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Importance of Shape and Weight towards the Recital of Simple Adaptive Median Filter in Plummeting Impulse Noise Level from Digital Images

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Abstract- Noise is impulse on images due to several aspects like malfunctioning in pixels due to camera sensor, transmission of images in noisy channel, hardware problem etc. This study reviews various techniques for removal of impulse noise. To reduce the impulse noise level in Digital images various filters were introduced amongst which Simple Adaptive Median (SAM) is one of the method which uses Hybrid Technique of Adaptive Median Filter And Switching Median Filter. SAM filter which uses Square Filter as its basis has an ability to change the size of the filter spatially based on the approximated local noise level. Based on Local Noise Level on digital images size of filter is changed i.e. Square Filter Technique is used basically in SAM. SAM was compared with three derivatives namely Weighted SAM (WSAM), Circular SAM (CSAM) and Weighted CSAM (WCSAM) and images were restored maximum of Impulse Noise, but as Circular Filter has complicated implementation that resulted in increase of execution time. This study investigates the effect of shape and weight on digital images using SAM filter and restore all the digital images impulse with noise with reducing execution time for all three derivatives

Keywords- Impulse, Noise Level, Digital Image, SAM.

1. INTRODUCTION

Digital Image Processing is the technology of applying a number of computer algorithms to process digital images. The outcomes of this process can be either images or a set of Representative Characteristics or properties of the original images. The applications of Digital Image Processing have been commonly found in Robotics/Intelligent Systems, Medical Imaging, Remote Sensing, Photography and Forensics. For example, Figure 1.1 (a) illustrates an image impulse with noise when processed through filter algorithm produces noise free image shown in Figure 1.1 (b) [1]

(a) (b)

Figure 1.1 Illustration of image enhancement by applying a filter to an image: (a) original, (b) enhanced image.

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Noise is impulse on images due to several factors like malfunctioning in pixels due to Camera Sensor, transmission of images in Noisy Channel, Hardware Problem, Environmental Conditions (e.g. Light, Temperature) etc. [2]

Filtering is a fundamental operation in image processing. It can be used for Image Enhancement, Noise Reduction, Edge Detection, and Sharpening. [3]

Conventional Median Filter is a technique to remove Impulse Noise from despoiled images but the negative aspect with Conventional Method is that it does not distinguish between noise free and noisy pixels. Due to which all pixels in the images are given same precedence and which outcome in loss of useful details like borders, lines and images are blurred or distorted. After variety of improvement Median Filter was introduced. Median Filter is a filter which estimates the median value from surrounding neighborhood pixel and substitutes the pixel with the median value and the corrupted images is restored. Another subdivision of Median filter famous as Adaptive Median Filter which evaluates the median with a Threshold and decides whether the pixel is noisy pixel or noise free pixel either to replace it or increase the neighborhood size and recalculate. In Adaptive Median Filter the pixel in which noise is determined or noisy pixel are affected. This method is fine for little or prominent noise densities. [4]

Noise detection and Noise cancellation are two core steps in filtering in any digital images. Noise detection identify noisy pixels which are caused by analog to Digital Converter, Errors in Transmission, Transmission of Images in Noisy Channel, Hardware Problem etc. [5]

II. RELATED WORK

Digital Image Processing is the system in which input is a corrupted image which is then processed through algorithm and output provided is free from variety of distortion, Pepper, salt, noise etc.. Much wider range of algorithms is provided to filter the digital images from the Impulse Noise. Here, in this Survey paper various study algorithms provided by the authors to remove impulse noise [6].

1.1 Center Weighted Median Filters

CWM is a filtering technique in which filter gives added weight only to the central value of a window, and thus it is easier to design and implement than general WM filters [7].

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1.2 Adaptive Median Filters

Adaptive Median Filter has flexible window size for removal of impulse noise. It evaluates the median with a threshold and decides whether the pixel is noisy-pixel or noise free pixel either to replace it or increase the neighborhood size and recalculate.

1.3 Median filter

It is a filter which calculates the median value from contiguous neighborhood pixel and replaces the pixel with the median value and the corrupted images is restored [8].

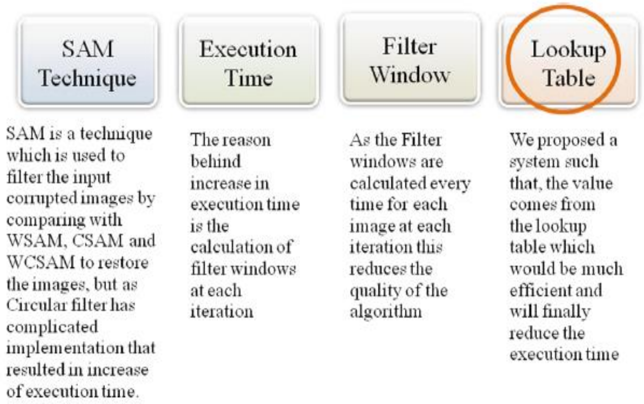
1.4 Simple Adaptive Median

Working of SAM is divided in two stages. In first stage Noisy pixel and noise free pixel are recognized. In second stage Noisy pixel are processed and noise free pixel are derivative to output image [9].

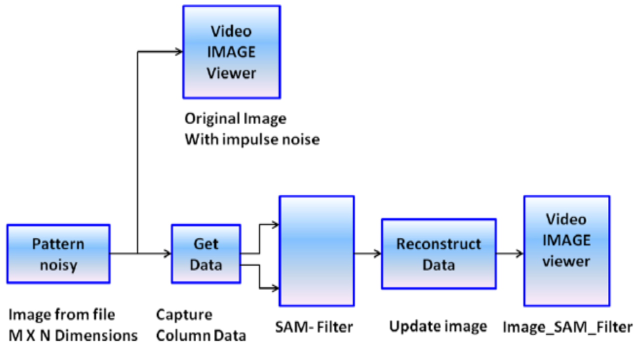
III. PROBLEM IDENTIFICATION

This method is a hybrid of Adaptive Median Filter with Switching Median Filter. It uses the Adaptive Median Filter framework in order to enable the flexibility of the filter to change its size accordingly based on the approximation of local noise density. Switching Median Filter was used framework in order to speed up the process because only the noise pixels are filtered. In addition to this switching median filter also allows local details in the image to be preserved. Here, it divides this method into two stages, which are the noise detection, and the noise cancellation. In order to implement this method, there is need of three 2D arrays of same size to hold the pixel values of the input image (f) while the output image (g), and the mask to mark the “noise pixels” (α). The dimensions of these arrays are equal to the dimensions of f (i.e. M×N).

SAM is a technique which is used to filter the input corrupted images by comparing with WSAM, CSAM and WCSAM to restore the images, but as Circular Filter has complicated implementation that resulted in increase of execution time. The reason behind increase in execution time is the calculation of filter windows at each iteration. As the Filter windows are calculated every time for each image at each iteration, this reduces the quality of the algorithm. Here, it is proposed a system such that the value comes from the lookup table which would be much efficient and will finally reduce the execution time.[10]



IV. METHODOLOGY



a. Proposed Algorithm

The algorithm works on two steps:

A. Detection of Noisy Pixels

An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. Due to this reason images that are impulse with salt and pepper noise appear as white and black dots. The amplitude of the Imposed noise in the image is very high as compared to the original signal strength of the image. Let L be the intensity of the corrupted pixel in the range of two extreme values (minimum and maximum) in the range from 0 or L-1.So at pixel position (x, y) we find the value of β

$$\beta(x, y) = \begin{cases} 1 & : \; z(x, y) = 0 \text{ or } L-1 \\ 0 & : \; \text{otherwise} \end{cases}$$

Where Z denotes the Input image and values 1and 0 represent noisy and noise free pixels. Here, Noise Level is detected using Lookup Table. Median Filter is used for noise removal which requires a Median Filter mask. This mask is generated from a formula which is too complex in terms of calculations, here pre-calculation of all terms with this formula and using the same in removing noise with the help of Median Filter.

B. Removal of Noisy Pixels

By using switching median filter the output image f is obtained.

obtained.

$$f(x, y) = \begin{cases} z(x, y) : \beta(x, y) = 0 \\ n(x, y) : \text{otherwise} \end{cases}$$

1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1

Fig 1.4 (a): *SAM Filter*

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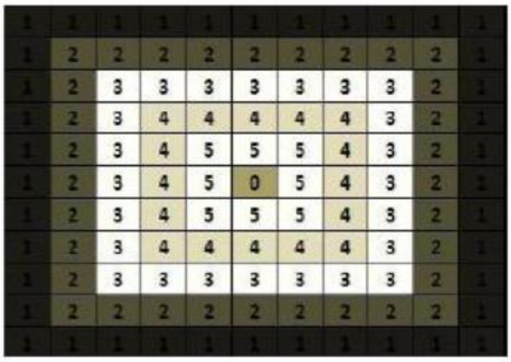

Fig 1.4(b): WSAM Filter

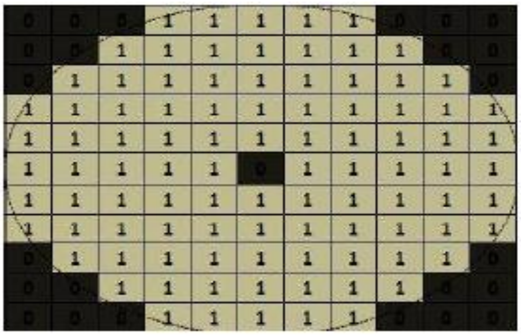

Fig 1.4 (c): *CSAM Filter*

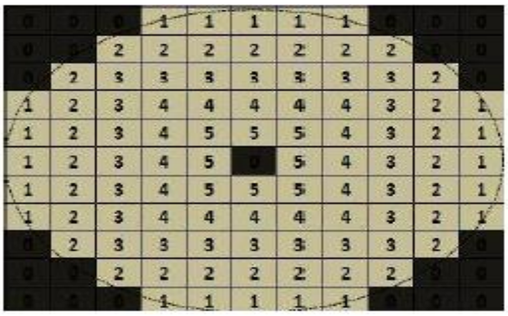

Fig 1.4 (d): *WCSAM Filter*

Where η is the output of the lookup table Output of the lookup table decides the noise free pixels. . Calculate the value of n(x, y) based on the "noise free pixels" contained in window of size M x N. Update the value of f(x, y) by using the step (4).

4.2 Proposed Modification To SAM

SAM is a filter which calculates the median value from surrounding neighborhood pixel and replaces pixel with the median value and then corrupted images is restored, i.e. noisy pixel and noise free pixels are identified while noises free are directly copied to output image while noisy pixel are processed. In this Filtering method Filter windows are calculated every time for each image at each iteration. This reduces the quality of the algorithm. Here, it is proposed a system (Filtering method) where the value comes from the lookup table which would be much more efficient which reduces the execution time. SAM Fig 1.4 (a) is used to filter the input corrupted image in comparison with Weighted SAM (WSAM) Fig 1.4 (b), Circular SAM (CSAM) Fig 1.4 (c) and Weighted CSAM (WCSAM) Fig 1.4 (d) is depicted. The modification on these filters is done on the basis of their shape and weights assigned to them. In SAM filter we use square filters while CSAM use circular filter. The advantage in using circular filter is that it minimizes the errors associated with the square kernel as the corner most pixels are not important in calculating the median value. These two filters SAM and CSAM were further modified to WSAM and WCSAM by including weights in them.

The center most pixels are given more weight as a result it contributes in improved result.

Weighting process also has been introduced into both SAM and CSAM, producing WSAM and WCSAM, respectively. The weighting process gives additional weight to the center pixels of the filter. By doing this, the filter will have enhanced local image preservation ability. The implementation of both WSAM and WCSAM still follow the proposed algorithm, except that the weighting process is added into it. These weights match up to the number of occurrences of pixel underneath the mask for the determination of variables. The outermost pixels of the filter will be given weight of one. The weight function is a linear function, monotonically escalating towards the center of the kernel, based on Chebyshev distance. The weight of the pixel at the centre of the kernel (i.e. the innermost pixel) is given the numeral value of the radius of the equivalent circular kernel.

V. CONCLUSION

In this paper, various techniques for removal of impulse noise compared in terms of MSE value, processing time and by visual inspection were studied. Visually, all methods produce almost similar results. Comparison showed that Circular (CSAM) has longer processing time. Implementation of a look-up table in the algorithm which was proposed that resulted in reduction of execution time for all the three derivatives.

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