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A New Approach for Image De-Noising with Fuzzy Filtering Technique using Centroid Method

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***Abstract*— In this paper a new approach for image denoising is introduced, that uses area and centroid method. It preserves any type of edges (including tiny edges) in any direction. By using this method either color or black & white image is denoised.Various types of median filters are present in literature like standard median filter, weighted median filter, switching median filter, progressive switching median filter (PSMF) and Signal-dependent rank-ordered mean filter (SDROMF), adaptive centre weighted median (ACWM).But Fuzzy-Median filters have great importance in digital image processing. For preserving the actual data from median filtered output image centroid method is applied.**

Keywords*— *Median Filter, Image Denoising, Edge Preservation

I. Introduction

Whenever an image is converted from one form to another, such as, digitizing, scanning, transmitting, storing, etc., some degradation occurs at the output. Hence, the output image has to undergo a process called image enhancement. Fuzzy image processing is the collection of all approaches that understand, represent and process the images, their segments and features as fuzzy sets. The representation and processing depend on the selected fuzzy technique and on the problem to be solved. The idea of fuzzy sets is simple and natural. For instance, we want to define a set of gray levels that share the property dark. In classical set theory, we have to determine a threshold, say the gray level 100. All gray levels between 0 and 100 are element of this set: the others do not belong to the set. But the darkness is a matter of degree. So, a fuzzy set can model this property much better. The basis for fuzzy logic is the basis for human communication. This observation underpins many of the other statements about fuzzy logic. Because fuzzy logic is built on the structures of qualitative description used in everyday language, fuzzy logic is easy to use. A filtering system needs to be capable of reasoning with vague and uncertain information, this suggests the use of fuzzy logic.

In many data acquisition,transmission and storage systems,images are often corrupted by noise.Noise is often inevitable as caused by various factors. For example, failures in sensors, readout circuits,A/D converters,or communication channels may introduce impulsive noise in digital images [16].In the literature various methods have been introduced for impulse noise removal. One of the most popular methods for impulse noise removal is the median filtering method. Different kinds of median filters have been developed.

The standard median filter [3, 9] reduces noise reasonably well, but in the process some information is also lost at low noise densities. The weighted median filter [4,3] and the centre-weighted median filter have been proposed to avoid the inherent drawbacks of the standard median filter by controlling the tradeoff between the noise suppression and detail preservation. Switching median filter is like an impulse detector. It replaces the corrupted centre pixel with the output of the median filter, if centre pixel is identified as corrupted by this filter. Otherwise it is left unchanged. But fuzzy median filters have lot of importance in digital image processing.

II. Proposed Method

If any image is transmitting, then some noise is added during transmission due to improper channel, atmospheric disturbance, relative motion between camera and objects [2] or any other reason. For removing noise from the image following method is used:-

step1: Let input of median filter $=X(i, j, k)$ (1)

Output of median filter $=Y_1(i, j, k)$ (2)

The median filter uniformly replaces the central pixel of a window (W) by the median of the pixels bounded by predefined window (W) size $w \times w$. The output of the median filter [3, 4, 5, and 6] is given by

$$Y_1(i, j, k) = \text{median}\ \{ X(i-s; j-t; k-v) : (s,t,v) \in W \}$$
$$\text{and } W = \{(s, t): -n \le s, t \le n\}$$

consider n=1

step2: The pixel values of the neighborhood pixels of (i,j,k) of original image are sorted in some specific order.

Step3: The Fuzzy membership[3, 8,7,10,9] value is assigned for each pixel in a window of w×w size using some suitable membership functions. The membership function used here is given below.

(i) A triangular shaped membership function is used.
(ii) The highest and lowest gray values get the membership value zero.
(iii) Assign the membership value 1 to the mean value of the gray level of the window of size w×w.

The triangular membership function, also called bell-shaped function with straight lines, can be defined as follows:

$$\mu(X;\alpha,\beta,\gamma) = \begin{cases} 0 & \text{if } X \leq \alpha \\ (X-\alpha)/(\beta-\alpha+1) & \text{if } \alpha < X \leq \beta \\ (\alpha-X)/(\beta-\alpha+1) & \text{if } \beta < X \leq \gamma \end{cases} \quad (3)$$

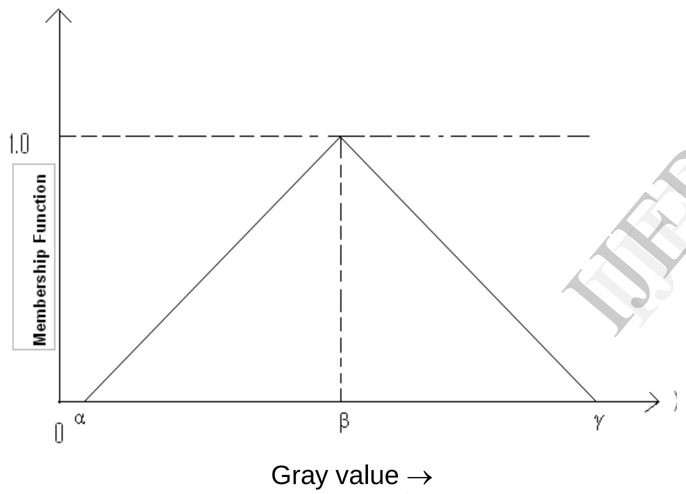


Figure 1: Triangular membership function

Step 4: Now de-fuzzyfy [3,8,10] the membership value using the Centroid method by the following formula, and select the output for that window. Let it be $Y_2(i,j,k)$ at the point (i,j,k*)* in the window of size w×w

$$Y_2(i,j,k) = \text{sum}(\text{Area} * \text{Centroid})/\text{sum}(\text{Area}) = \frac{\sum_X X\mu(i,j,k)}{\sum_X \mu(i,j,k)} \frac{\sum_X X\mu(i,j,k)}{\sum_X \mu(i,j,k)} \quad (4)$$

If we apply the above steps on the noisy image, noise would be removed. But the problem is, though the noises are represented as 0 and 255, so all 0 and 255 will also be removed; even of those were not noises. For preserving the actual data we pursues the following steps

Step 5: For the noisy pixel at the point (i,j,k), we compute p(i,j,k) and q(i,j,k) by the following formulas:

$$P(i,j,k) = |f(i,j) - \text{median}\{Lf(i,j,k)\}| \quad (5)$$

Here L(f(i,j,k)) is the 8-neighborhood of point (i,j,k).

$$Q(i,j,k) = \frac{|f(i,j,k) - fc1(i,j,k)| + |f(i,j,k) - fc2(i,j,k)|}{2} \quad (6)$$

Here fc1(i,j,k), fc2(i,j,k) are the closest values of f(i,j,k) in the filter window of size w×w.Then rearrange P(i,j,k) and Q(i,j,k) in ascending order for all i,j,k =0,1,2….

Step 6: Compute W(i,j,k)

$$W(i,j,k) = 1 - \frac{P(i,j,k) + k1}{P(i,j,k) + Q(i,j,k) + k2} \quad (7)$$

Here k1 and k2 are real quantity, which depends on the quality of the input images. Select the maximum W(i,j,k).

Step 7: If $Y_1(i,j,k) \neq Y_2(i,j,k)$

Then $Y_3(i,j,k) = W(i,j,k)Y_1(i,j,k) + (1 - W(i,j,k)Y_2(i,j,k))$ (8)

Else $Y_3(i,j,k) = Y_1(i,j,k)$

Step 8: Continue this process for all the pixels which are noisy.

III. FLOW CHART

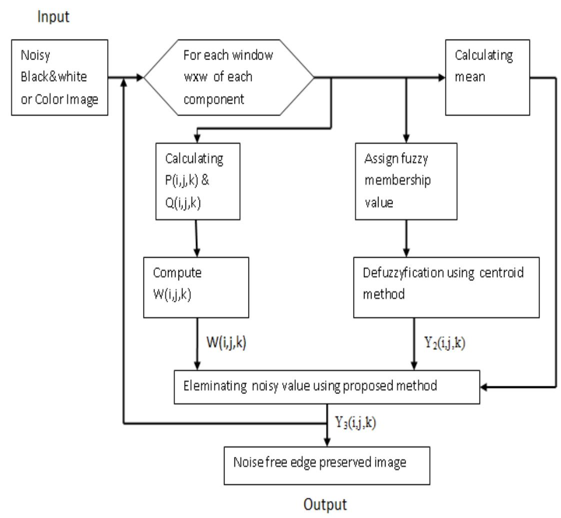


Figure 2

IV. EXPERIMENTAL RESULT

The proposed model is tested for removing fixed value impulse noise.Noise is added to the origional image.Then median filtered image (Y_1) is tested.

Median filtered image PSNR (Peak Signal to Noise Ratio) and MSE(Mean Squared Error) values are calculated.Now centroid method is applied to the median filtered output,thus (Y_3) is to be found,that is proposed method output.The PSNR and MSE are calculated for this output image.

$$PSNR = 10\log_{10}(\Sigma_K 255^2 / \Sigma_K ((d(k)-y(k))^2)$$

$$MSE = (1/MN)\Sigma_K ((d(k)-y(k))^2 \frac{1}{MN} \quad (9)$$

Where 255 is the peak pixel value of the image, d(k) represents the value of the desired output,and y(k) represents the value of the physical output.NxM is the number of processed pixel.

Proposed filter output is compared with median filter output.

Table 1: Experimental Resuts Of Different Images

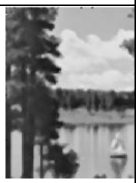
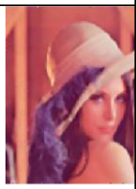
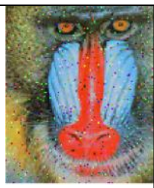
Image Name	Original Images	Noisy Images	Median Filter Output	Proposed Filter Output
CAMERA MAN				
HOUSE				
JET PLANE				
LAKE				
LENA				
LIVING ROOM				
MAN DRIL				

Table 2: PSNR Comparison Table

Image Name	PSNR for Median Filter (in dB)	PSNR Proposed filter (in dB)
CAMERAMAN	75.0848	75.0833
HOUSE	78.0595	78.0855
JETPLANE	74.6068	74.6198
LAKE	73.4275	73.4293
LENA	77.6623	77.6860
LIVINGROOM	75.0559	75.0858
MANDRIL	74.6206	74.6505

Table 3: MSE Comparison Table

Image Name	MSE for Median Filter	MSE Proposed filter
CAMERAMAN	0.0020	0.0020
HOUSE	0.0010	0.0010
JETPLANE	0.0022	0.0022
LAKE	0.0030	0.0030
LENA	0.0011	0.0011
LIVINGROOM	0.0020	0.0020
MANDRIL	0.0022	0.0022

V. CONCLUSION

This paper proposed a new approah for image denoising,which is based on area and centroid method.It preserves the tiny edges.The results are compared with the median filter by numerical measures and visual inspection.From the table 2 it is cncluded,that proposed method gives the best PSNR and table 3 gives the MSE of proposed method,which is less or same as the median filter MSE. Experimental results show,that proposed method gives the better result for each test image.

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