Vector Base Approach Filter for One Channel Noise Removal in A Color Digital Image

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Abstract. The digitization process can cause misinformation in the digital image. The distortion of information in a digital image is called noise, this condition causes visual damage to the image. Therefore, the damaged image needs to be repaired to enhance the image quality. In this paper, new image filtering method with vector approach is proposed. This method compares the intensity level of each pixel in every part of image. The experimental results show that the proposed method works well and restores the visual of the image as it is in the real condition. This is because the process of determining new pixel value on the proposed method considers the pixels value in image globally.

Keywords: Vector, Image filtering, Impulse noise.

1. Introduction
An image is the reflection result of real conditions into two dimensions. Image as a communication medium is growing in line with the development of technology [1]. From an image we can get various types of information clearly. Therefore, the exchange of information using images has been used in many aspects including defense and military aspects. To obtain good information, a good quality image is needed. Not all images are in good quality, some images have visual disturbance which causes loss of information in the image. Visual disturbances that occur in images are usually caused by noise that appears due to environmental conditions, sensor temperature, lack of lighting, or transmission process. Impulse noise is a type of noise that occurs due to miss transmissions [2]. The appearance of noise in an image causes a change in the pixel value which results in the overall appearance of the image. This problem can be solved by improving the image quality by performing a process of image filtering. Median filter is a filtering technique performed on a fixed size window and can completely remove noise from the image. To date, many researchers have modified and developed the median filter to obtain better filtering techniques.

A number of proposed techniques focus on fixed size windows and propose new methods of determining new pixel value such as median filter, modified decision based unsymmetric trimmed median filter, based pixel density filter, and tropical algebra based median filter [3-6]. Aside from fixed size windows, some research has also modified the target window using adaptive window technique to increase the effectiveness of proposed methods such as noise adaptive fuzzy switching median filter, different applied median filter, and tropical algebra based adaptive filter [7-9]. Most of the existing filtering techniques work locally where the decision making in determining the new pixel value focuses on a number of pixels around the processed pixel. In this paper, a new filtering technique for RGB
images is proposed using the norm vector approach by considering every pixel in the image globally. This is to obtain a new pixel value closest to the actual pixel value.

2. Proposed Method
As mentioned earlier, the filtering process is performed globally on all pixels in RGB images. In this study it is assumed that noise is in one of the Red, Green, or Blue channels, which means that in one pixel there is only one channel that is corrupted by noise. Initially, processed RBG image is extracted into red, green, and blue channels.

\[ P = (R, G, B) \]  

Furthermore, from the \( m \times n \) resolution image, an \( X \) array consisting of \( R, G, B \) denoted \( X = [R_{ij} \ G_{ij} \ B_{ij}] \), channels is constructed in such a way

\[ X = [R_{ij} \ G_{ij} \ B_{ij}], \begin{cases} X^n_{ij}, & \text{noisy pixels} \\ X^c_{ij}, & \text{free – noise pixels} \end{cases} \]  

Let every row of \( X_{ij} \) is a couple. Subsequently, find a couple \( \bar{x} \in X^c_{ij} \) such that minimizing the norm level of the noisy pixels in \( X^n_{ij} \) and replace it is noisy value with \( \bar{x} \) value.

3. Experimental Result
The performance of the proposed technique is tested on several color images with noise at different density level. Experiments were performed on three different images, such as fighter, satellite view, and house. In addition, several existing methods such as median filter (MF), based pixel density filter (BPDF), tropical algebra based median filter (TMF), tropical algebra based adaptive filter (TAF), and different applied median filter (DAMF) will be compared.

Table 1. PSNR values from the experimental results on three images with different noise densities.

| Image (noise level) | Noisy channel | MF   | BPDF | TMF   | DAMF  | TAF   | Proposed |
|---------------------|---------------|------|------|-------|-------|-------|----------|
| Fighter (10%)       | Red           | 32.58| 39.57| 43.04 | 43.17 | 43.18 | 40.38    |
|                     | Green         | 32.82| 39.29| 40.86 | 41.18 | 41.41 | 44.96    |
|                     | Blue          | 32.98| 39.88| 44.82 | 45.54 | 46.24 | 41.63    |
|                     | Average       | 32.78| 39.78| 42.91 | 43.29 | 43.61 | 42.32    |
| Satellite view (30%)| Red           | 22.86| 26.75| 28.31 | 28.94 | 28.83 | 35.73    |
|                     | Green         | 22.79| 26.99| 28.53 | 29.19 | 29.01 | 37.58    |
|                     | Blue          | 22.87| 26.79| 28.52 | 29.06 | 29.24 | 39.32    |
|                     | Average       | 22.84| 26.84| 28.45 | 20.06 | 29.02 | 37.54    |
| House (50%)         | Red           | 20.18| 33.33| 34.73 | 37.54 | 37.56 | 32.32    |
|                     | Green         | 19.55| 27.93| 29.77 | 29.75 | 29.77 | 29.77    |
|                     | Blue          | 19.52| 31.21| 33.08 | 35.02 | 35.11 | 35.72    |
|                     | Average       | 19.75| 30.82| 32.52 | 34.10 | 34.14 | 32.45    |

In Table 1, the results of the peak signal to ratio (PSNR) calculation from the filtering results on images with different noise levels are presented. The higher the PSNR value indicates that the better the output results obtained, which means the method used is also good. Based on Table 1, it is found that quantitatively the proposed method can work well compared to several existing methods.
Figure 1. The filtering results on the image with 10% noise; (a) This column presents a case for a noisy red channel, (b) This column presents a case for a noisy green channel, (c) This column presents a case for a noisy blue channel.

Figure 2. The filtering results on the image with 50% noise; (a) This column presents a case for a noisy red channel, (b) This column presents a case for a noisy green channel, (c) This column presents a case for a noisy blue channel.
Figure 1 and Figure 2 present the visual results of the proposed method on images with low and medium density noise. The proposed method can reconstruct the corrupted image into a clean image without noise on it. In addition, the output image has a high similarity to the original image because the restoration process compares every pixel in the image as a whole until the pixel value closest to the actual value is obtained.

4. Conclusion

During the transmission process, digital image may experience interference that cause impulse noise to appear in the image. This causes visual damage to the image and losses some of the original information contained in the image. Image filtering is a technique to improve the quality of a digital image by repairing the pixels in the corrupted image. A large number of currently developed methods work locally on the neighbourhood pixels of the processed pixels. In this paper, a new filtering technique is proposed that uses a vector approach and considers every pixel in the image as a whole. The experimental result shows that the proposed method works better in removing noise for one channel problem from RGB images. This is supported by the results of statistical calculations as shown in Table 1 and the visual output in Figure 1 and Figure 2. The proposed technique focuses on color image with the noise case for one channel. For future research, this technique will be improved so that it can be applied to noisy images in general.

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