PERFORMANCE ANALYSIS OF ADAPTIVE PROBABILITY FILTER USING PYTHON

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Abstract - Median filtering (MF) is a canonical image processing operation truly useful in many practical applications. Using adaptive probability filter, the salt and pepper noises are detected based on characteristic of maximum and minimum values of an image as well as distribution of noise. For certain probability if the noise-free intensity in the neighborhood is repeated, then the noise free intensity with the highest repeated frequency is used to remove noise based on statistical significance. The result of adaptive probability filter can be viewed by calculating PSNR and mean square error values, hence to overcome the drawback of existing median filters for salt and pepper noises, an APF is been proposed.

***Key Words*:** Median filters, recursive and adaptive median filter (RAMF), switching median-mean filter (SMMF).

1. INTRODUCTION *(Size 11, Times New roman)*

Digital images are usually corrupted by impulse noise due to the errors originated while sensing the images with faulty sensors and transmitting them in a noisy channel. Salt-and-pepper noise is a type of impulse noise which alters some of the pixel values either at its extreme maximum or at its extreme minimum to make them as white and black dots. Median filters are profoundly used in removing salt and pepper noises due to their good performance and low computational complexity. While a standard median filter can de noise effectively at low noise densities, it shows poor performance at high noise densities. Some improved versions of the standard median filters have been made by giving more weights to certain selected pixels in neighborhood such as weighted median filter and centre weighted median filter, as well as adaptive median filters the neighborhood sizes of which vary adaptively with the noise densities. However, these filters deal with all pixels uniformly without protecting noise-free pixels.

The present generation of technology generates and processes huge amount of information, particularly in the form of images. Because of several reasons, e.g., instrumental faults during acquisition and transmission, these images are contaminated with various types of noises.

In, Meher and Singhawat proposed a recursive and adaptive median filter (RAMF). It removes the noise only by the median of sorted noise-free pixels. The filters mentioned above show good performance at low noise densities, but at high noise densities, there are few noise-free pixels in neighborhood, so that it cannot imply ideal de-noising effect. A hybrid of the mean filter and median filter could offer a good de-noising performance such as the switching median-mean filter (SMMF). However, the SMMF cannot de-noise quite well at low noise densities. Recently, decision-based filter greatly improves the de-noising performance with robust strategies of noise detection and noise removal such as implementation of decision-based algorithm (IDBA) for median filter to extract impulse noise proposed in, and probabilistic decision-based filter to remove impulse noise using patch else trimmed median (PDBF).

The most common approach for reducing this noise is to use the zero-mean distribution property, which can be realized by average of neighbor pixel values. There are two models of impulse noise generation, namely, fixed valued (also called salt and pepper) and random valued impulsive noise. Fixed valued noise, i.e., salt and pepper noise changes the pixel value of an image into 0 or 255, whereas random valued impulse noise changes the intensity value into a random value in the dynamic range, e.g., [0,5] and [250,255]. The present study focuses mainly in designing filters for fixed impulse noise values of 0 and 255, and provides a brief description about its performance for the random impulse noise.

For the sake of the above drawbacks, we try to propose an adaptive probability filter (APF) that performs better in noise detection and noise removal.

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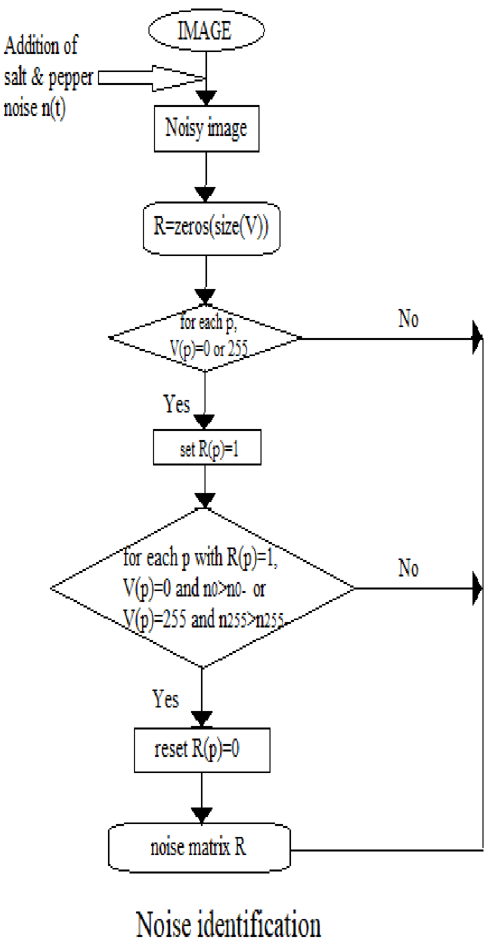
2. PROCEDURE FOR ADAPTIVE PROBABILITY FILTER (APF)

2.1 Noise identification based on statistics

According to the above analysis, the pixels with intensity 0 or 255 are further detected by the following method.

For an image V, denote by V(p) the intensity of pixel p, which ranges from 0 to 255. Consider a neighborhood Np(k) of a pixel p with size k × k. We prefer to take k = 5, for k = 3 is too small and makes Np(k) lacking statistical significance, and k ≥ 7 is too large and makes Np(k) lacking correlation. Denote by ni the number of pixels in Np(5) of intensity i, ni− the number of pixels in Np(5) of intensity other than i. Then we propose the following strategy. Suppose V(p) = 0. If n0 is significantly greater than n255, i.e. n0 ≫ n255, here we set n0 > n0−, it can be inferred that its neighbourhood Np(5) is originally black or almost black, the pixel p is then identified to be noise free; otherwise, it is identified to be noise.

Similarly, for V(p) = 255, if n255 ≫ n0, here we set n255 > n255−, pixel p is identified to be noise free, or to be noise.



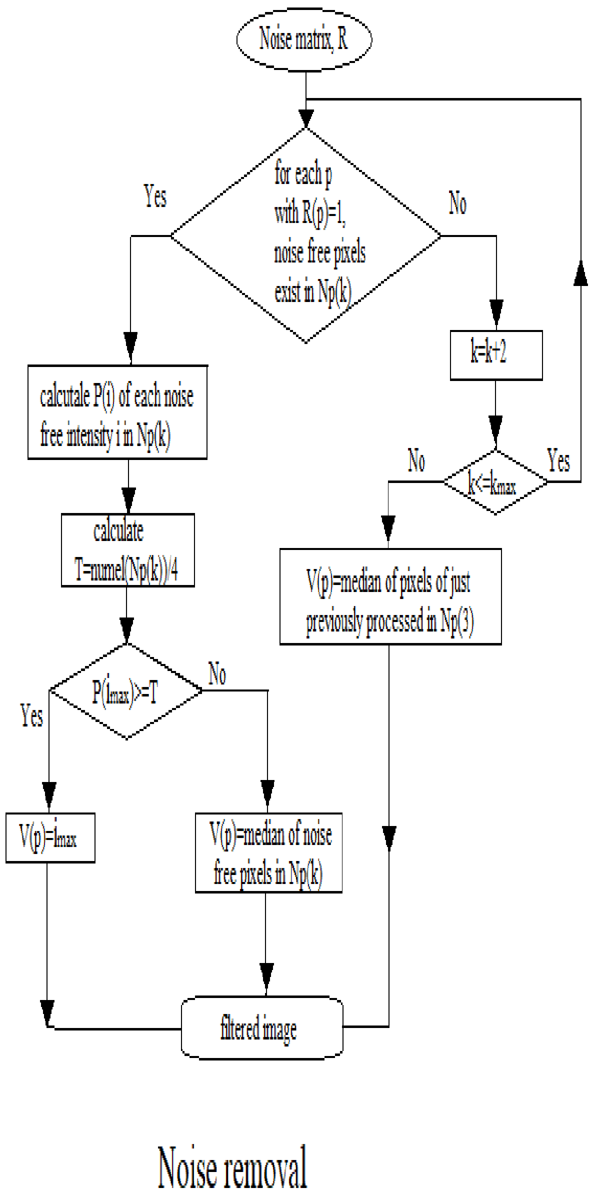
Flow chart -1: Noise identification

2.2 Removing noise based on statistics

In general, pixels are strongly correlated within a neighborhood some intensities would even repeat many times. This provides a hint for noise removal. For a noisy pixel *p*, let P(*i*) be the probability of repetition of the noise-free intensity *i* in the neighborhood *Np*(*k*). On the basis of the statistical significance, take

*i*max = argmax*i*∈*Np*(*k*)*P*(*i*)

Let *T*be an adaptive threshold. If *P*(*i*max) ≥ *T*, then *i*max is used as the original intensity of *p*; otherwise, it lacks statistical significance and the median of noise-free pixels in *Np*(*k*) is used as the originalintensity of *p*. If there are no noise-free pixels in *Np*(*k*), then enlarge *Np*(*k*) to obtain noise- free pixels. Here, define *T* = numel[*Np*(*k*)]/4, where numel[*Np*(*k*)] represents the number of noise-free pixels in *Np*(*k*).



Flow chart -2: Removing noise based on statistics

3. RESULT

By comprehensive comparison of all the metrics including PSNR, IEF, and visual representation, it can be easily identified that the APF proposed in this paper outperforms the state-of-the-art filters employed for comparison. It can also be noted that the superiority of APF over other filters varies slightly in different images. For images with a few homogeneous intensity levels, the superiority of APF over other filters is more significant than that for images with rich details. Furthermore, for high noise densities, the superiority of APF over other filters is more significant than that for low noise densities.

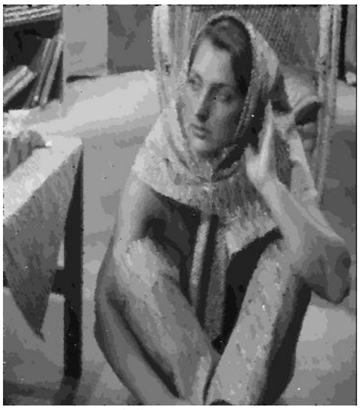


Fig1 (a).

Fig1 (b).

Fig1 (c).

Fig1 (d).

Fig1 (a) - (e) shows the Performance comparison of the proposed APF against existing filters using image Barbara in terms of visual appearance; de-noising results of,(a) original image,(b) input noisy image,(c) SMMF, (d) PDBF, (e) APF.

The result of this paper gives out the comparison of the adaptive probability filter with median filters such as switching mean-median filter (SMMF) and probabilistic decision based median filter (PDBF).

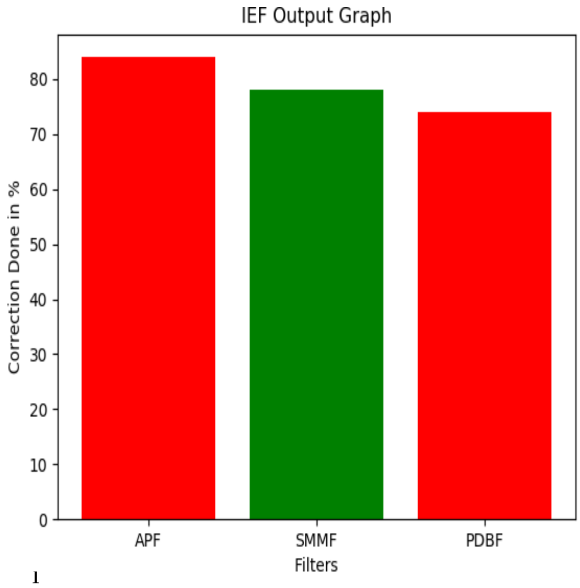


Fig2 (a): IEF output Graph for Barbara

Fig2 (a) & (b) Shows the Performance comparison of the proposed APF against existing filters using graph of Barbara image in terms of visual appearance; de-noising results of APF, SMMF, PDBF while (a) IEF output graph, (b) PSNR output graph.

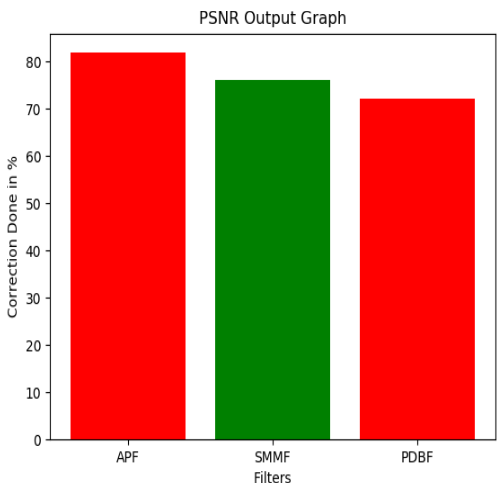


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Fig3 (a) - (e) shows the Performance comparison of the proposed APF against existing filters using image Lenna in terms of visual appearance; denoising results of, (a) original image,
(b) input noisy image, (c) SMMF, (d) PDBF, (e) APF.

Fig3 (a). Original image

Fig3 (b). Input noisy image

Fig3 (c). SMMF

Fig3 (d). PDBF

Fig3 (e). APF

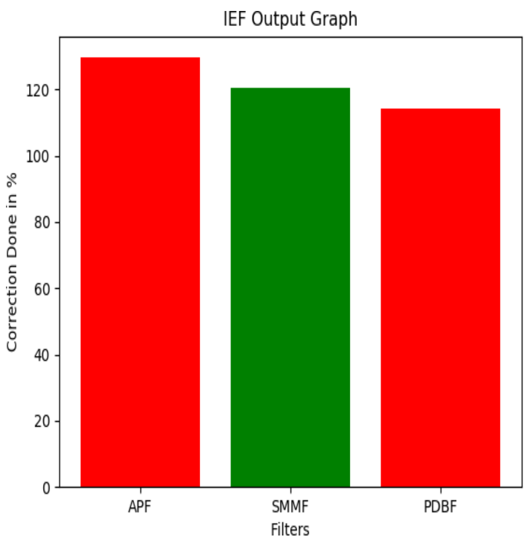

Fig4 (a): IEF output Graph for Lenna

Fig4 (a) & (b) shows the Performance comparison of the proposed APF against existing filters using graph of lenna image in terms of visual appearance; denoising results of APF, SMMF, PDBF while (c) IEF output graph, (d) PSNR output graph

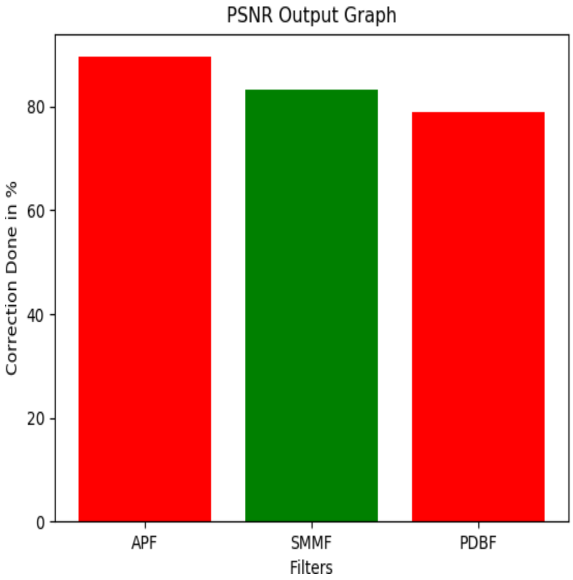

Fig4 (b): PSNR output Graph for Lenna

In the above graph it is shown that the performance comparison of the proposed filter (APF) adaptive probability filter against the existing filter like (SMMF) switching mean and median filter and (PDBF) probabilistic decision based filter of Lenna image

CONCLUSION

An APF is proposed in this paper to detect salt and pepper noises based on the characteristics of minimum and maximum intensity values of an image, as well as the distribution of salt and pepper noises. If the noise-free intensities repeat with a certain probability in neighborhood, according to the statistical significance, the noise-free intensity with the highest repeated frequency is used to remove noise.

It was observed through the experimental results that noise detection by the proposed APF is more accurate. Furthermore, both qualitatively and quantitatively, the APF is justified to be superior to the others in de-noising performance.

References

1. Sadi, F., Lee, S.Y., Hasan, M.K.: 'Removal of ring artifacts in computed tomographic imaging using iterative center weighted median filter', *Comput. Biol. Med.*, 2010, **40**, (1), pp. 109–118.
2. Vijayarajan, R., Muttan, S.: 'Analysis of FCM clustering on pre and post iterativerelaxed adaptive center weighted median filter in MRI and CT brain images', *Int. J. Comput. Sci. Issues*, 2012, **9**, (4), pp. 134–141.
3. Saleem, S.A., Razak, T.A.: 'An effective noise adaptive median filter for removing high density impulse noises in color images', *Int. J. Electr. Comput.Eng.*, 2016, **6**, (2), pp. 611–620.
4. Venkatachalam, K., Mohan, E.: 'A novel algorithm for image denoising using modified adaptive median filter', *Res. J. Appl. Sci. Eng. Technol.*, 2015, **10**, (4), pp. 373–375.
5. Balasubramanian, G., Chilambuchelvan, A., Vijayan, S., et al.: 'An extremely fast adaptive high-performance filter to remove salt and pepper noise using overlapping medians in images', Imaging Sci. J., 2016, 64, (5), pp. 241–25.
6. Astola, J., Haavisto, P., Neuvo, Y.: 'Vector median filters', *Proc. IEEE*, 1990,**78**, (4), pp. 678–689.
7. Ko, S.J., Lee, Y.H.: 'Center weighted median filters and their applications to image enhancement', *IEEE Trans. Circuits Syst.*, 1991, **38**, (9), pp. 984–993.
8. Roy, A., Singha, J., Manam, L., *et al.*: 'Combination of adaptive vectormedian filter and weighted mean filter for removal of high-density impulse noise