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Modified Two-Stage Approach for Minimizing Very High Density Salt and Pepper Noise

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Abstract: In this digital era, huge amount of digital data is transferred from place to another due to vast digital technology. The transfer of data and images from one point to another plays a vital role in this digital world. One of the common examples of digital data is image. During transferring of image, it may lose its quality and it is also sensitive to noise which degrades the quality of the image or destroy its edges. To overcome all these problems image processing is used. In image processing, non-linear filters plays a vital role in removal of impulse noise (salt and pepper noise) as linear filter fails to do so. At very high noise density the existing non linear filter either fails to preserve edges or fails to get better denoised image at noise density as high as 99%. In present work, a modified two-stage algorithm is proposed which is the fusion of best existing non linear filtering techniques, for retaining the denoised image as much as possible. Different grayscale images are tested using proposed algorithm. The qualitative and quantitative results are examined by performance metrics like Peak Signal to Noise Ratio (PSNR), Structural Similarity Index Measure (SSIM), and Image Enhancement Factor (IEF).
Keywords: Salt and Pepper Noise (SPN), Image Processing, Image Denoising, Peak Signal to Noise Ratio (PSNR), Structural Similarity Index Measure (SSIM), Image Enhancement Factor (IEF)

I. INTRODUCTION

Image restoration problems in image processing field are proposed, as input image quality is greatly improved using this technique. A two-stage filter is suggested for SPN removal with high density. The suggested denoising algorithm works well for removing the noise from images corrupted with low to high density [1]. A new technique to recover an image corrupted by SPN utilizing a hybrid genetic algorithm (HGA) is presented with varying densities. The suggested algorithm helped in combining the image denoising techniques with hybrid genetic algorithm [2]. A novel approach is suggested for SPN removing from a given corrupted image. The suggested algorithm worked on the basis of statistical quantities like standard and mean deviation. This technique facilitates iteratively and can remove the impulse peaks reinstating the edges with minute details [3]. An Iterative Mean Filter (IMF) for SPN eliminating is proposed. IMF calculates the average value of gray images with noiseless pixels for a window with fixed-size. This feature finds helpful for IMF for evaluating a gray value for central pixel. Various performance matrices like PSNR, Structural Similarity, Image Enhancement Factor, Visual Information Fidelity, and Multiscale Structure Similarity were analyzed for assessing the image quality [4]. A kriging interpolation technique based on adaptive decision for removing of high density SPN in images is presented. The non noisy pixels are isolated with proposed algorithm and only noisy pixels are processed. This method needs a minimum three noiseless pixels in existing window; otherwise, window size increases adaptively [5]. The drawbacks of the existing filters for SPN removal are overcome by proposing an adaptive probability filter. Experimental results indicated that the suggested technique is very much capable for identifying noise more precisely and perform superior to other existing filters as per performance matrices like PSNR, visual representation, and image enhancement factor etc. at approximately all noise densities [6]. Images are normally debased with SPN during picture transmission over the channels because of faulty correspondence. Middle channels are most widely utilized and are best-known for the capability of evacuating the SPN without damaging the edges. Calculations for evacuating high-thickness SPN using altered Median Filter (AMF) are proposed [7]. In a noisy image, the pixels are classified as per SPN in two classes: noisy pixels and noise-free pixels. Noise filtering only allows noise-free pixels but does not allow noisy pixels. An adaptive filtering along with weighting mean algorithm removed excellent noise and achieved superior detail preservation for noisy pixels [8]. A novel and adaptive fuzzy based algorithm is presented with a weighted mean filter for SPN removal. Two stages are used for denoising: such as noise recognition and noise removal. For a noise-free pixel, it should be retained as unchanged; light corrupted pixel is replaced with average of weighted value and mean value; and a heavy corrupted pixel is changed into the weighted mean [9]. The possibility of improving the medical diagnosis accuracy of a radiographic image infected with SPN is indicated using FPGA filters. The results are established in terms of resources consumption, filtered images, and lowest response time [10].

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If chosen window contains the corrupted pixel along with other pixel values then corrupted pixel is substituted by modified mean instead of median of the elements and if it contains only the noisy elements then noisy pixel is substituted by calculating the mean value of window function, it preserves the fine details of the image at high noise densities [11].

In this paper, Section 1 describes the comprehensive literature review of various papers published by different authors on SPN removal in image processing. Whereas, the proposed algorithm is provided in Section 2. Results and discussions are described in Section 3. Also, conclusions drawn from present research work are provided in Section 4.

II. PROPOSED ALGORITHM

The filtering process in this proposed algorithm is consisting of two phases. In proposed algorithms all the pixels with gray values ('0' or '255') are considered as corrupted pixels. When a corrupted pixel is detected, a window of fixed size is taken by considering the corrupted pixel as center pixel of this window. In the phase-I, if processing window is bearing only non-corrupted pixel having value (0 and 255) then it is left unaltered and phase-II is used to process it. If processing window is bearing noisy pixels along with other non-noisy pixels, then the processing pixel is substituted by Winsorized mean value of the processing window. Also, if processing window bears all pixel 0's exclusively and 255's exclusively, then the processing pixel is substituted by the global mean value of the image, excluding 0's and global mean value of image, excluding the 255's respectively. The phase-II is executed if the image recovered from phase-I is still consisting of noisy pixel, then the processing pixel is substituted with the Winsorized mean value of weighed diagonal pixels. Fig. 1 provide the proposed algorithm.

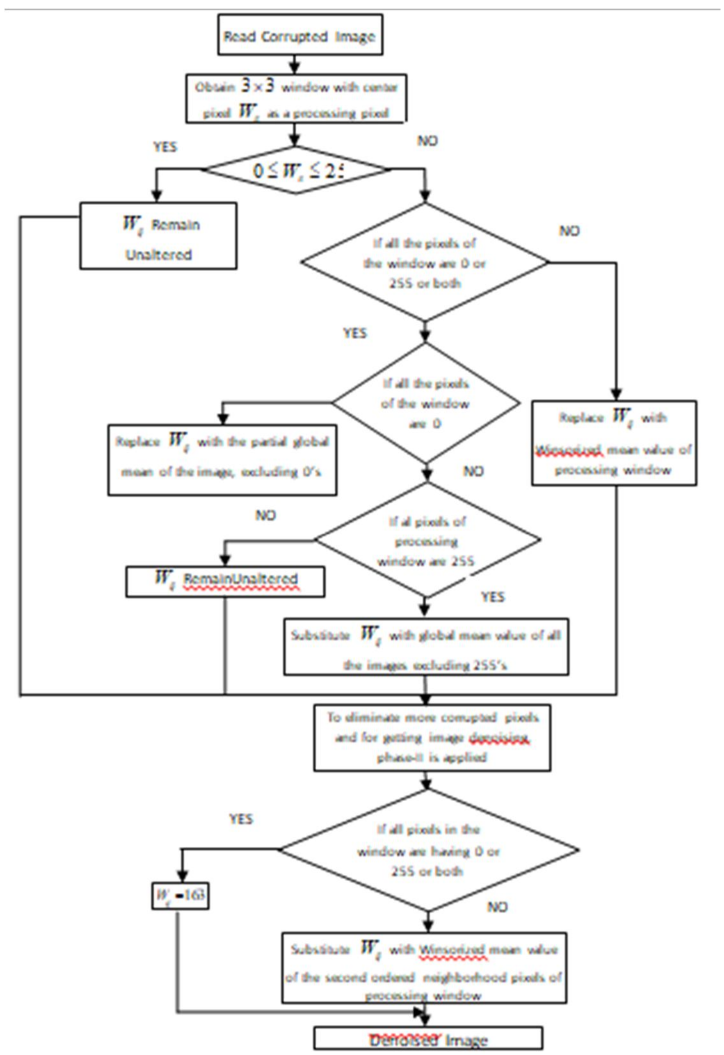

Figure 1: Flowchart for Proposed Algorithm

III. RESULTS AND DISCUSSIONS

The proposed algorithm is evaluated for testing its performance using various grayscale images. The intensity of noise is varied from 60% to 97%. The proposed algorithm's performance is quantitatively evaluated using performance matrices like PSNR, IEF and SSIM as defined using equations 1 to 3 respectively.

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right) \quad (1)$$

$$IEF = \frac{\sum_i \sum_j \left(n_{ij} - o_{ij}\right)^2}{\sum_i \sum_j \left(r_{ij} - o_{ij}\right)^2} \quad (2)$$

$$SSIM\,(p,q) = \frac{\left(2\mu_p\mu_q + c_1\right)\left(2\sigma pq + c_2\right)}{\left(\mu_p^2\mu_q^2 + c_1\right)\left(\sigma p^2 + \sigma q^2 + c_2\right)} \quad (3)$$

Here 'o' represents original image, noisy image is represented by 'n', and 'r' denotes the restored image. 'M' represents width of image and 'N' represents the height of image. μ_p Denotes the original image mean intensity and μ_q denotes the restored image mean intensity. σ_p Represents the original image standard deviation and σ_q denotes the restored image standard deviation. σ_{pq} is covariance between original and recovered images. c_1 and c_2 are variables such as $c_1 = \left(0.01L\right)^2$ and $c_2 = \left(0.03L\right)^2$ where L is the dynamic range and for gray scale images, L = 255.

For the purpose of comparing proposed algorithm with other conventional algorithms, Lena image is used as reference. This image is as shown in Fig. 2.

Figure 2: Grayscale image of Lena for comparing different algorithms

In this Lena image, 90% noise density is added and then it is termed as noisy image as shown in Fig. 3 (a). Then different algorithms such as DATMWMF (Fig. 3b) DBANMF (Fig. 3c), DBPTGMF (Fig. 3d), DBUTWMF (Fig. 3e), MDBUT_GM (Fig. 3f), MDBUTMF (Fig. 3g), and Proposed algorithm (Fig. 3h) are applied to remove noise from the noisy image.

As can be seen from Figure 3h, the proposed algorithm provides the best results as compared to other conventional algorithms for removing the salt and pepper noise (SPN) from the noisy image.

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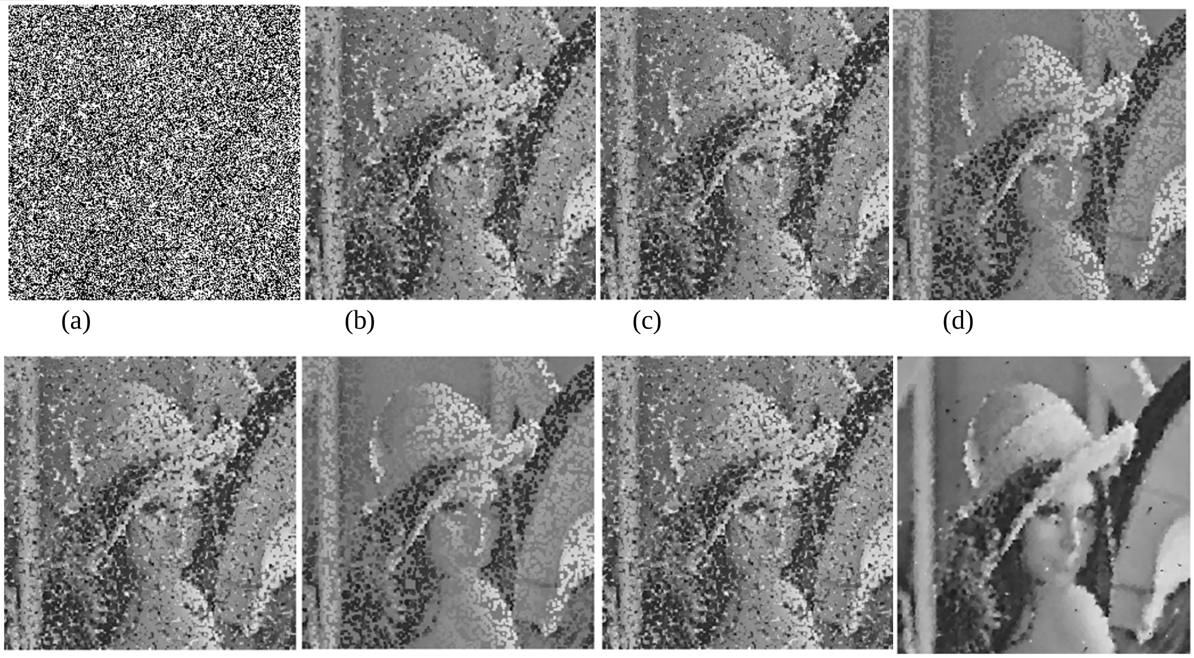

Figure 3: Qualitative results of Lena Image at noise density 90% for different algorithm (a) Noisy image (b) DATMWMF (c) DBANMF (d) DBPTGMF (e) DBUTWMF (f) MDBUT_GM (g) MDBUTMF (h) Proposed algorithm.

Table 1 provides the PSNR variation of different algorithms at diverse noise densities (ranging from 60 % to 97 %). It is evident from the results that proposed algorithm provides best results as compared to other conventional algorithms at varying noise densities for Lena image.

Table 1: PSNR values for different algorithms at various noise densities for Lena image

Noise Density in %	MDBUTMF	MDBUT_GM	DBPTGMF	DBUTWMF	DBANMF	DATMWMF	PA
60	36.3769	36.3750	36.3784	36.5238	35.2658	36.3333	36.6182
70	34.9399	34.8080	34.8072	35.0372	34.2917	34.9267	35.5854
80	33.0977	32.9209	32.9248	33.1274	32.7905	33.0942	34.6495
90	30.5779	30.3324	30.3319	30.5847	30.5138	30.5766	33.3226
95	29.2475	28.8630	28.8642	29.2486	29.2369	29.2476	31.9970
97	28.6585	28.3897	28.3853	28.6587	28.6767	28.6583	31.3274

Figure 4 provides the PSNR versus noise density variation for different algorithms for Lena image. Best PSNR values are represented by proposed algorithm.

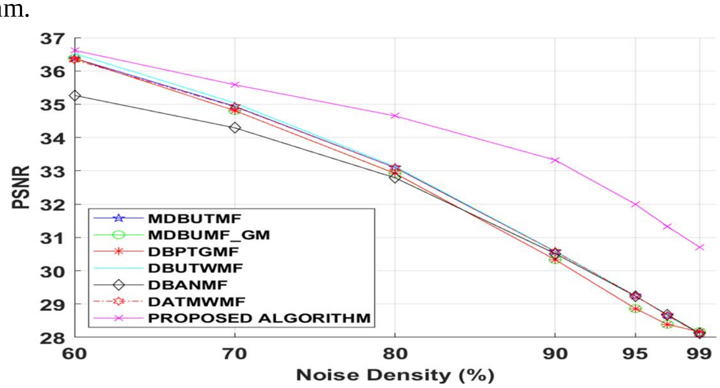

Figure 4: PSNR versus Noise Density variation for Lena Image

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Table 2 provides the IEF variation of different algorithms at diverse noise densities (ranging from 60 % to 97 %). It is evident from the results that proposed algorithm provides best results as compared to other conventional algorithms at varying noise densities for Lena image.

Table 2: IEF values for different algorithms at various noise densities for Lena image

Noise Density in %	MDBUTMF	MDBUT_GM	DBPTGMF	DBUTWMF	DBANMF	DATMWMF	PA
60	86.4293	103.5041	103.4572	93.0270	59.2561	85.9107	127.8342
70	47.8988	65.9726	65.5834	49.0672	39.6099	47.7846	105.6558
80	21.3878	34.1227	33.8324	21.5234	19.6510	21.3773	79.0283
90	9.9122	16.5189	16.2843	9.9176	9.3662	9.9103	54.4211
95	6.5102	11.3477	11.0770	6.5107	6.2186	6.5100	32.1346
97	5.6229	9.9378	9.6733	5.6231	5.3570	5.6230	19.6571

Figure 5 provides the IEF versus noise density variation for different algorithms for Lena image. Best IEF values are represented by proposed algorithm.

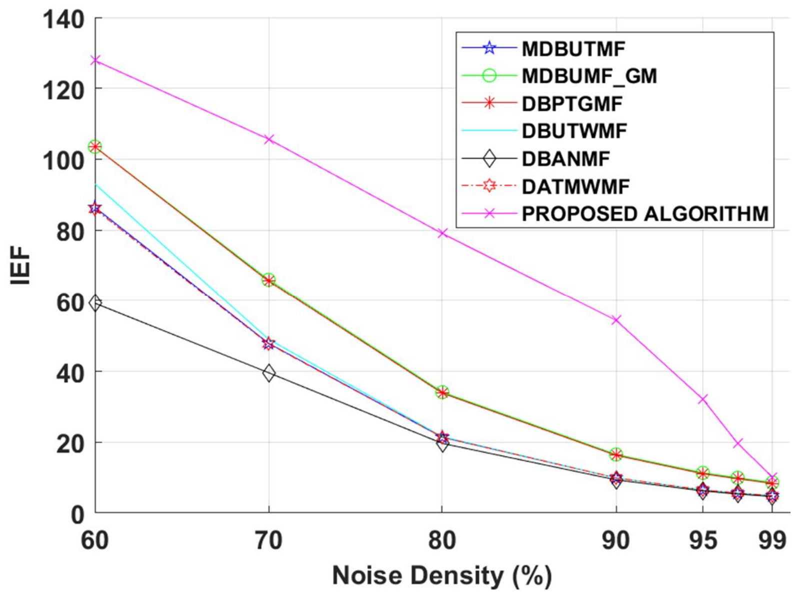

Figure 5: IEF versus Noise Density variation for Lena Image

Table 3 provides the SSIM variation of different algorithms at diverse noise densities (ranging from 60 % to 97 %) for Lena image. It is evident from the results provided in this table that proposed algorithm provides best SSIM values as compared to other conventional algorithms at varying noise densities.

Table 3: SSIM values for different algorithms at various noise densities for Lena image

Noise Density in %	MDBUTMF	MDBUT_GM	DBPTGMF	DBUTWMF	DBANMF	DATMWMF	PA
60	0.8475	0.8650	0.8650	0.8541	0.8033	0.8467	0.9053
70	0.6852	0.7458	0.7449	0.6883	0.6509	0.6849	0.8708
80	0.4440	0.5690	0.5666	0.4455	0.4163	0.4439	0.8191
90	0.2149	0.3813	0.3754	0.2149	0.1995	0.2149	0.7273
95	0.1162	0.3150	0.3024	0.1162	0.1062	0.1162	0.6053
97	0.0797	0.3137	0.2968	0.0797	0.0720	0.0797	0.5285

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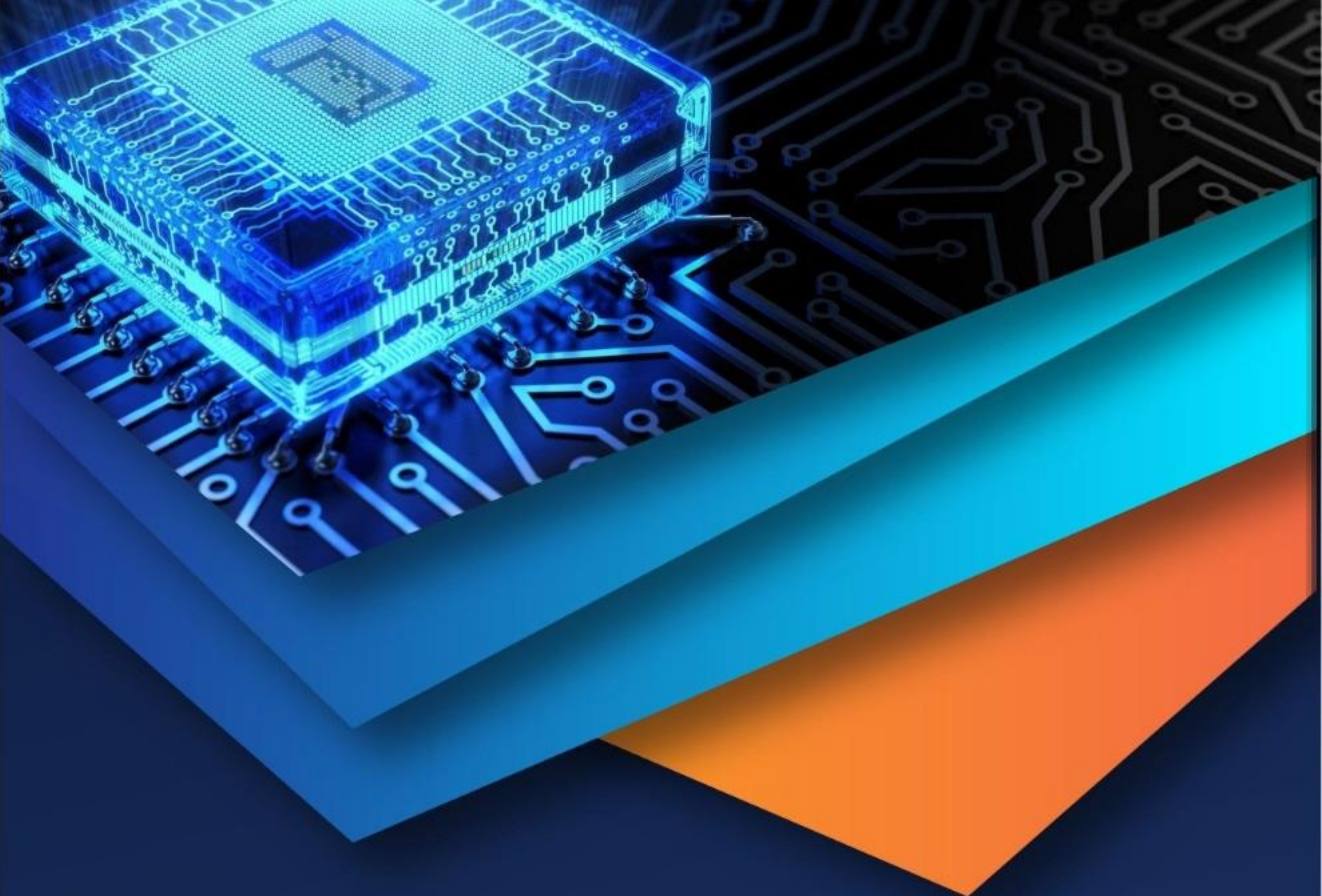
IV. CONCLUSIONS

In this research work a modified two-stage approach for minimizing very high density salt and pepper noise (noise levels up to 97 %) is analyzed and discussed. Proposed algorithm provided superior performance as compared to numerous conventional non-linear filters in terms of quantitative as well as qualitative analysis. The proposed algorithm provided best results using different images preserved fine details of these images. This was obtained by fusion of DBPTGMF, DBUTWMF, and DBDNA and represents excellent two-phase scheme. It represents better PSNR, IEF and SSIM. Hence the proposed algorithm is worthy for removing salt and pepper noise with high density. From the simulation results, it can be concluded that implemented scheme has high imperceptibility and enhanced performance when compared to the other non-linear filtering techniques.

REFERENCES

[1] Thanh, D.N.H., Hai, N.H., Prasath, V.B.S. et al. A two-stage filter for high density salt and pepper denoising. Multimed Tools Appl 79, 21013–21035 (2020).
[2] Alaoui, N., Mitiche A., Houda A.B., and Mitiche, L. Effective hybrid genetic algorithm for removing salt and pepper noise. IET Image Processing, 14(2), 289-296 (2020).
[3] Halder A., Halder S., Chakraborty S., and Sarkar A. Statistical Salt-and-Pepper Noise Removal Algorithm. International Journal of Image and Graphics, 19(01), 1950006 (2019).
[4] Erkan U., Thanh D.N.H., Hieu L.M., and Engínoğlu S. An Iterative Mean Filter for Image Denoising. IEEE Access, 7, 167847-167859 (2019).
[5] Varatharajan R., Vasanth K., Gunasekaran M., Priyan M., and Gao X.Z. An adaptive decision based kriging interpolation algorithm for the removal of high density salt and pepper noise in images. Computers & Electrical Engineering, 70, 447-461, (2018).
[6] Chen J., Zhan Y., Cao H. and Wu X. Adaptive probability filter for removing salt and pepper noises. *IET Image Processing*, 12(06), 863-871, (2018).
[7] Soni A. and Shrivastava R. Removal of high density salt and pepper noise removal by modified median filter. *2017 International Conference on Inventive Communication and Computational Technologies (ICICCT)*, Coimbatore, 282-285, (2017).
[8] Chen Q., Hung M., and Zou F. Effective and adaptive algorithm for pepper-and-salt noise removal. *IET Image Processing*, 11(09), 709-716, (2017).
[9] Wang Y., Wang J., Song X., and Han L. An Efficient Adaptive Fuzzy Switching Weighted Mean Filter for Salt-and-Pepper Noise Removal. *IEEE Signal Processing Letters*, 23(11), 1582-1586, (2016).
[10] Junior E.I., Garces L.M., Cabrera A.J., and Pimenta T. C. Performance Analysis of Algorithms over FPGA for Removing Salt and Pepper Noise. *IEEE Latin America Transactions*, 14(05), 2120-2127, (2016).
[11] Vasant K., Manjunath T.G., and Raj S.N. A decision based unsymmetric trimmed modified winsorized mean filter for the removal of high density salt and pepper noise in images and videos. Eleventh International Multi-Conference on Information Processing, 595-604, (2015).



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