ ~~5~~ ~~6~~ ~~7~~

The median value is computed to be 3. Then, the original pixel value of 4 will be replaced by the computed median value of 3.

Let the input image is given in the form

$$\begin{pmatrix} 18 & 22 & 33 & 25 & 32 & 24 \\ 34 & 128 & 24 & 172 & 26 & 23 \\ 22 & 19 & 32 & 31 & 28 & 26 \end{pmatrix}$$

Here the goal is to compute the median values of the marked pixels and replace the pixels 128, 24, 172 and 26 by their median values of the neighborhood defined by the mask. The mask to be used is a 3 x 3 mask.

Step I: To compute the median value of the marked pixel 128.

$$\begin{pmatrix} 18 & 22 & 33 & 25 & 32 & 24 \\ 34 & 128 & 24 & 172 & 26 & 23 \\ 22 & 19 & 32 & 31 & 28 & 26 \end{pmatrix}$$

Step 1a: The nine neighbors of the marked pixel '128' are now arranged in ascending order as follows:

18 19 22 22 24 32 33 34 128

Step 1b: The median value is computed as **24**.

~~18~~ ~~19~~ ~~22~~ ~~22~~ 24 ~~32~~ ~~33~~ ~~34~~ ~~128~~

Step 3:To compute the median value of the marked pixel 172

Step 3a: Arrange the pixels in the neighborhood of 172 in the ascending order.

$$\begin{pmatrix} 18 & 22 & 33 & 25 & 32 & 24 \\ 34 & 128 & 24 & 172 & 26 & 23 \\ 22 & 19 & 32 & 31 & 28 & 26 \end{pmatrix}$$

After arranging the pixel values in the neighborhood in the ascending order , we have

24 25 26 28 31 32 33 172

Step 3b: The median value is computed as **31**

~~24~~ ~~25~~ ~~26~~ ~~28~~ 31 ~~32~~ ~~33~~ ~~172~~

Step 4: To compute the median value of the marked pixel 26

Step 4a: Arrange the pixels in the neighborhood of **26** in the ascending order:

$$\begin{pmatrix} 18 & 22 & 33 & 25 & 32 & 24 \\ 34 & 128 & 24 & 172 & 26 & 23 \\ 22 & 19 & 32 & 31 & 28 & 26 \end{pmatrix}$$

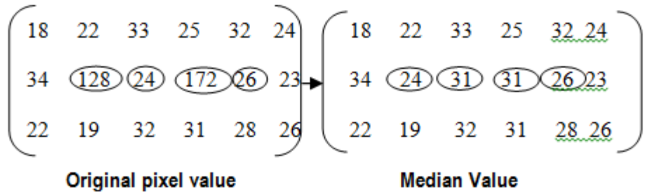
After arranging the pixel values in the neighborhood in the ascending order, we have

23 24 25 26 26 28 31 32 172

Step 4a: The median value is computed as **26**.

~~23~~ ~~24~~ ~~25~~ ~~26~~ 26 ~~28~~ ~~31~~ ~~32~~ ~~172~~

The original pixel values and the values replaced by their median are shown below



From the above illustration it is clear that the pixel value '128' is replaced by the median value 24 and the pixel value '172' is replaced by the median value 31. Here, the values 128 and 172 are entirely different from their neighboring pixels. When we take the median value, the pixel values which are very different from their neighboring pixels are replaced by a value equal to the neighboring pixel value. Hence, a median filter is capable of reducing salt-and-pepper noise. Here, salt corresponds to the maximum gray value (white) and pepper corresponds to the minimum gray value (black). Random occurrence of black and white pixels in an image is generally termed 'salt-and-pepper' noise. A median filter is an effective tool to minimize salt-and-pepper noise.

Spatial domain high-pass filtering

High-pass filtering[5],[9],[10] is used for sharpening the image. The objective of high-pass filtering or image sharpening is to high light fine details in the image through enhancing the high frequency components. The spatial filter or spatial mask which performs image sharpening is given below:

The spatial mask which performs image sharpening is given as

$$1/9 \times \begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

The sum of all the weights is zero; this implies that the resulting signal will have zero dc value.

High-boost Filtering

A high-boost filter[2] is also known as a high-frequency emphasis filter. A high-boost filter is used to retain some of the low-frequency components to aid in the interpretation of an image. In high-boost filtering input image f(m, n) is multiplied by an amplification factor A before subtracting the low-pass image. Thus, the high-boost filter expression becomes-

High boost = A x f(m, n) – low pass

Adding and subtracting 1 with the gain factor, we get

High boost = (A - 1) x f(m, n) + f(m, n) - low pass

But f(m, n) – low pass = high pass

High boost = (A -1) x f(m, n) + high pass

Unsharp Masking

Unsharp masking[1],[7] is one of the techniques typically used for edge enhancement. In this approach, a smoothened version of the image is subtracted from the original image; hence, tipping the image balance towards the shaper content of the image. The procedure to perform unsharp masking is given below:

- Blur filter the image.
- Subtract the result obtained from step 1 from the original image.
- Multiply the result obtained in step 2 by some weighting fraction.

Add the result obtained in step 3 to the original image.

Mathematically, the unsharp masking operation is given by

$$f'(m, n) = f(m, n) + \alpha[f(m, n) - f(m, n)]$$

where f(m, n) is the original image,

f(m, n) is the blurred version of the original image,

α is the weighting fraction, and

f'(m, n) is the sharpened result.

Output of Median Filtering

The output of median filtering is shown in fig 1

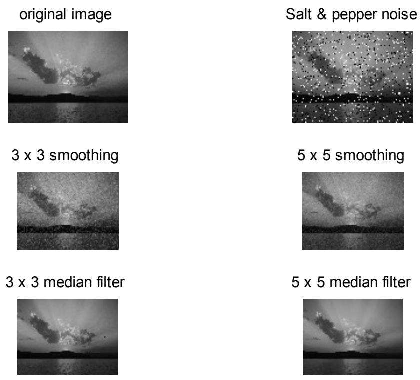


Fig. 1

OUTPUT OF UNSHARP MASKING

The output of unsharp masking is shown in the fig 2 and the original image is shown in fig 3

Fig. 2 and 3

Result and Conclusion

In this paper we have proposed the Median filter and High-pass filter techniques for image enhancement, The outputs of the proposed techniques have been complied in Matlab 7.0.1 environment. It is concluded that median filter is effective tool to remove the random while occurrence of salt-and-pepper noise and unsharp masking will perform the edge enhancement.

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