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Research paper

Effect of matrix size in affecting noise reduction level of filtering

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Abstract

Improved image quality needs to be done to improve data processing on the image. This quality improvement can be made by doing masking technique. Median Filter is one technique to enhance the quality of an image in a particular space. Median filtering improves the image by specifying a specific pixel from its neighboring pixels. The median filtering calculation uses a matrix block with an odd number. Each matrix block will have a middle value after the pixel values have regularly been sorted. This method is included in the category of nonlinear filtering. With the median filtering, the output pixel value is determined by the median of the specified mask environment. Median Filter has different results when using different matrix sizes as well. The results of this process can determine how gentle the result of noise reduction. In general, the larger the size of the matrix, the higher the blurriness of an image.

Keywords: *Image Processing; Median Filter; Matrix Size*

1. Introduction

Information is a precious data delivered through the power grid. [1] [2]. Without the presence of electricity, the computer can not display the image. Information retrieval is the most important thing [3]–[11] An image can save the beauty of a moment, giving and hiding valuable information [12]–[14]. Image smoothing is a step to reduce noise on an image. It can be done with a median filter. The smoothing process is done by determining the pixel statistics that are in the neighborhood area [15]–[17] Any potentially changing pixels will be replaced with the median value of the pixel value set that exists in the window of this neighborhood after ordering. The median filter is used to create a softer image than the original. For example, photos were taken at night often experience noise [18]. Noise is the value that appears most rarely in an image [19] [20]. It causes the median filter to work on the original image that has variations in the color intensity that tend to be homogeneous. This technique can be combined using other statistics. The noise can be reduced so that the photo looks cleaner than the original [21]. The median filter has a unit of measure to determine the degree of blurring [22]. It is expressed by the size of the matrix on each test block. The resulting object has different noise reduction levels. The matrix used is odd. In this study will be tested several sizes, 3 x 3, 5 x 5, and 7 x 7. Each matrix will have a significant difference to the others. Specifying the size of the matrix will allow the user to choose the best image. Each size has different speeds. The median filter image can be used for extracting features and other processes.

2. Theories

2.1. Noise reduction

Images are visualizations of an activity. Each image has three color layers [23]–[26] Noise on an image can occur due to gray-level characteristics or random variables that occur due to the characteristics of the Probability Density Function. If the image containing the noise is directly processed and extracted, then its important features can cause accuracy problems [27]–[29] So it should be cleaned out of noise first, and then processed to extract its important features. The technique for reducing noise is order-statistics filters, which are spatial filters where the response results are based on the sorting of pixel values enclosed by filters [30].

2.2. Median filtering

Image quality is the selling value that makes money when viewed from economic factors [31]. Median filtering is the most known order-statistic filter. The workings of these filters are formulated in the following equations:

$$F(x,y) = \text{Median } (s,t) € \text{ sxy } \{g(s,t)\}$$

The median filtering takes a certain area of the image according to the size of the specified mask [32], then views each pixel value in that area, and the value of the area in the change with the median value [33] [34]. The method of obtaining the median value is: the gray value of the points on the matrix is sorted from the smallest to the largest, then in the middle value of the pixel series [27].

For certain types of noise, this filter provides excellent reducing capacity, with less blurring than a linear smoothing filter for the same image size [35]–[37] Median filtering offers excellent results for images exposed to bipolar and unipolar impulse noise [38]. Examples of noise reduction results using median filtering can be seen in the following figure [39].

Fig. 1: (A) Noisy Image (B) Median Filtering Image.

Figure 1 (a) explains that the image contains noise in the form of grayish white spots that disturb the eye. These spots are created because the quality of the camera is less suitable for a low light condition. The result of median filter improvement can be seen in Figure 1 (b) where the grayish white spots have faded or disappeared and are disguised based on the neighboring pixels depending on the size of the matrix used [40].

3. Methodology

3.1. Median filtering 3 x 3

Median filtering uses a matrix to perform calculations of replacement pixel values. The calculation below has a 3 x 3 matrix size. The initial image given is a 10 x 10 pixel size as shown in the following table.

Table 1: Initial Pixel Data

164	187	181	217	129	156	234	172	44	143
102	10	208	180	9	97	253	75	234	126
75	202	2	210	59	82	144	24	5	68
179	164	32	16	167	217	20	14	16	42
227	170	123	171	167	58	114	188	220	16
93	218	190	97	102	172	210	212	168	243
158	50	28	108	221	38	33	195	253	176
0	87	226	219	39	148	163	63	84	17
168	125	191	57	42	45	33	38	230	132
241	130	190	145	211	244	22	100	141	231
63	176	25	138	82	192	126	177	32	113

Table 1 describes the pixel value of the original image. The first stage is to take as much as 9 pixels from the upper left corner of the image. Image snippets can be seen as follows:

164	187	181
102	10	208
75	202	2

The pixel values are exposed in a one-dimensional vector. The value of the pixel is sorted first from small to large to produce as below.

2	10	75	102	164	181	187	202	208

The median value is 164. It is located in the fifth column. The pixel in the middle of 3 x 3 matrix will be replaced by the median value. The value “10” is replaced by “164”. The new pixel formation is shown in the following block.

164	187	181
102	164	208
75	202	2

3.2. Median filtering 5 x 5

The median filtering calculation on the 5 x 5 matrix is the same as the 3 x 3 matrix. The fundamental difference is the number of neighboring pixels to be compared. The illustration below describes the calculation. The pixel data table used is the same as before. The pixel block will be loaded 25 pixels consisting of five columns and five rows as shown below.

164	187	181	217	129
102	10	208	180	9
75	202	2	210	59
179	164	32	16	167
227	170	123	171	167

The pixel values are exposed in a one-dimensional vector as well. The value of the pixel is sorted first from small to large to produce as below.

2	9	10	16	32
59	75	102	123	129
164	164	167	167	170
171	179	180	181	187
202	208	210	217	227

The median value is 167. It is located column 13. The pixel in the middle of 5 x 5 matrix will be replaced by the median value. The value “2” is replaced by “167”. The new pixel formation is shown in the following block.

164	187	181	217	129
102	10	208	180	9
75	202	167	210	59
179	164	32	16	167
227	170	123	171	167

3.3. Median filtering 7 x 7

The median filtering calculation on the 7 x 7 matrix takes 49 pixels. The illustration below describes the calculation. The pixel data table used is the same as before. The pixel block will be loaded consisting of seven columns and seven rows as shown below.

164	187	181	217	129	156	234
102	10	208	180	9	97	253
75	202	2	210	59	82	144
179	164	32	16	167	217	20
227	170	123	171	167	58	114
93	218	190	97	102	172	210
158	50	28	108	221	38	33

The pixel values are exposed in a one-dimensional vector as well. The value of the pixel is sorted first from small to large to produce as below.

2	9	10	16	20	28	32
33	38	50	58	59	75	82
93	97	97	102	102	108	114
123	129	144	156	158	164	164
167	167	170	171	172	179	180
181	187	190	202	208	210	210
217	217	218	221	227	234	253

The median value is 156. It is located column 25. The pixel in the middle of 7 x 7 matrix will be replaced by the median value. The value “16” is replaced by “156”. The new pixel formation is shown in the following block.

164	187	181	217	129	156	234
102	10	208	180	9	97	253
75	202	2	210	59	82	144
179	164	32	156	167	217	20
227	170	123	171	167	58	114

93	218	190	97	102	172	210
158	50	28	108	221	38	33

4. Result and discussion

4.1.Good quality image test

This section tests the noisy image. The median filtering results in the image will be compared against other imagery. The image will have a variation in the degree of blurring. The first test takes an image of 600 x 600 pixels.

Fig. 2: 3 X 3 Median Filtering (600 X 600 Pixels).

Figure 2 illustrates an image using a 3 x 3 matrix size as a median filtering process. There is no significant result to these two images because of the small size of the matrix. The median filter process at this size has pretty good speed.

Fig. 3: 5 X 5 Median Filtering (600 X 600 Pixels).

The image resulted in Figure 3 has started to blur a bit. The sharpness of the image is deficient due to the smoothing of the resulting image by using the 5 x 5 matrix. This measure shows good median values. Noise on the original image will decrease if this process is done.

Fig. 4: 7 X 7 Median Filtering (600 X 600 Pixels).

The use of the 7 x 7 matrix in Figure 4 affects the image results significantly. The original image and the image of the median filter feels so different. It happens because the size of this matrix compares 49 pixels so that there are parts that will become blurred due to the effect of median filter usage.

4.2. Low resolution image test

The second test tests the image with low quality. The image tested is a 130 x 100 pixel image.

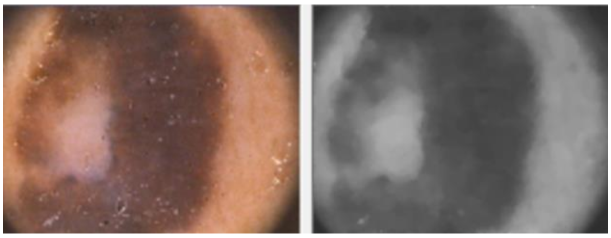

Fig. 5: 3 X 3 Median Filtering (130 X 100 Pixels).

In the low-resolution test, the use of 3 x 3 matrix size can display significant results. Figure 5 illustrates some white noise; this noise has been terminated on the median filter results.

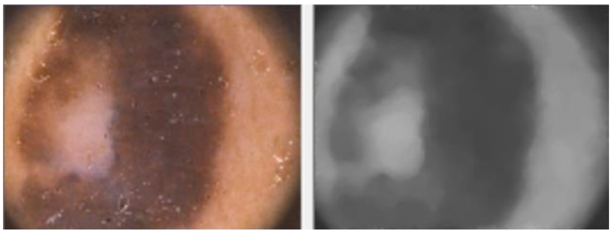

Fig. 6: 5 X 5 Median Filtering (130 X 100 Pixels).

Figure 6 has similar results to figure 5, but in this image, the image blur of the median filter is higher. Sharp shapes produce more curved and blurred lines.

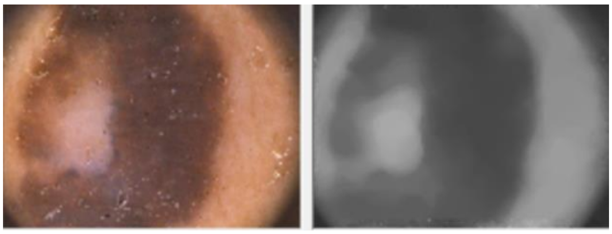

Fig. 7: 7 X 7 Median Filtering (130 X 100 Pixels).

Figure 7 has a very high degree of vagueness. The 7 x 7 matrix size will have different results if applied to different resolutions. In low-resolution, the use of this size will change the image like a cartoon image. From previous experiments, it can be seen that the higher the number of matrices, the higher the blur of the image.

5. Conclusion

Median filtering is an excellent method to reduce the noise level in an image. Examining neighboring patterns by calculating the mean of the pixels will help mask the noise gaps in the image. The larger the masking space on the median filtering, the higher the blurred image level. The weakness of the median filtering lies in the small image size. Implementing this method on a small image will undermine the authenticity of the image.

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