The Removal of Random Valued Impulse Noise Using Contrast Enhancement and Decision Based Filter

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***Abstract*—** Digital images are transmitted in noisy environment and it will frequently affected by impulse noise .To remove this noise from the image is a fundamental problem of image processing. There are various types of noise in an image especially salt and pepper noise and random valued impulse noise. This paper introduces a new filtering scheme based on contrast enhancement filter and decision based filter for removing the random valued impulse noise. The application of a nonlinear function to increasing the difference between noise pixels and noise-free and results in efficient detection of noisy pixels. As the performance of a filtering system, in general, depends on the number of iterations used, the effective stopping criterion based on noisy image characteristics to determine the number of iterations is also proposed. This proposed method removes only the corrupted pixel by its neighboring pixel values. As a result of this, the proposed method removes the noise effectively and preserves the edges without any loss up to 80% of noise level.

Keywords: *CBEF, Decision-based filter, Random valued impulse noise, and nonlinear filter*

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I. INTRODUCTION

The median filter is the most popular choice for removing the impulse noise from images because of its effectiveness and high computational efficiency[1]. However, when the median filtering is carried out for every pixel across the image, it modifies both noisy as sell as noise-free pixels. Consequently, some desirable details are also removed from the images. In order to overcome this drawback of median filter, many filtering algorithms with an impulse detector have been proposed. The performance of these filters is dependent on the capabilities of the detectors employed in the filtering schemes. In case of random valued impulse noise, the detection of an impulse is relatively more difficult in comparison with salt-and-pepper impulse noise. Hence, the performance of most of the filters is not good when the impulse noise is random-valued.

Images are often corrupted by noise in the process of image acquisition and transmission. Hence, an efficient denoising technique is very important for the image processing applications[3], [4]. Recently, many image denoising methods have been proposed to carry out the impulse noise suppression. Some of them employ the standard median filter or its modifications, to implement denoising process. However, these approaches might blur the image since both noisy and noise-free pixels are modified.

Contrast enhancement based filter is applied iteratively. The number of iterations required is decided by the stopping criterion. In general, the number of iterations varies from 2 to 6, depending upon the noise level and image characteristics. As a result of this, the proposed method removes the noise effectively up to 50% of noise level.

Decision based filter is proposed for restoration of images that are highly corrupted by random valued impulse noise[5].

II. LITERATURE SURVEY

Digital Image, a digital remotely sensed image is typically composed of picture elements (pixels) located at the intersection of each row i and column j in each K bands of imagery. Associated with each pixel is a number known as Digital Number (DN) or Brightness Value (BV) that depicts the average radiance of a relatively small area within a scene (Figure 1). A smaller number indicates low average radiance from the area and the high number is an indicator of high radiant properties of the area. The size of this area effects the reproduction of details within the scene. As pixel size is reduced more scene detail is presented in digital representation.

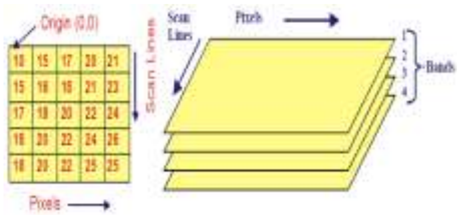

Figure1:Structure of a Digital Image and Multispectral Image

Color Composites, While displaying the different bands of a multispectral data set, images obtained in different bands are displayed in image planes (other than their own) the color composite is regarded as False Color Composite (FCC). High spectral resolution is important when producing color components. For a true color composite an image data used in red, green and blue spectral region must be assigned bits of red, green and blue image processor frame buffer memory. A color infrared composite ‘standard false color composite’ is displayed by placing the infrared, red, green in the red, green and blue frame buffer memory.

Image Rectification and Registration Geometric distortions manifest themselves as errors in the position of a pixel relative to other pixels in the scene and with respect to their absolute position within some defined map projection. If left uncorrected, these geometric distortions render any data extracted from the image useless. This is particularly so if the information is to be compared to other data sets, be it from another image or a GIS data set.

Rectification is a process of geometrically correcting an image so that it can be represented on a planar surface, conform to other images or conform to a map. That is, it is the process by which geometry of an image is made plan metric. It is necessary when accurate area, distance and direction measurements are required to be made from the imagery. It is achieved by transforming the data from one grid system into another grid system using a geometric transformation. Rectification is not necessary if there is no distortion in the image.

Image Enhancement Techniques Image enhancement techniques improve the quality of an image as perceived by a human[7]. These techniques are most useful because many satellite images when examined on a colour display give inadequate information for image interpretation. There is no conscious effort to improve the fidelity of the image with regard to some ideal form of the image. There exists a wide variety of techniques for improving image quality. The contrast stretch, density slicing, edge enhancement, and spatial filtering are the more commonly used techniques. Image enhancement is attempted after the image is corrected for geometric and radiometric distortions.

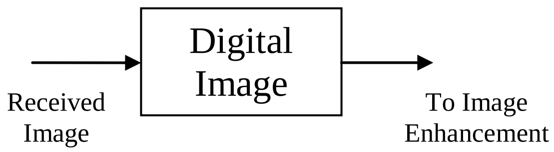

Figure 2. Digital Filter Stage

Noise reduction techniques are most often divided into two classes’ linear techniques, and nonlinear techniques. Linear processing techniques have been widely used in digital signal processing applications, since their mathematical simplicity and the availability of a unifying linear system theory make these techniques relatively easy to analyze and implement.

III. PROPOSED METHOD

A. CEBF:

CEBF is composed of three components; they are Impulse Detection, Image Filtering, and Stopping Criterion.

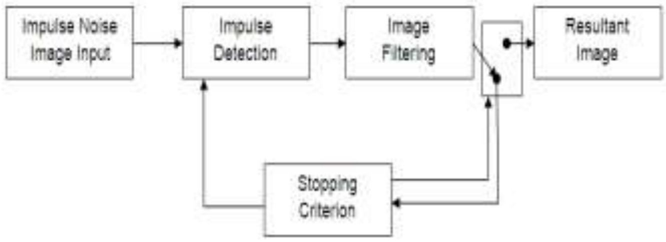

Figure 3: proposed method CEBF

The first block just reads an image which is affected by a Impulse Noise [6]. It could read any image format and without affecting the characteristics of the image it is directed to the Image Removal Block.

B. Impulse Detection:

The impulse detection is based on the assumption that a noise free image contains locally smoothly varying areas separated by edges. In an image contaminated by random valued impulse noise the detection of noisy pixel is more difficult in comparison with fixed valued impulse noise, as the gray value of noisy pixel may not be substantially larger or smaller than those of its neighbors[8].

In order to overcome this problem, we use a non linear function to transform the pixel values within filter window in a progressive manner [10]-[12].

C. Filtering:

Image filtering is a process by which we can images. A weighted filter is used when different pixels need to be given different importance in calculating the image. Since, a random valued noise is considered; a weighted filter is used in this project.

D. Stopping Criterion:

The detection and filtering operations are performed iteratively until the stopping criterion is satisfied. The number of iterations required for optimum performance of an image depends upon the image statistics and the noise percentage. Thus the stopping criterion is based on some image parameters. The last block is used to show the output image. The output image will be of same format and size of the input image. The only difference is the removal of noise in this block. This block gets the image from the FILTER block only if the Stopping Criterion is satisfied.

E. Impulse Detection and Filtering

The impulse detection is based on the assumption that a noise free image contains locally smoothly varying areas separated by edges. Let the image of size M x N has 8-bit gray scale pixel resolution, that is, I € [0,255]. In a (2L+1)x(2L+1) window $W^{(x)}(i,j)$ at location (I,j), the center pixel value is denoted as x(I,j), and L is an integer[9]. We assume the following impulse noise model, with noise probability p:

$$x(i,j) = \begin{cases} o_{ij}, \text{ with probability } 1-p \\ n_{ij}, \text{ with probability } p \end{cases}$$

Where o_{ij} and n_{ij} denote the pixel values at location (I,j) in the original uncorrupted image and the noisy image, respectively. The noisy pixel value, n_{ij}, is uniformly distributed between the minimal (0) and maximal (255) possible pixel values.

F. Decision based filter:

The proposed algorithm processes the corrupted image by first detecting the random valued impulse noise. The detection of noisy and noise free pixels is decided by checking whether the value of a processed pixel element lies between the maximum and minimum values that occur inside the selected window. If the value of the pixel processed is within the range, then it is a noisy pixel and is replaced by its neighborhood values.

IV. CODE IMPLEMENTATION USING MATLAB

A. SYNTAX

MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

- FPRINTF

  Write formatted data to file
  Syntax
  [count, errmsg] = fprintf(fid, format, A, ...)
  Image Processing Toolbox User's Guide
  Deblurring with the Lucy-Richardson Algorithm

- IMREAD

  Read image from graphics file
  Syntax
  A = imread(filename,fmt)
  Description
  The imread function supports four general syntaxes, described below. The imread function also supports several other format-specific syntaxes. See Special Case Syntax for information about these syntaxes.

- MSE

  Mean squared error performance function
  Syntax
  perf = mse(E,X,PP)
  perf = mse(E,net,PP)
  info = mse(code)
  Description
  mse is a network performance function. It measures the network's performance according to the mean of squared errors

- IMSHOW

  Display image
  Syntax
  imshow(I)
  imshow(I,[low high])
  imshow(RGB)
  imshow(BW)
  Description
  imshow(I) displays the grayscale image I.
  imshow(I,[low high]) displays the grayscale image I, specifying the display range for I in [low high]. The value low (and any value less than low) displays as black; the value high (and any value greater than high) displays as white. Values in between are displayed as intermediate shades of gray, using the default number of gray levels. If you use an empty matrix ([]) for [low high], imshow uses [min(I(:)) max(I(:))]; that is, the minimum value in I is displayed as black, and the maximum value is displayed as white. imshow(RGB) displays the truecolor image RGB.

A. PARTIAL CODE

- NOISE ADDITION

```
function output_image = randomnoise( input_image, spdensity )
PEPPER_VALUE = 0;
SALT_VALUE = 255;

I = rgb2gray(input_image);
[j k] = size(I);
```

```
n_pixels = j*k;
n_noisy_pixels = round(n_pixels * spdensity);
```

- NOISE FILTER

```
function[A,RI] = imgMaskMed(src_matrix,dim_matrix)

copy_matrix = src_matrix;
[X, y] = size (copy_matrix);
a = dim_matrix;
b = dim_matrix;

for j = 1:b
[a_temp, b_temp] = size (copy_matrix);
copy_matrix = vertcat (copy_matrix, copy_matrix (a_temp, :));
copy_matrix = vertcat (copy_matrix (1, :), copy_matrix) ;
copy_matrix = horzcat (copy_matrix, copy_matrix (:, b_temp));
copy_matrix = horzcat (copy_matrix (:,1), copy_matrix);
end
```

V. SIMULATION RESULTS

To assess the performance of proposed scheme, the standard gray-scale test images used in our expeiments have distinctly different features. The tested images are highly corrupted with random valued impulse noise. To evaluate the image restoration performance, PSNR is used as the criterion. The noise density in the noisy images is varied from 60% to 80%.

A. Enter the file name of an image : Onion.png
Iteration : 1
ROUGHNESS INDEX OF AN IMAGE : 30.739968
Iteration : 2
ROUGHNESS INDEX OF AN IMAGE : 3.359775
Iteration : 3
ROUGHNESS INDEX OF AN IMAGE : 2.267606
Iteration : 4
ROUGHNESS INDEX OF AN IMAGE : 2.115950
Iteration : 5
ROUGHNESS INDEX OF AN IMAGE : 2.060594
Iteration : 6
ROUGHNESS INDEX OF AN IMAGE : 2.028553
REACHED MAX THRESHOLD

B. **Enter the file name of an image : peppers.png**
Iteration : 1
ROUGHNESS INDEX OF AN IMAGE : 30.369915
Iteration : 2
ROUGHNESS INDEX OF AN IMAGE : 3.165532
Iteration : 3
ROUGHNESS INDEX OF AN IMAGE : 1.877210
Iteration : 4
ROUGHNESS INDEX OF AN IMAGE : 1.722850
Iteration : 5
ROUGHNESS INDEX OF AN IMAGE : 1.671018
Iteration : 6
ROUGHNESS INDEX OF AN IMAGE : 1.644844
REACHED MAX THRESHOLD

C. **Enter the file name of an image : pears.png**
Iteration : 1
ROUGHNESS INDEX OF AN IMAGE : 29.977351
Iteration : 2
ROUGHNESS INDEX OF AN IMAGE : 2.521047
Iteration : 3
ROUGHNESS INDEX OF AN IMAGE : 1.269237
Iteration : 4
ROUGHNESS INDEX OF AN IMAGE : 1.121000
Iteration : 5
ROUGHNESS INDEX OF AN IMAGE : 1.071832
Iteration : 6
ROUGHNESS INDEX OF AN IMAGE : 1.0444339

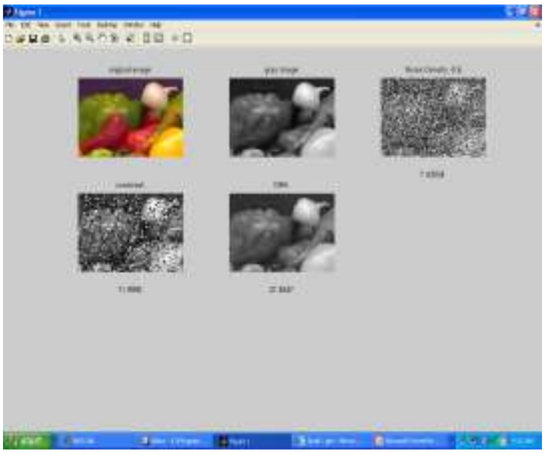

Figure 4 CEBF and DBF for noise level 60%

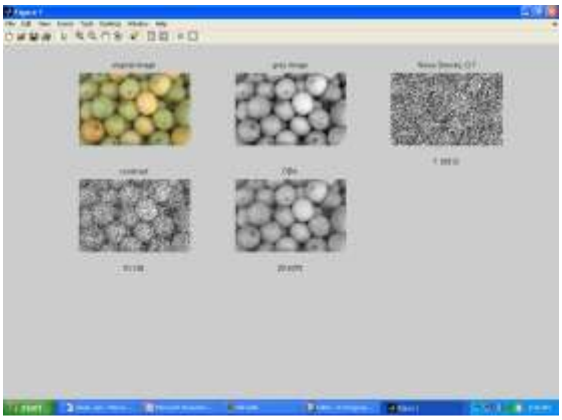

Figure 5 CEBF and DBF for noise level 70%

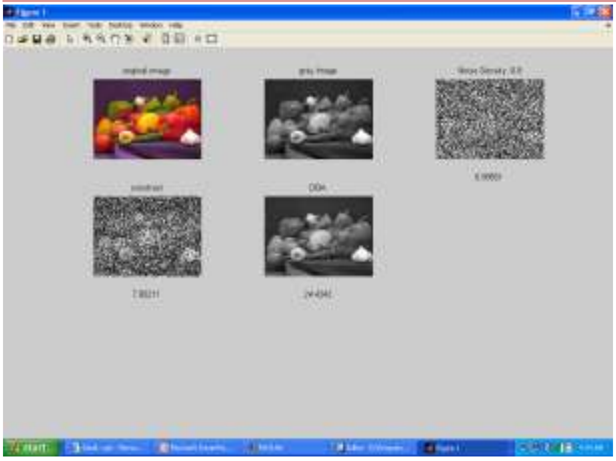

Figure 6: CEBF and DBF for noise level 80%

VI. CONCLUSION

A Contrast enhancement based filter is applied iteratively. The number of iterations varies from 2 to 6, depending upon the noise level and image characteristics. As a result of this, the proposed method removes the noise effectively up to 50% of noise level. A Decision based filter has been proposed for restoration of images that are highly corrupted by random valued impulse noise. Results reveal that the proposed filter exhibits better performance and higher PSNR value .The proposed filter uses a small 3x3 window having neighbors of the pixel that have higher correlation; this provides more edge details, leading to better edge preservation up to 80% noise level.

VII. REFERENCES

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