iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

IMPROVING MEDIAN AND AVERAGE DIGITAL FILTERS PERFORMANCE

Prof. Yousif Eltous [1]
Prof. Ziad Alqadi [2]
Professors, Albalqa Applied University

ABSTRACT
Denoising gray and color images from the effects of salt and pepper noise is a vital issue, because clean images are needed to implement various computer applications. In this paper research a modified median and modified average filters will be proposed. These filters are to be used to enhance the quality of the denoised gray or color image, even if this image is infected by a salt and pepper noise with high noise ratio. It will be shown that the proposed filters will be efficiently used to reduce the negative effects of salt and pepper noise with any noise ratio (low or high).
The proposed filters will be used to treat only the infected noisy pixels in the noisy image, a special window will be created and used to calculate the new optimal value of the noisy pixels. This window can be easily created using simple data structures which include padded noisy image and index matrices. The index matrices will be used to simplify the process of covering window creation.
The proposed method will be tested using noisy images with various noise ratio values, the results will be compared with average and median filters results to show the improvements provided by the proposed filters.

Keywords:
Salt and pepper, NR,window, index matrix, AF, MF, PMAF,PMMF.

INTRODUCTION

Digital images [40-43] (gray and color) are very important digital data which are used in many computer applications. These applications required clean image to operate normally. Digital gray image can be easily processed, because it is represented by a 2D matrix (see figure 1) [35-40], while the color image is represented by a 3D matrix (one 2D matrix for each color (see figure 2). Gray and color pixels have an integer values within the range 0 to 255 [25-30].

Gray image

Part of the image matrix

52	80	95	103	116	131	141	145	139	138	145
42	67	75	91	100	117	142	148	145	146	148
65	114	103	129	145	145	141	132	143	154	149
81	119	107	141	150	141	141	139	165	155	146
96	117	118	155	147	138	157	151	157	152	142
92	82	140	158	139	142	152	154	162	141	133
116	77	123	136	127	143	156	150	149	139	131
120	78	116	126	122	144	159	148	139	134	132
123	90	126	135	126	143	161	152	138	130	134
144	100	131	137	129	146	168	158	137	130	134
146	102	120	126	130	153	171	156	130	130	131

Figure 1: Gray image representation

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

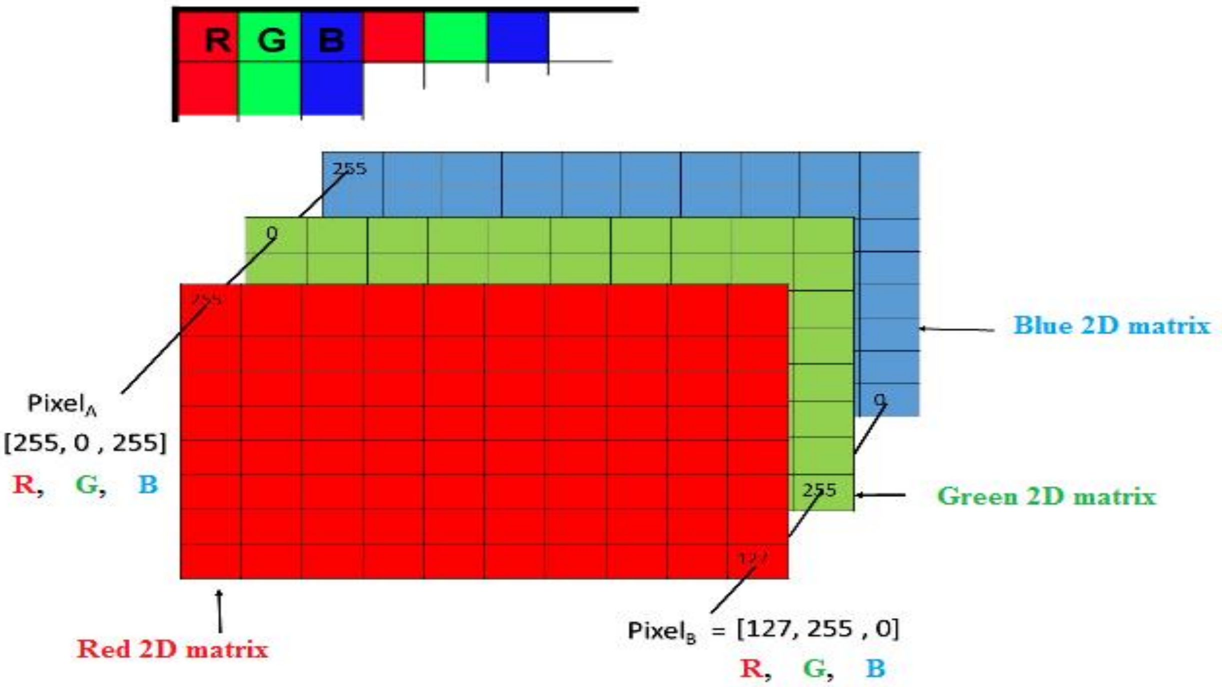


Figure 2: Color image representation

Digital images [30-40] can be affected by various noises which negatively affect the image quality, one of the most common noises is salt and pepper noise (SAPN), this noise can affect gray and color images replacing some pixel's values to 0s and other pixel values to 255s, the number of changed pixels depends on the noise ratio (NR) (number of affected pixel to the image size) as shown in figure 3 [1-11].

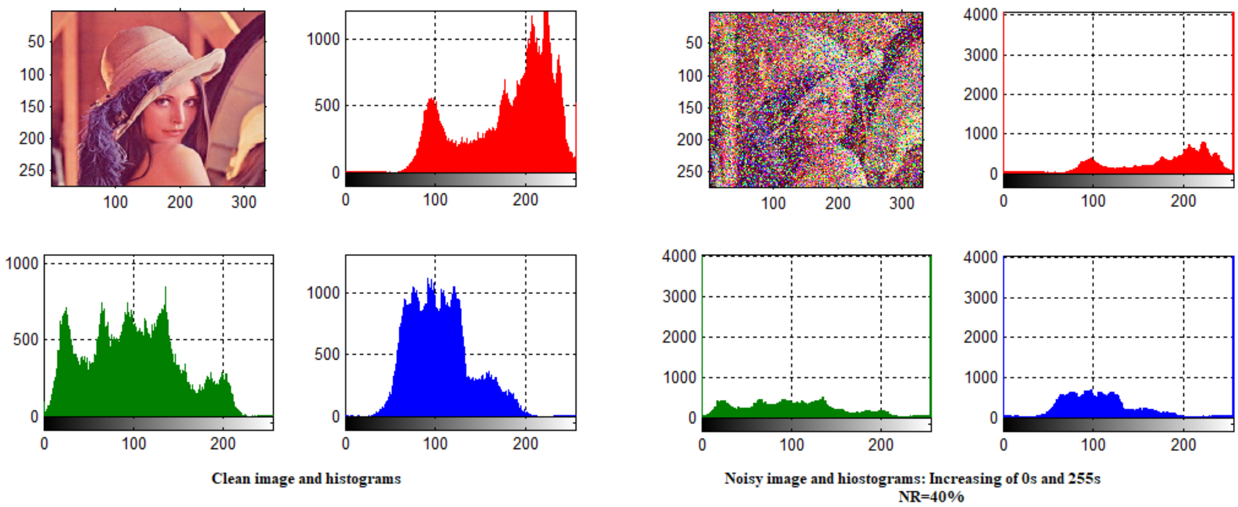


Figure 3: SAPN increases 0s and 255s in the image

Increasing the NR will increase the repetition of zeros and 255s in the image and this will affect the quality of the image making it un clear and difficult to be used in a computer application [20-25].
Digital median filters (MF) and average filters (AF) are the most popular filters used to reduce the effects of SAPN, but they have the following disadvantages [12-18]:

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

- The two filters process the clean and the noisy pixel, changing the values of clean pixel will negatively affect the quality of the denoised images.
- Increasing the NR ratio will negatively affect the outputs of these filters, for higher NR (NR>20) these filters fail to handle the noise and the produced denoised images have a low quality

MF and AF filters use a window to cover the selected pixels in order to find the median value or the average value, and for high NR value these filters will be inefficient even if the window size was increased.
Figure 4 and 5 show the algorithm of operations implemented by MF and AF [19-25].

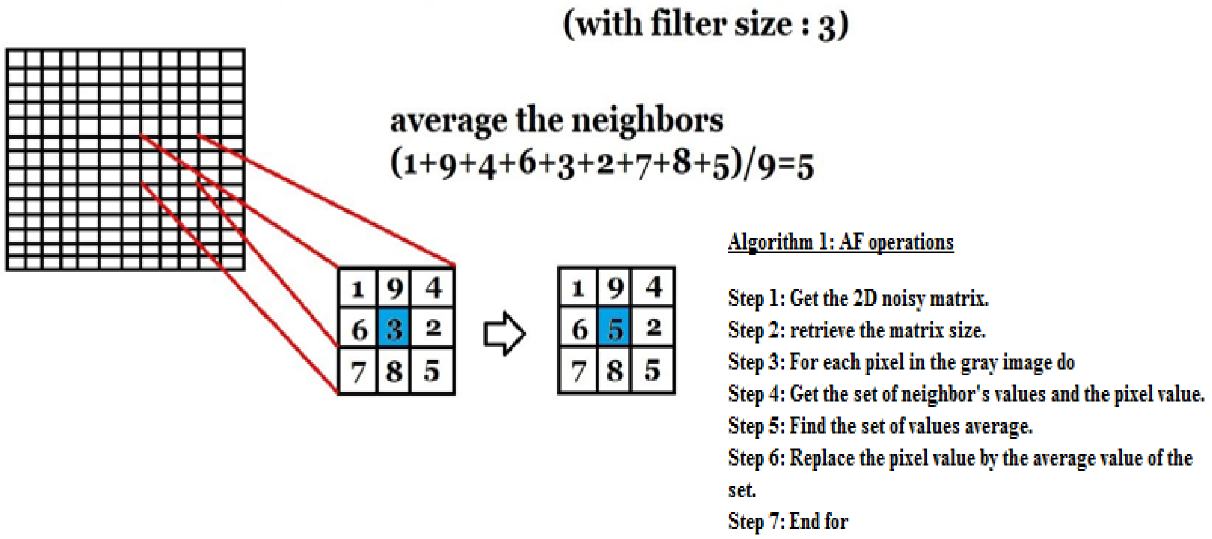


Figure 4: AF operation and algorithm

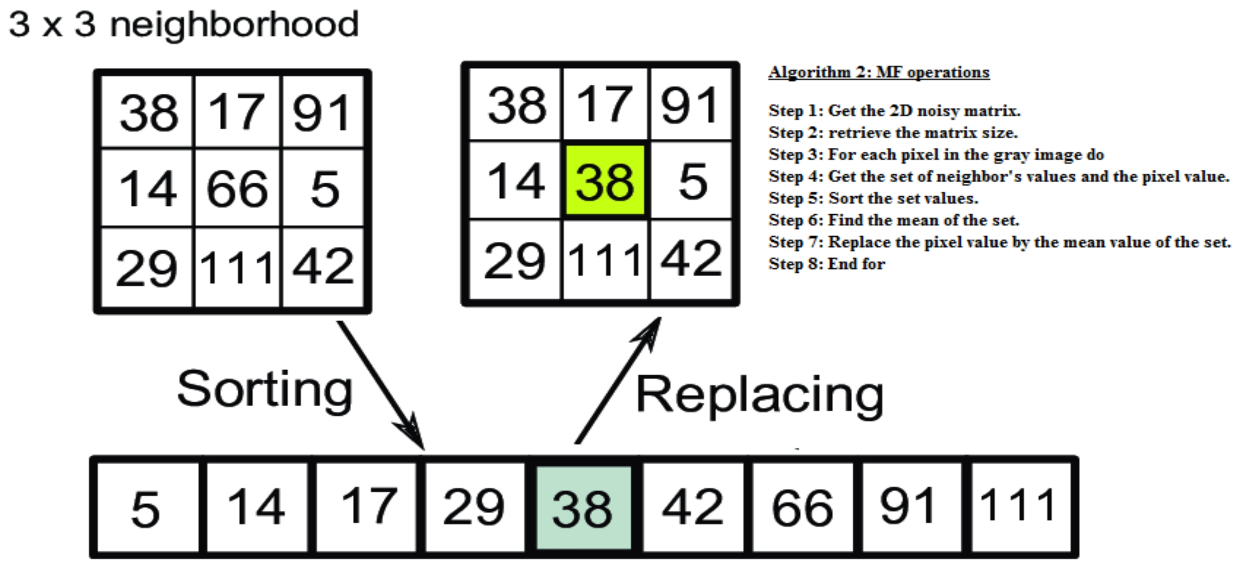


Figure 5: MF operation and algorithm

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

OBJECTIVES

The main objective of the study is to enhance the performance of median and average digital filters. These filters are to be used to enhance the quality of the denoised gray or color image, even if this image is infected by a salt and pepper noise with high noise ratio. It will be shown that the proposed filters will be efficiently used to reduce the negative effects of salt and pepper noise with any noise ratio (low or high).

METHODOLOGY

The proposed method is based on MF and AF and it can be used to improve the performance of these two filters. The proposed method is to be used by treating only the noisy pixels keeping the clean pixels as they are without changing, this will increase the quality of the denoised image.

Three data structures are used in the proposed method:

- Noisy index matrix which contains zero and ones, zeros point to noisy pixels in the associated noisy matrix; one's point to the clean pixels in the noisy matrix.
- Padded noisy matrix, the padding factor depends on the size of the selected window.
- Padded noisy index matrix with zeros and ones.

Figure 6 shows an example of noisy matrix, while figure 7 shows the required index matrices:

Clean matrix

229	24	176	76	175
178	20	116	228	164
66	80	246	253	139
227	143	196	91	90

Noisy matrix

255	24	0	76	175
178	20	116	228	164
66	80	246	253	139
255	143	196	91	90

Figure 6: Noisy image example

Noisy indexed

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

Padded index

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

Windows:(I-5:I+5,J-5:J+5)

Figure 7: Index matrices

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

For the noisy pixel a window must be created, the size of this window will be investigated in the implementation part. To find the new value of the noisy pixel the summation of index window will be found, if the summation is not equal zero the new pixel value will equal the median (average) values of all values in padded image window excluding the noisy pixels, in figure 7 windows of 11 by 11 were shown for the three noisy pixels.
Figure 8 shows how to create 6 by 6 windows to the pointed pixels.

93	225	243	223	145	145	223	243	225	93	93	225	243	223	145
93	225	243	223	145	145	223	243	225	93	93	225	243	223	145
163	163	145	25	102	102	25	145	163	163	163	163	145	25	102
207	3	91	62	128	128	62	91	3	207	207	3	91	62	128
43	100	240	254	146	146	254	240	100	43	43	100	240	254	146
43	100	240	254	146	146	254	240	100	43	43	100	240	254	146
207	3	91	62	128	128	62	91	3	207	207	3	91	62	128
163	163	145	25	102	102	25	145	163	163	163	163	145	25	102
93	225	243	223	145	145	223	243	225	93	93	225	243	223	145
93	225	243	223	145	145	223	243	225	93	93	225	243	223	145
163	163	145	25	102	102	25	145	163	163	163	163	145	25	102
207	3	91	62	128	128	62	91	3	207	207	3	91	62	128
43	100	240	254	146	146	254	240	100	43	43	100	240	254	146
43	100	240	254	146	146	254	240	100	43	43	100	240	254	146

Figure 8: 6 by 6 windows for the pointed pixels

Below is an example of using various windows, figure 9 shows the clean and noisy images:

Clean matrix

229	24	176	76	175
178	20	116	228	164
66	80	246	253	139
227	143	196	91	90

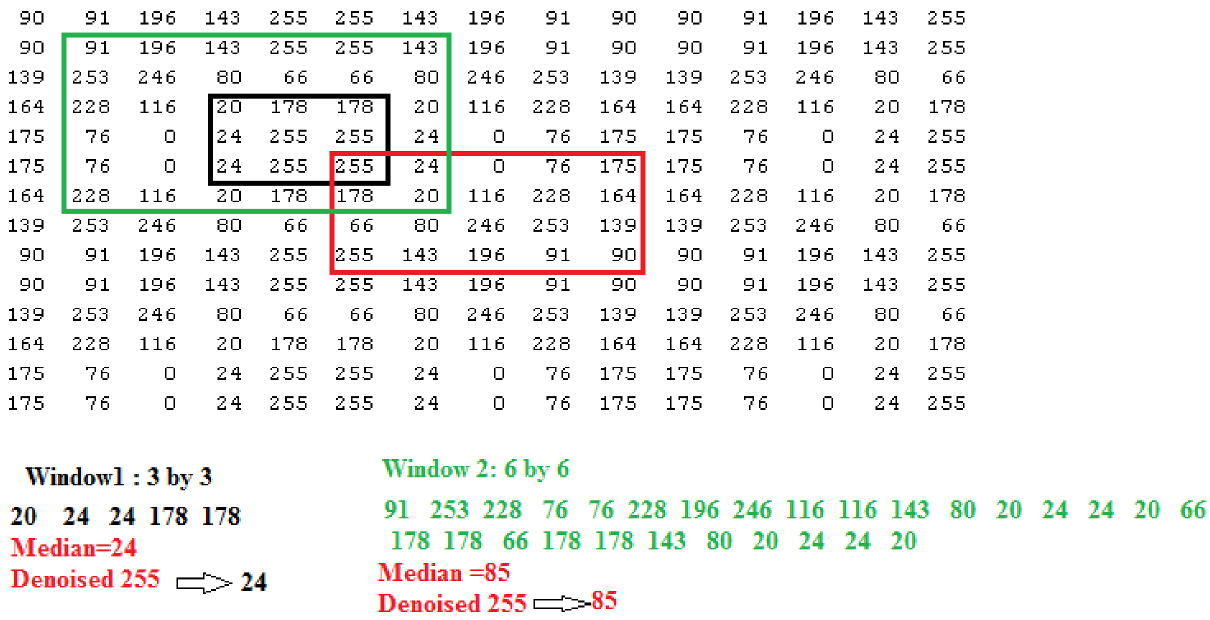
Noisy matrix

255	24	0	76	175
178	20	116	228	164
66	80	246	253	139
255	143	196	91	90

Figure 9: Clean and noisy images

Figure 10 shows two created windows for the noisy pixel P (6,6), using black window the pixel value after processing will equal 24, while it will be equal 85 after using green window

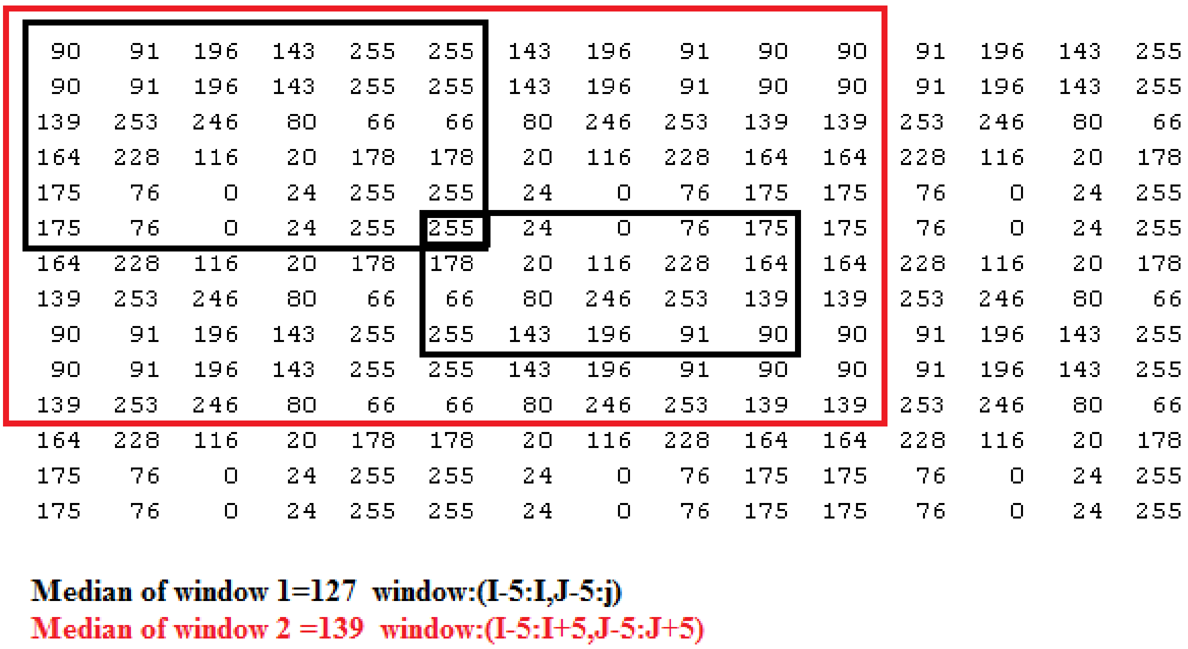
iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/



90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
139	253	246	80	66	66	80	246	253	139	139	253	246	80	66
164	228	116	20	178	178	20	116	228	164	164	228	116	20	178
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255
164	228	116	20	178	178	20	116	228	164	164	228	116	20	178
139	253	246	80	66	66	80	246	253	139	139	253	246	80	66
90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
139	253	246	80	66	66	80	246	253	139	139	253	246	80	66
164	228	116	20	178	178	20	116	228	164	164	228	116	20	178
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255

Figure 10: Using various created window

Figure 11 shows another two created windows and the resulting value of the noisy pixel after using each of these windows; figure 12 shows the final denoised image using the window 11 by 11 shown in figure 11:



90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
139	253	246	80	66	66	80	246	253	139	139	253	246	80	66
164	228	116	20	178	178	20	116	228	164	164	228	116	20	178
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255
164	228	116	20	178	178	20	116	228	164	164	228	116	20	178
139	253	246	80	66	66	80	246	253	139	139	253	246	80	66
90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
90	91	196	143	255	255	143	196	91	90	90	91	196	143	255
139	253	246	80	66	66	80	246	253	139	139	253	246	80	66
164	228	116	20	178	178	20	116	228	164	164	228	116	20	178
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255
175	76	0	24	255	255	24	0	76	175	175	76	0	24	255

Figure 11: Windows examples

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

Denoised matrix

139	24	139	76	175
178	20	116	228	164
66	80	246	253	139
255	143	196	91	90

Figure 12: Denoised image using window 11 by 11

The created window can be used to improve median and average filters, in the implementation part the size of the window will investigated and the optimal size will be recommended based on the obtained value of the calculated between the clear and noisy images peak signal to noise ratio (PSNR) [35-40].
The proposed modified median filter (PMMF) will be implemented by applying algorithm 3, shown below.

Algorithm 3: PMMF operations:

This algorithm can be easily used to de-noise gray and color images, in color image each color matrix must treated separately, and the denoised matrices must be combined in one 3D matrix to get the denoised color image, the window size was selected 11 by 11 (This selection will be explained later).

Step 1: Get the noisy image (A).
Step 2: Pad the noisy image 5 by 5 (pA).
Step 3: Get the noisy index matrix (B).
Step 4: Get the index padded matrix (pB).
Step 5: Get the size of pB (m and n).
Step 6: for row equal 6 to m-6 do
Step 7: for column equal 6 to n-6 do
Step 8: If the pixel is not noisy continue.
Step 9: Create a window with size 11 by 11 in pB.
Step 10: if the window summation equal zero continue.
Step 11: From the associated pA get a set of clean pixels.
Step 12: Let the new pixel value equal the median of the set.
Step 13: End for
Step 14: End for
Below is a matlab sequence of operation, which can be used to implement PMMF.

```
A=ab(:,:,1);
pA=padarray(A,[5 5],'symmetric');
pB=(~(pA==0 | pA==255));
B=(~(A==0 | A==255));
[m,n]=size(pB);
% First round
tic
      for I=6:m-6
         for J=6:n-6
            if(B(I-5,J-5)==0)
               if(sum(sum(pB(I-5:I+1,J-5:J+5)))~=0)
                R1=pA(I-5:I+5,J-5:J+5);% W1P creation
                R1=R1(R1>0 & R1<255);mR=median(R1); A(I-5,J-5)=mR;

               end
            end
         end
       end

 X(:,:,1)=A;
```

The proposed modified average filter (PMAF) will be implemented by applying algorithm 4, shown below.

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

Algorithm 4: PMAF operations:

Step 1: Get the noisy image (A).
Step 2: Pad the noisy image 5 by 5 (pA).
Step 3: Get the noisy index matrix (B).
Step 4: Get the index padded matrix (pB).
Step 5: Get the size of pB (m and n).
Step 6: for row equal 6 to m-6 do
Step 7: for column equal 6 to n-6 do
Step 8: If the pixel is not noisy continue.
Step 9: Create a window with size 11 by 11 in pB.
Step 10: if the window summation equal zero continue.
Step 11: From the associated pA get a set of clean pixels.
Step 12: Let the new pixel value equal the average value of the set.
Step 13: End for
Step 14: End for

Below is a matlab sequence of operation, which can be used to implement PMMF.

```
A=ab(:,:,1);
pA=padarray(A,[5 5],'symmetric');
pB=(~(pA==0 | pA==255));
B=(~(A==0 | A==255));
[m,n]=size(pB);
% First round
tic
        for I=6:m-6
            for J=6:n-6
               if(B(I-5,J-5)==0)
                   if(sum(sum(pB(I-5:I+1,J-5:J+5)))~=0)
                    R1=pA(I-5:I+5,J-5:J+5);% W1P creation
                    R1=R1(R1>0 & R1<255);mR=mean (R1); A(I-5,J-5)=mR;

                   end
               end
            end
          end

  X(:,:,1)=A;
```

RESULTS AND DISCUSSION

MF and AF have the following disadvantages:

- Both the filters treat noisy and clean pixels. And this will negatively affect the quality of the denoised image.
- Increasing the NR will rapidly decrease the quality of the denoised image.
- For higher NR (NR greater than 40%) these filter became inefficient by producing a low quality denoised image (see figure 13).

To overcome the above disadvantages, the proposed modifications of these filter were proposed, figure 14 and 15 show how the quality of the denoised images was improved.

The proposed MMF and MAF use a created window to calculate the new value of the noisy pixels, this window must have a size, below we will study how changing the window size will affect the quality of the denoised images, the size which will give a better PSNR value will be recommended to be used in the proposed filters.

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

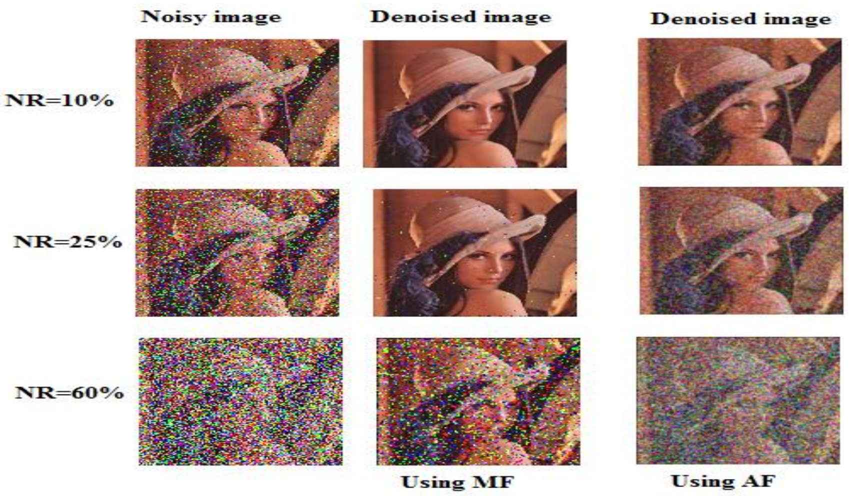


Figure 13: Denoising using MF and AF

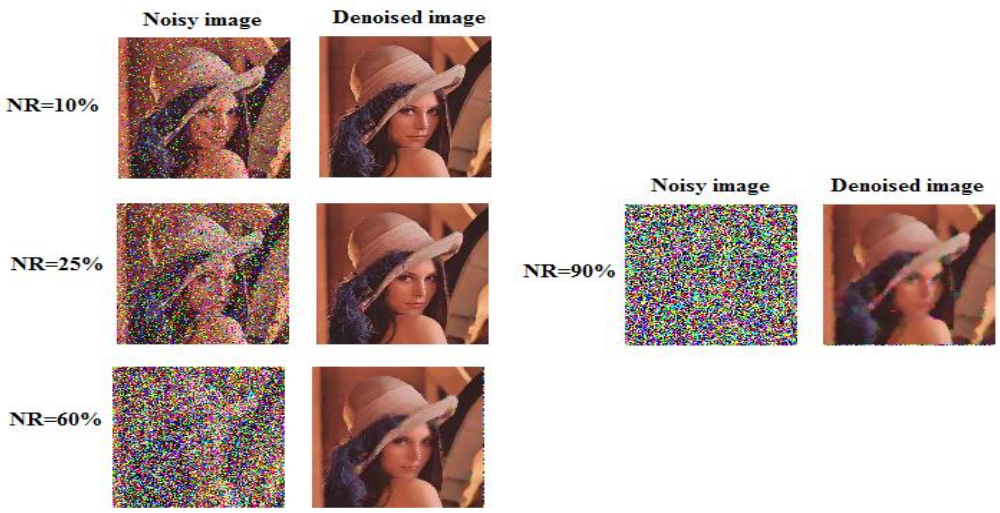


Figure 14: Denoising using PMMF

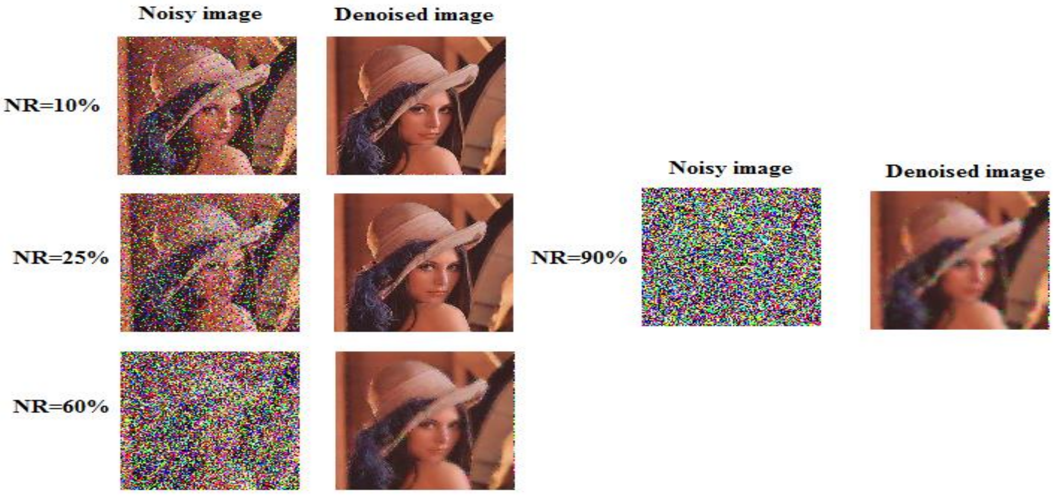


Figure 15: Denoising using PMAF

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

Table 1: PSNR for denoised image (NR=1%)

Window size	PMMF	PMAF
6 by 6	87.1595	87.3261
7 by 7	89.3918	87.3261
8 by 8	90.4535	91.4921
9 by 9	94.6706	90.7617
10 by 10	92.9698	92.4450
11 by 11	93.1901	93.3750

Table 2: PSNR for denoised image (NR=10%)

Window size	PMMF	PMAF
6 by 6	67.4077	68.2925
7 by 7	69.7028	69.9928
8 by 8	71.2209	71.3031
9 by 9	73.3999	72.4834
10 by 10	74.1617	72.4834
11 by 11	73.9447	72.4298

Table 3: PSNR for denoised image (NR=90%)

Window size	PMMF	PMAF
6 by 6	39.5729	39.9552
7 by 7	43.9299	45.1067
8 by 8	47.0501	47.9231
9 by 9	49.6029	49.5257
10 by 10	49.6029	49.7746
11 by 11	49.6029	49.6220

From tables 1, 2 and 3 we can see that the window size of 10 by 10 or 11 by 11 will give the optimal performance by maximizing the PSNR values for various NRs, and the following experiments we will adopt 11 by 11 window.
The image lena.png was affected by SAPN using various NR values, the affected images were processed using MF, AF, PMMF and PMAF, for each denoised image the PSNR value between the clean and the denoised image was calculated, table 4 shows the obtained results:

Table 4: Obtained PSNR values

NR %	MF	AF	PMMF	PMAF
0.1	79.3291	68.6273	97.6401	92.2662
1	78.9679	65.9888	91.2411	87.4468
5	76.6948	58.4085	80.8621	77.8291
10	72.7974	53.0426	74.6240	71.7734
15	68.8079	49.2783	68.5543	70.6474
20	63.6841	46.1879	65.9001	68.2954
30	52.1895	41.4962	61.7874	64.4530
40	42.2628	37.9330	59.2588	59.1057
50	34.3408	35.1340	59.0407	57.1043
60	27.4585	32.4529	56.8646	55.3528
90	14.6447	26.6507	50.7570	50.3085

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

From table 4 we can see that the PMMF optimized the PSNR values giving the maximum values, thus using it will enhance the quality of the denoised images. PMAF results were closed to PMMF results, figure 16 shows how the proposed filters enhanced the performance of Denoising SAPN by improving the quality of the obtained denoised image using various NRs values.

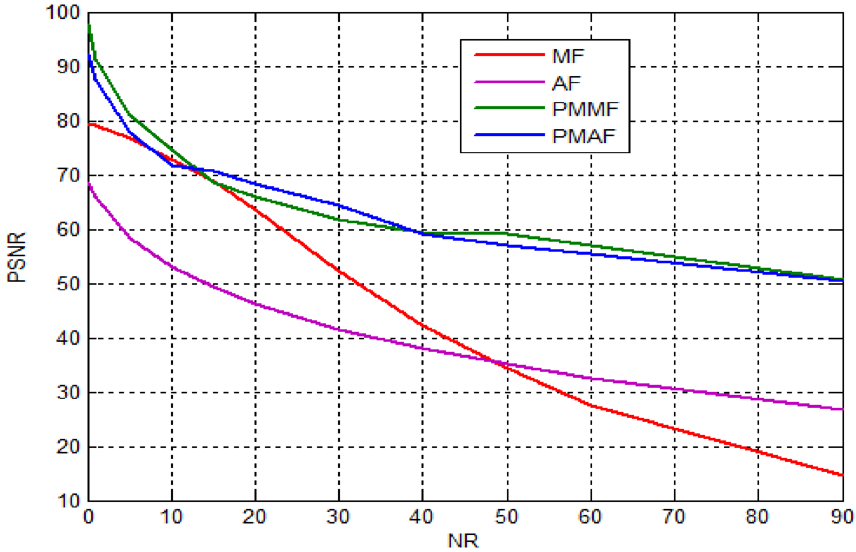


Figure 16: Filters comparisons

CONCLUSION

Efficient and simple modifications of median and average filters were introduced. The proposed methods were tested and implemented using noisy images with various noise ratios, it was shown that the proposed method improved the quality of the denoised images affected with high and low values of noise ratios. The proposed methods were used to treat only the infected pixel solving one of the median and average filters disadvantage. To find the optimal value of the noisy pixel a special window was created and used. The size of this window was investigated and it was shown that using a 10 by 10 or a 11 by 11 window will give the optimal solution. The proposed method used a simple data structures to create the covering window, and this window can be efficiently used to treat color and gray images.

REFERENCES

[1] Naseem Asad, Ismail Shayeb, Qazem Jaber, Belal Ayyoub, Ziad Alqadi, Ahmad Sharadqh, creating a Stable and Fixed Features Array for Digital Color Image, IJCSMC, Vol. 8, Issue. 8, August 2019, pg.50 – 62.
[2] Majed O. Al-Dwairi, Amjad Y. Hendi, Mohamed S. Soliman, Ziad A.A. Alqadi, A new method for voice signal features creation, International Journal of Electrical and Computer Engineering (IJECE), vol. 9, issue 5, pp. 4092-4098, 2018.
[3] Akram A. Moustafa and Ziad A. Alqadi, A Practical Approach of Selecting the Edge Detector Parameters to Achieve a Good Edge Map of the Gray Image, Journal of Computer Science 5 (5): 355-362, 2009.
[4] ZA Alqadi, Musbah Aqel, Ibrahiem MM El Emary, Performance analysis and evaluation of parallel matrix multiplication algorithms, World Applied Sciences Journal, vol. 5, issue 2, pp. 211-214, 2008.
[5] Ayman Al-Rawashdeh, Ziad Al-Qadi, using wave equation to extract digital signal features, Engineering, Technology & Applied Science Research, vol. 8, issue 4, pp. 1356-1359, 2018.
[6] Ziad Alqadi, Bilal Zahran, Qazem Jaber, Belal Ayyoub, Jamil Al-Azzeh, Enhancing the Capacity of LSB Method by Introducing LSB2Z Method, International Journal of Computer Science and Mobile Computing, vol. 8, issue 3, pp. 76-90, 2019.
[7] Ziad A. Alqadi, Majed O. Al-Dwairi, Amjad A. Abu Jazar and Rushdi Abu Zneit, Optimized True-RGB color Image Processing, World Applied Sciences Journal 8 (10): 1175-1182, ISSN 1818-4952, 2010.

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

[8] Waheeb, A. and Ziad AlQadi, Gray image reconstruction. Eur. J. Sci. Res., 27: 167-173, 2009.
[9] A. A. Moustafa, Z. A. Alqadi, "Color Image Reconstruction Using a New R'G'I Model", Journal of Computer Science, Vol.5, No. 4, pp. 250-254, 2009.
[10] K Matrouk, A Al-Hasanat, H Alasha'ary, Z. Al-Qadi Al-Shalabi, "Speech fingerprint to identify isolated word person", World Applied Sciences Journal, Vol. 31, No. 10, pp. 1767-1771, 2014.
[11] J. Al-Azzeh, B. Zahran, Z. Alqadi, B. Ayyoub, M. Abu-Zaher, "A Novel zero-error method to create a secret tag for an image", Journal of Theoretical and Applied Information Technology, Vol. 96. No. 13, pp. 4081-4091, 2018.
[12] Prof. Ziad A.A. Alqadi, Prof. Mohammed K. Abu Zalata, Ghazi M. Qaryouti, Comparative Analysis of Color Image Steganography, JCSMC, Vol.5, Issue. 11, November 2016, pg.37–43.
[13] M. Jose, "Hiding Image in Image Using LSB Insertion Method with Improved Security and Quality", International Journal of Science and Research, Vol. 3, No. 9, pp. 2281-2284, 2014.
[14] M. Juneja, P. S. Sandhu, An improved LSB based Steganography with enhanced Security and Embedding/Extraction, 3rd International Conference on Intelligent Computational Systems, Hong Kong China, January 26-27, 2013.
[15] H. Alasha'ary, K. Matrouk, A. Al-Hasanat, Z. A alqadi, H. Al-Shalabi (2013), Improving Matrix Multiplication Using Parallel Computing, International Journal on Information Technology (I.RE.I.T.) Vol. 1, N. 6 ISSN 2281-2911.
[16] Bilal Zahran, Ziad Alqadi, Jihad Nader, Ashraf Abu Ein A COMPARISON BETWEEN PARALLEL AND SEGMENTATION METHODS USED FOR IMAGE ENCRYPTION-DECRYPTION, International Journal of Computer Science & Information Technology (IJCSIT) Vol 8, No 5, October 2016.
[17] Z.A. Alqadi, A. Abu-Jazar (2005), Analysis of Program Methods Used for Optimizing Matrix Multiplication, Journal of Engineering, vol. 15 n. 1, pp. 73-78.
[18] Jamil Al-Azzeh, Bilal Zahran, Ziad Alqadi, Belal Ayyoub, Muhammed Mesleh: A Novel Based On Image Blocking Method to Encrypt-Decrypt Color JOIV: International Journal on Informatics Visualization, 2019.
[19] Jamil Al-Azzeh, Bilal Zahran, Ziad Alqadi, Belal Ayyoub and Mazen Abu-Zaher: A Novel Zero-Error Method to Create a Secret Tag for an Image; Journal of Theoretical and Applied Information Technology 15th July 2018.
[20] Jamil Al Azzeh, Ziad Alqadi Qazem, M. Jabber: Statistical Analysis of Methods Used to Enhanced Color Image Histogram; XX International Scientific and Technical Conference; Russia May 24-26, 2017.
[21]] Jamil Al Azzeh, Hussein Alhatamleh, Ziad A. Alqadi, Mohammad Khalil Abuzalata: Creating a Color Map to be used to Convert a Gray Image to Color Image; International Journal of Computer Applications (0975 – 8887). Volume 153 – No2, November 2016.
[22] Khaled Matrouk, Abdullah Al- Hasanat, Haitham Alasha'ary, Ziad Al-Qadi, Hasan Al-Shalabi Analysis of Matrix Ziad Alqadi et al, International Journal of Computer Science and Mobile Computing, Vol.8 Issue.3, March- 2019, pg. 76-90.
[23] Mohammed Abuzalata; Ziad Alqadi, Jamil Al-Azzeh; Qazem Jaber Modified Inverse LSB Method for Highly Secure Message Hiding: International Journal of Computer Science and Mobile Computing, Vol.8 Issue.2, February- 2019, pg. 93-103.
[24] Qazem Jaber Rashad J. Rasras, Mohammed Abuzalata, Ziad Alqadi, Jamil Al-Azzeh; Comparative Analysis of Color Image Encryption-Decryption Methods Based on Matrix Manipulation: International Journal of Computer Science and Mobile Computing, Vol.8 Issue.2, 2019/3.
[25] Jamil Al-Azzeh, Ziad Alqadi, Mohammed Abuzalata; Performance Analysis of Artificial Neural Networks used for Color Image Recognition and Retrieving: International Journal of Computer Science and Mobile Computing, Vol.8 Issue.2, February- 2019.
[26] Rashad J. Rasras, Mohammed Abuzalata; Ziad Alqadi; Jamil Al-Azzeh; Qazem Jaber, Comparative Analysis of Color Image Encryption-Decryption Methods Based on Matrix Manipulation International Journal of Computer Science and Mobile Computing, Vol.8 Issue.3, March- 2019, pg. 14-26.

iJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

[27] Jamil Al-Azzeh, Bilal Zahran, Ziad Alqadi, Belal Ayyoub, Muhammed Mesleh; A Novel Based on Image Blocking Method to Encrypt-Decrypt Color; INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION VOL 3, (2019)
[28] B. Zahran, J. AL-Azzeh, Z. Al Qadi, M. Al Zoghoul and S. Khawatreh, “A MODIFIED LBP METHOD TO EXTRACT FEATURES FROM COLOR IMAGES", Journal of Theoretical and Applied Information Technology(JATIT), Vol.96. No 10, 2018.
[29] J. AL-AZZEH, B. ZAHRAN, Z. ALQADI, B. AYYOUB, M. ABU-ZAHER, "A novel Zero-error Method to Create a Secret Tag for an Image", Journal of Theoretical and Applied Information Technology(JATIT), Vol.96. No 13, 2018.pp: 4081-4091.
[30] J. AL-AZZEH, B. ZAHRAN, Z. ALQADI," Salt and Pepper Noise: Effects and Removal", International Journal on Informatics Visualization, Vol.2. No 4, 2018.pp: 252-256.
[31] Jihad Nader, Ziad Alqadi, Bilal Zahran, "Analysis of Color Image Filtering Methods", International Journal of Computer Applications (IJCA), Volume 174, issue 8, 2017, pp:12-17.
[32] Ziad Alqadi, Bilal Zahran, Jihad Nader, " Estimation and Tuning of FIR Low pass Digital Filter Parameters", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 7, Issue 2, 2017, pp:18-23.
[33] Khaled Aldebei, Mua’ad M. Abu-Faraj, Ziad A. Alqadi, Comparative Analysis of Fingerprint Features Extraction Methods, Journal of Hunan University Natural Sciences, vol. 48, issue 12, pp. 177-182, 2022.
[34] Dr. Mohamad Barakat Prof. Ziad Alqadi, Highly Secure Method for Secret Data Transmission, International Journal of Scientific Engineering and Science, vol. 6, issue 1, pp. 49-55, 2022.
[35] Ziad A. Alqadi Mua’ad M. Abu-Faraj, Rounds Reduction and Blocks Controlling to Enhance the Performance of Standard Method of Data Cryptography, International Journal of Computer Science and Network Security, vol. 21, issue 12, pp. 648-656, 2021.
[36] Ziad Alqadi Mua’ad Abu-Faraj, Khaled Aldebei, DEEP MACHINE LEARNING TO ENHANCE ANN PERFORMANCE: FINGERPRINT CLASSIFIER CASE STUDY, JOURNAL OF SOUTHWEST JIAOTONG UNIVERSITY, vol. 56, issue 6, pp. 686-694, 2021.
[37] Ziad A. Alqadi Mua’ad M. Abu-Faraj, Improving the Efficiency and Scalability of Standard Methods for Data Cryptography, International Journal of Computer Science and Network Security, vol. 21, issue 12, pp. 451-458, 2021.
[38] Mua’ad M. Abu-Faraj Prof. Ziad Alqadi, Using Highly Secure Data Encryption Method for Text File Cryptography, International Journal of Computer Science and Network Security, vol. 20, issue 11, pp. 53-60, 2021.
[39] AlQaisi Aws, AlTarawneh Mokhled, A Alqadi Ziad, A Sharadqah Ahmad, Analysis of Color Image Features Extraction using Texture Methods, TELKOMNIKA, vol. 17, issue 3, 2018.
[40] Ziad A AlQadi Amjad Y Hindi, O Dwairi Majed, PROCEDURES FOR SPEECH RECOGNITION USING LPC AND ANN, International Journal of Engineering Technology Research & Management, vol. 4, issue 2, pp. 48-55, 2020.
[41] Ziad A Alqadi, Mohamad Tariq Barakat, A Case Study to Improve the Quality of Median Filter, International Journal of Computer Science and Mobile Computing, vol. 10, issue 11, pp. 19 – 28, 2021.
[42] Dr. Hatim Ghazi Zaini Prof. Ziad Alqadi, High Salt and Pepper Noise Ratio Reduction, International Journal of Computer Science and Mobile Computing, vol. 10, issue 9, pp. 88 – 97, 2021.
[43] Prof. Mohamad K. Abu Zalata, Hussein N. Hatamleh, Prof. Ziad A. Alqadi, Detailed Study of Low Density Salt and Pepper Noise Removal from Digital Color Images, IJCSMC, Vol. 11, Issue. 2, PP. 56 – 67, February 2022.