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Implementation of Novel Image Restoration Technique from High Density Impulse Noise through Adaptive Max-Min Filter

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Abstract: ***Noise is ardent factor that reduces the quality of any system, disturbing the corresponding output. This is very noticeable especially in image processing techniques, wherein the image output is distorted to a very large extent. To reduce the effect of noise and to improve the quality of any image, it is mandatory to completely remove high density salt-and-pepper impulse noise. The salt-and –pepper impulse noise is a major hindrance that has to be eliminated by restoring the image using a specialized method that applies to all noise pixels. Involving edge protection and noise control, significant improves image quality compared to those restored by using just a nonlinear filter. The significant feature of the proposed idea is that removal of salt-and-pepper-noise as high as 95%.is obtained.***

Keywords **: Impulse noise, Order statistics filter, Edge protection, averaging, Mid-Point Filter**

I. INTRODUCTION

The major reason for impulse noise is due to the presence of faulty pixels in any camera sensing element, damaged memory locations in a storage device, or communication proceeded in a noisy channel [1]. Impulse noise and the salt-and-pepper noises are two types of noise commonly available in images. That cannot be valued in a random fashion. When images are corrupted by salt-and-pepper noise, the respective pixels can take only either a minimum or a maximum value only within the given dynamic range[2]. Restoration of images corrupted by impulse noise is generally restored by many ways using non-linear digital filters [3].

One of the most popular method that was used to remove impulse noise was to use the median filter. This was due to the very high computation efficiency and exceptional de-noising power [4].

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But this filter too had its own short comings such as, data distortion and loss when the noise level exceeded 50%. The resulting image obtained was generally a smeared image by the filter. Different classes of median filters such as multi-state median filter, adaptive median filter or median filter based on homogeneity have been employed, but failed to produce the expected results [5].

Median filters produced a near satisfactory result as its methods were either decision-based or switched [6]. These filters first identify the corrupted pixels and then replace them with some center values, without disturbing the other unaffected, adjacent pixels. The major disadvantage that is faced while involving this technique is that some center value is considered without considering the local features such as edges [7]. This results only in partial recovery of the image, as intricate details and edges are missed out. This is very evident when ever the noise level is greater than 50%. Hence complete and optimum image restoration is not achieved.

Whenever the images are degraded by Gaussian noise, Weiner filter is employed to effectively restore the image. This technique gives an excellent output as it uses the technique of edge-preserving regularization. This takes care of the image edges and henceforth the information in the image. However when it comes to the case of impulse noise being present in the image, Weiner filter is not completely successful. This is due to the high intensity of noise that is present, which hinders the preserving of edges and consequently the information in the image. Secondly, the Weiner filter employed not only alters the corrupted pixels, but the entire uncorrupted pixel group present in the image, changing the image completely. This paper emphasizes on a very efficient novel filtering technique that provides the optimal combination of order statistics with conventional averaging method. The resultant is a very an efficient filter design referred to as Max-Min (Mid-Point) filter. This method effectively discriminates the noise pixels from the good ones and then the filtration technique is applied. The Mid-Point filter is applied for good pixels and a reference is obtained. Using this as standard, the noise affected pixels are effectively restored. Since the edges of these noise pixels are sealed, the restoration process does not affect the good pixels. Thus, this hybrid combinational approach is much superior than other conventional techniques. The effectiveness of this technique is that, almost 95% of salt-and-pepper noise is effectively filtered and image made clean.

The paper can be summarized as follows. Section II elaborates on mid-point filter, while section III details on the de-noising scheme employed in the proposed idea. The various results obtained after experimenting are illustrated to give a vivid picture in section IV. The end output obtained and the merits are explained in section V to highlight on the uniqueness of the proposed system.

II. MID-POINT FILTER

Mid-Point filter is a type of Order Statistics filter, categorized under non-linear spatial filters. These filters produce an output by ordering or ranking pixels concentrated by the filter in the specified image. Next, the value of the middle pixel is replaced by the respective value determined from the ranking result.

Max-filter is most helpful in determining the brightest point on the image by taking the arguments as follows

$$\tilde{f}(x,y) = \max_{(s,t)\in S_{xy}} \{g(s,t)\} \qquad (1)$$

where S_{xy} is the coordinate set defined within a rectangular sub image window m x n , centered at point (x, y) and g(x,y) is the noisy image in the area defined by S_{xy} and $\tilde{f}(x,y)$ is the restored image.

On the contrary, the darkest or dullest point in the image is determined with the aid of Min-filter as follows

$$\tilde{f}(x,y) = \min_{(s,t)\in S_{xy}} \{g(s,t)\} \qquad (2)$$

Where S_{xy} and g(x,y) are as already defined for max-filter.

From the minima and maxima points obtained, the Mid-point filter easily computes the mid point between the obtained maximum and minimum values in the area under the filter scan.

$$\tilde{f}(x,y) = \frac{1}{2}\left[\max_{(s,t)\in S_{xy}} \{g(s,t)\} + \min_{(s,t)\in S_{xy}} \{g(s,t)\}\right] \qquad (3)$$

III. MAX-MIN ADAPTIVE METHOD

A. Noise Detection

The image is sub divided into sub images of 3 x 3 size using the mask. In that sub image noisy pixels are separated by using maximum and minimum values in the gray scale range as the salt pixels take maximum value and the pepper pixels take the minimum value.

B. Replacement

If the center pixel of the sub image is a corrupted pixel then Mid-point filter acts on the values of the good pixels present in the sub image to find the replacement value. If the center pixel is not corrupted then the original value is retained.

Consequently, the above procedure is repeated by moving the filter mask over the next successive pixel, for effective noise removal.

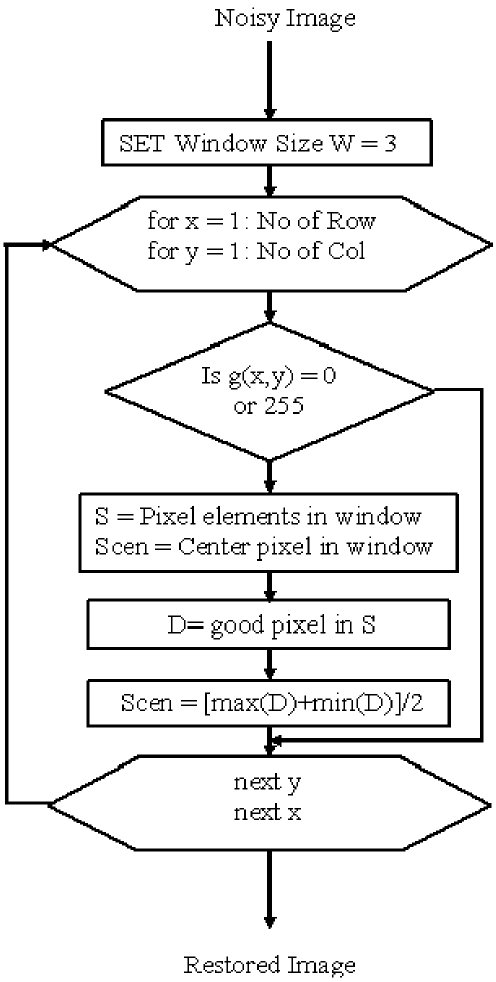

Fig. 1. Flow chart for the Proposed Algorithm

IV. RESULTS

The proposed algorithm is tested using image such as pout. The filters performance is evaluated at different levels of noise densities. The proposed methodology is tested for various noise density levels and the corresponding results compared with those of some standard filters , such as Median Filter (MF), Wiener filter (WF) and so on.

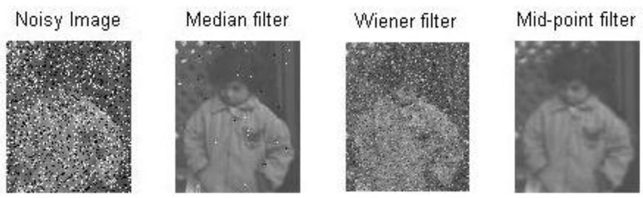

Fig. 2. Results for 20 % Noisy Image

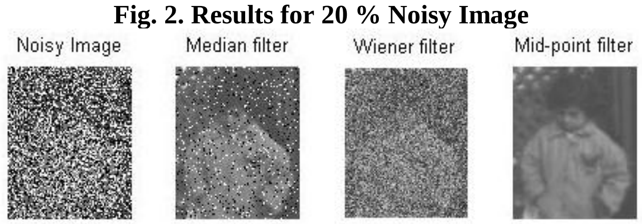

Fig. 3. Results for 50 % Noisy Image

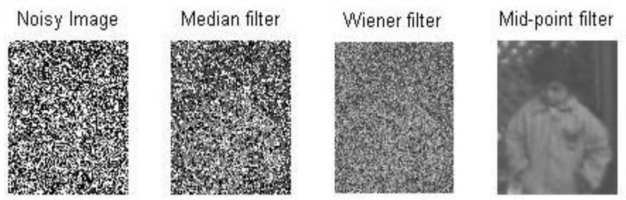

Fig. 4. Results for 75 % Noisy Image

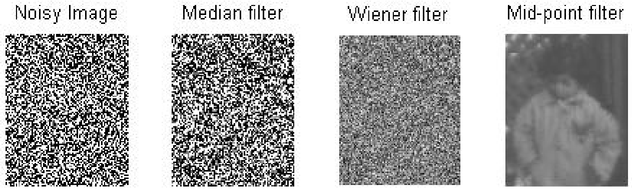

Fig. 5. Results for 90 % Noisy Image

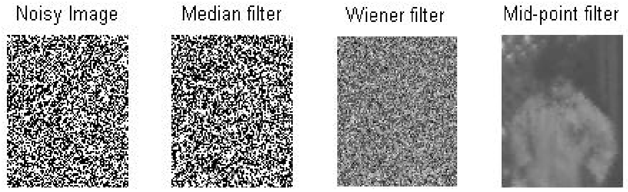

Fig. 6. Results for 95 % Noisy Image

V. CONCLUSION

The method proposed here is very novel as it is decision-based and also preserves the restoring information. Thus, the filter obtained here is the ultimate of its kind for removing high density impulse noise. The proposed filter exhibits a far better performance when compared to Median and Weiner filters as its noise removal rate is as high as 95%. Even when noise level is exceptionally high, the intricate details such as texture and edges are preserved. Involving noise detectors and regularization functions can remove a variety of noises such as impulse noise or impulse-plus-Gaussian noise.

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