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Detection and Removal of Salt and Pepper Noise in Images and Videos

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ABSTRACT: An image is a two dimensional function of spatial coordinates. During transmission it may be corrupted by impulse noise like salt and pepper noise due to malfunctioning pixels in camera sensors, or faulty memory locations in hardware. For images corrupted by salt and pepper noise, the noisy pixels can take only the maximum value and the minimum value in its dynamic range. In median value computation, the original value of the pixel is also included. They provide excellent noise reduction capabilities for certain types of random noise. But median filter fails at higher noise density and they tend to modify both good pixels and noise pixels. So, sometimes, some important information's may be lost from the image. This is the major disadvantage of conventional median filter. In this paper, an algorithm based on median filter is proposed to detect and eliminate salt and pepper noise in color images and videos. In this proposed method, the denoising procedure is carried out in two steps, in the first step, the noisy pixels are detected and in the second step filtering is done only on these pixels. In color images, there are three different color channels for each pixel, Video signal is referred to as a sequence of still images representing still images in motion. Like images, video signals are often corrupted with impulsive noise. For de-noising, video signal using the proposed filter, first it is converted into video frames. The filtering is done on these frames using proposed median filter. Finally these video frames are converted back to video information. De-noising of color images and videos is desirable in many image processing applications. The simulation results were analyzed for the performance calculation, which shows the proposed filter keeps the edges very clear..

KEYWORDS: Salt and pepper noise, Conventional median filter, improved median filter, Peak signal to noise ratio

I. INTODUCTION

The fields of digital image processing have been increasing day by day. The color image processing is a sub field of digital image processing, and it has vital role in various applications. An image is defined as a two dimensional function of spatial coordinates [2]. A digital image is obtained when all the amplitude of this function is finite and discrete. These amplitude values are knownas pixel values. When these pixel values include color information in it, the digital image becomes color image. Video signal is a sequence of image frames, which can apply in different time intervals.

Digital signals and images are valid information sources to varied fields of engineering and science. They in the course of acquisition/ transmission have their true values in random positions impaired by corruptive values in extreme ranges called impulses. So impulse removal algorithms are essential for signal restoration to precede reliable digital signals/ images through varied image processing applications. Various noises can occur in images due to false acquisition and problems of capturing environment [7]. So image de-noising is an important step for further image processing.

There are different techniques to remove noise in images. Linear filters and non linear filters have been used for this purpose. Impulse noise is an important type of noise that can creep into the image. Salt and pepper noise is an impulse noise. This paper looks into salt and pepper noise alone. For a grey scale image, the pixels value ranges from 0 to 255. Value 0 represents the black spot and the value 255 represents white spot. Salt and pepper noise takes this 0(minimum) value and value 255 (maximum) and appears in image like black and white spot. The black spot will beMedian filter is an important type of non linear filter [1]. For the removal of salt and pepper noise, median filtering is the best option. Because non linear filter is used for the removal of this type of noise with maximum perfection. In median filtering, the filtering technique is carried out by taking the median of the pixels masked by window of main filter mask [4].

The conventional median filter has both advantages and disadvantages. Even though median filtering is applied uniformly in the image it will modify both informative and noisy pixels. This is one of the main disadvantages. This paper proposes a new median based filtering technique. Here only the noisy pixels are removed by selective filtering.

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The proposed filter is applied to both color images and videos. This paper is organized as follows: Section II briefly describes the concept and characteristics of conventional median filter and the steps involved in filtering. Section III deals with proposed median filter which is the modification of conventional median filter. Section IV analyzes the results obtained for the proposed filter and at the same time comparing it to other existing techniques and finally, Section V concludes the work of this paper. in bright region and white spot will be dark region

- 3×3 original image:

91	55	90
77	68	95
115	151	210

- Median filtering using the full 3×3 neighborhood
  55 , 68 , 77 , 90 **, 91** , 95 , 115 , 151 , 210
- median value = 91

II. PROPOSED METHOD

In order to overcome the difficulties of conventional median filter, some modification is done. That is, the filtering technique carried out in two steps. In the first step, the noisy pixels are detected and in the second step filtering is done only on these pixels. The proposed filter is applied to both color and videos. In color images, there are three different color channels for each pixel. Video signal is referred to as a sequence of still images representing still images in motion. It is composed of individual components known as video frames. Like images, video signals are often corrupted with impulsive noise. For de-noising, video signal using proposed filter, first it is converted into video frames. The filtering is done on these frames using proposed median filter. Finally these video frames are converted back to video information. De-noising of color images and videos is desirable in many image processing applications.
Many denoising schemes are “decision-based” median filters. This means that the noise candidates are first detected by some rules and are replaced by the median output or its variants. For instance, in Algorithm I, the noise candidate $yi;j$, $(i; j)$ 2 N, is replaced by $s^{ij}_{med;w}$. These schemes are good because the uncorrupted pixels will not be modified. However, the replacement methods in these denoising schemes cannot preserve the features of the images, in particular the edgesare smeared.In contrast, Algorithm II can preserve edges during denoising but it has problem in detecting noisypatches, i.e., a connected region containing many noisy pixels [7]. Combining both methods will avoid the drawbacks of either one of them. The aims of our method are to correct noisy pixels and preserve edges in the image.

III. METHODOLOGY OF THE PROPOSED ALGORITHM

(1) Detect all the noisy pixels.ie, pixel with values 0 and 255.
(2) Filtering is done only on these pixels.
(3) If a pixel ‘p’ is detected as noisy the following steps are performed.
(a) A window of proper size is taken and centered on the pixel ’p’.
(b) Arrange the pixels beneath the window in ascending or descending order.
(c) Calculate the median value of this arrangement.
(d) Replace the median value with the pixel ‘p’.

IV. RESULTS AND DISCUSSION

For the performance calculation, the proposed median filter is applied to color images and videos. We have tested the filter performance with JPEG Lena image and ‘traffic.avi’ video. In this section, the performance of proposed filter is compared with conventional median filter and two other existing filtering techniques. They are mean filter and wiener

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filter. In color image de-noising each time the image is corrupted with different densities of salt and pepper noise. The noise density ranges from 20% to 90% with an interval of 10% noise density. For video de-noising, first it is converted into successive video files. The salt and pepper noise is added into it. As in the case of color images, video frames with different noise density is tested. We got very promising results for both color image and video sequence.We have taken the lena image in JPEG format. This is shown below.

Fig. 1: Original lena image

For comparing it with different existing methods, some performance parameters are taken. They are PSNR & COR.

$$PSNR = 20\log_{10}\left(\frac{255}{RMSE}\right) \quad (1)$$

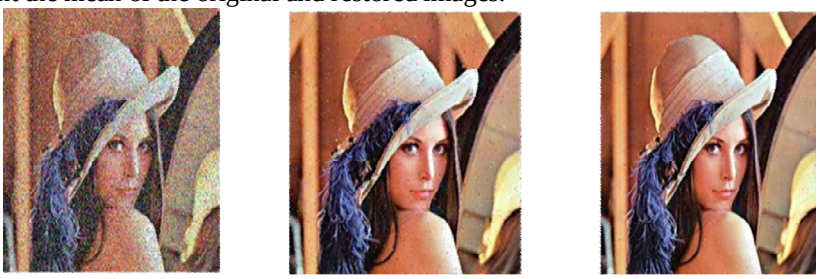
where, RMSE(Root Mean square)

$$RMSE = \sqrt{\frac{1}{MN}\sum_{i,j}(y_{i,j} - x_{i,j})^2} \quad (2)$$

COR(Correlation)

$$COR = \frac{\sum_{i,j}(y_{i,j} - \mu_y)(x_{i,j} - \mu_x)}{\sqrt{\sum_{i,j}(y_{ij} - \mu_y)^2 \sum_{i,j}(x_{i,j} - \mu_x)^2}} \quad (3)$$

Where, YijandXij denote the pixel values of the restored and original image respectively. MxN is the size of the image, and represent the mean of the original and restored images.



30% noise added image

50% noise added image

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Noisy image | 80% noise added image | Output of conventional median filter | Output of proposed filter

Fig. 2: Pictorial results of salt and pepper noise removal for the conventional median filter and proposed median filter on lena color image

Fig. 3: Results obtained for the noise corrupted video frames with 30% noise density and its corresponding denoised frames (top four frames are noise frames and corresponding bottom frames are denoised frames).

Table 1: Conventional and proposed median filter results for video frames at different noise density

Noise density (%)	Conventional median filter	Proposed median filter
20	.9331	.9727
40	.8272	.8667
50	.7345	.7719
70	.4433	.4566
90	.4566	.1549

V. CONCLUSION

An improved algorithm to remove salt and pepper noise from color images and video sequences is proposed. Here the noisy pixels are detected and filtered. Since the noisy pixels are replaced with the median of the neighborhood pixel values the image quality is improved. The computational complexity is reduced because

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of lower number computations. In each time the image or video is added with different noise density. This proposed algorithm is tested with lena color image and video for various noise densities ranging from 20% to 90% and it gives good results. This proposed filter is then compared with other existing filtering techniques. For video denoising, the video is converted into frames. After denoising the frames are converted back to original sequence. The simulation result shows that the proposed median filter outperforms the conventional median filter and the mean filter.

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