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An Efficient Nonlinear Filter for Removal of Impulse Noise in Color Video Sequences

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ABSRRACT: An efficient non linear filter for detecting and removing high level of salt-and-pepper noise.First determine the adaptive window size by continuously enlarging the window size until the maximum and minimum values of two successive windows are equal respectively.The current pixel is regarded as noise candidate if it is equal to the maximum or minimum values, otherwise, it is regarded as noise-free pixel.Finally, the noise candidate is replaced by the weighted mean of the current window, while the noise-free pixel is left unchanged.Experiments and comparisons demonstrate that our proposed filter has very low detection error rate and high restoration quality especially for high-level noise.

KEYWORDS: Colour video filtering; impulse detector; local statistics; random valued impulse noise; directional weighted median filtering; vector directional filtering.

I. INTRODUCTION

Images and video sequences are often affected by noise due to bad acquisition, transmission, or recording. In general,video data tends to be more noisy than single image due to high-speed capturing rate of video camera [1]. Video noise removal is necessary for video application systems, such as traffic observations, surveillance systems, and autonomous navigation.The most common noise types that can be distinguished are impulse noise, additive noise, and multiplicative noise [2], [3]. In the case of impulse noise, the affected pixels are replaced by noise values. Additive noise contamination means that a random value from a given distribution (e.g., a Gaussian distribution) is added to each pixel. In the multiplicative noise type, the intensity of the noise value added to a pixel depends on the intensity of the pixel itself (e.g., speckle noise).Video denoising methods may be roughly classified based on two different criteria [4]: whether they are implemented in spatial domain (including temporal domain and joint spatiotemporal domain) or transform domain and whether motion information is directly incorporated. Spatial domain denoising is usually done by using the color values of the pixels inside a local window.A review of spatial domain filtering methods can be found in [5].

Types of Digital Images

Binary: In binary image the value of each pixel is either black or white. The image have only two possible values for each pixel either 0 or 1, we need one bit per pixel.

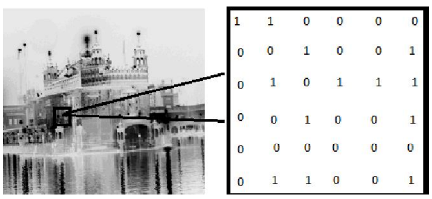

Figure 1.1:binary image

Grayscale: In grayscale image each pixel is shade of gray, which have value normally 0 [black] to 255 [white]. This means that each pixel in this image can be shown by eight bits, that is exactly of one byte. Other grayscale ranges can be used, but usually they are also power of 2.

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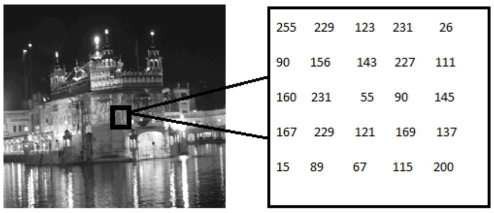

Figure 1.2: greyscale image

Indexed: Mostly all the colors images have a subset of more than sixteen million possible colors. For ease of storage and handling of file, the image has an related color map, or we can say the colors palette, that is simply a list of all the colors which can be used in that image. Each pixel has a value associated with it but it does not give its color as for as we see in an RGB image. Instead it give an index to the color in map. It is convenient for an image if it has 256 colors or less. The index values will require only one byte to store each. Some image file formats such as GIF which allow 256 color only.

True Color or RGB: Each pixel in the RGB image has a particular color; that color in the image is described by the quantity of red, green and blue value in image. If each of the components has a range from 0–255, this means that this gives a total of 2563 different possible colors values. That means such an image is "stack" of three matrices; that represent the red, green and blue values in the image for each pixel. This way we can say that for every pixel in the RGB image there are corresponding 3 values.

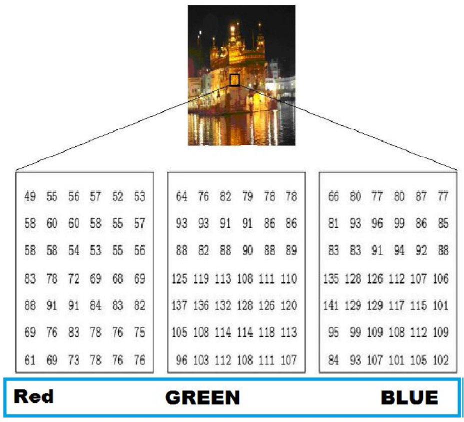

Figure 1.3: color image

NOISE MODELS: The main source of noise in digital images arises during image acquisition (digitization) or during image transmission. The performance of image sensor is affected by variety of reasons such as environmental condition during image acquisition or by the quality of the sensing element themselves. For instance, during acquiring images with CCD camera, sensor temperature and light levels are major factors that affecting the amount of noise in the image after the resulting. Images are corrupted while during transmission of images. The principal reason of noise is due to interfering in the channel which is used for the images transmission.We can model a noisy image as follows:

$$C(x,y)=A(x,y)+B(x,y)$$

Where A(x ,y) is the original image pixel value and B(x ,y) is the noise in the image and C(x ,y) is the resulting noise image.

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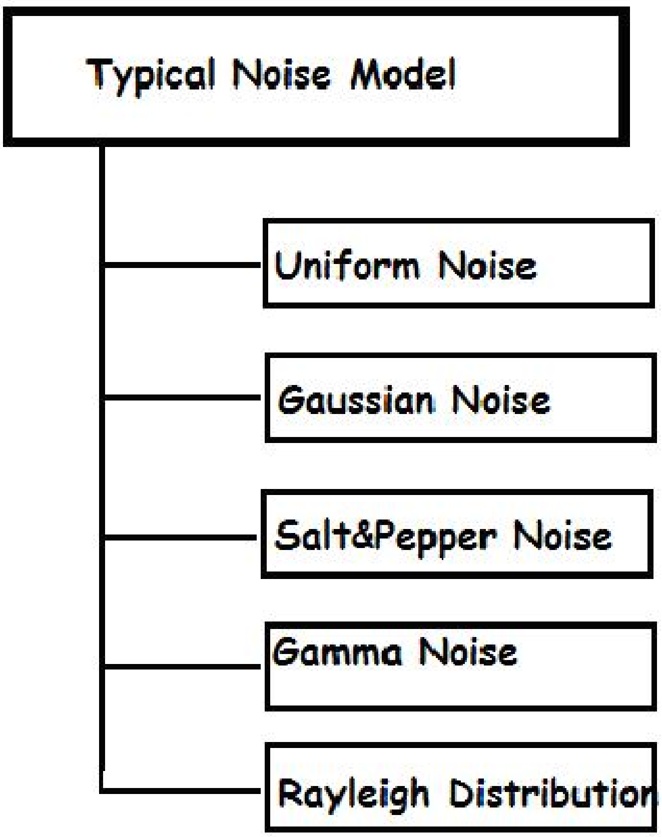
The original meaning of "noise" was and remains "unwanted signal"; unwanted electrical fluctuations in signals received by AM radioscaused audible acoustic noise ("static"). By analogy unwanted electrical fluctuations themselves came to be known as "noise".[1] Image noise is, of course, inaudible.

Image noise is random (not present in the object imaged) variation of brightness or color information in images, and is usually an aspect of electronic noise. It can be produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Image noise is an undesirable by-product of image capture that adds spurious and extraneous information.

The magnitude of image noise can range from almost imperceptible specks on a digital photograph taken in good light, to optical andradioastronomical images that are almost entirely noise, from which a small amount of information can be derived by sophisticated processing (a noise level that would be totally unacceptable in a photograph since it would be impossible to determine even what the subject was).



TYPES OF NOISE

Uniform Noise:

The uniform noise cause by quantizing the pixels of image to a number of distinct levels is known as quantization noise. It has approximately uniform distribution. In the uniform noise the level of the gray values of the noise are uniformly distributed across a specified range. Uniform noise can be used to generate any different type of noise distribution. This noise is often used to degrade images for the evaluation of image restoration algorithms. This noise provides the most neutral or unbiased noise

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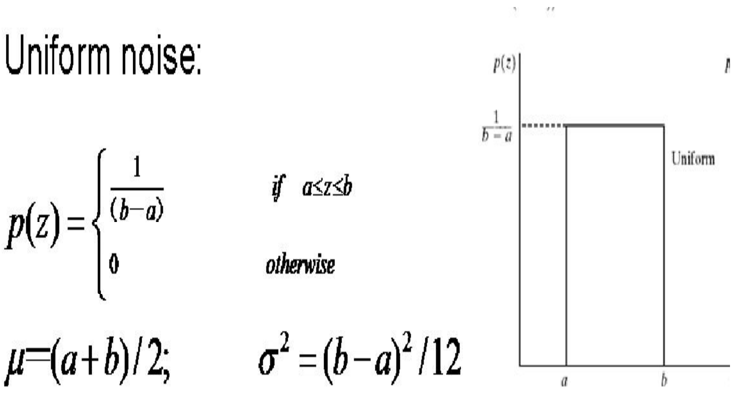
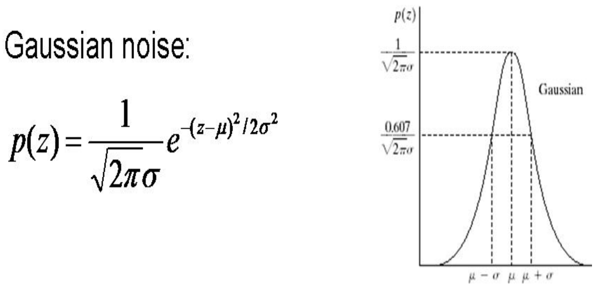


Gaussian Noise or Amplifier Noise:

In Gaussian noise, each pixel in the image will be changed from its original value by a (usually) small amount. A histogram, a plot of the amount of distortion of a pixel value against the frequency with which it occurs, shows a normal distribution of noise. While other



Salt and Pepper Noise:

In salt and pepper noise (sparse light and dark disturbances), pixels in the image are very different in color or intensity from their surrounding pixels; the defining characteristic is that the value of a noisy pixel bears no relation to the color of surrounding pixels.

Reasons for Salt and Pepper Noise:

a. By memory cell failure.

b. By malfunctioning of camera's sensor cells.

c. By synchronization errors in image digitizing or transmission.

II. EXISTING METHOD

A new quaternion vector filter for removal of random valued impulse noise in color video sequences is presented.The noisy and noise free frames are detected by analyzing the spatio temporal order-statistic information about the samples along horizontal,vertical and diagonal direction in current frames and the samples of adjacent frames on motion trajectory.3-D weighted vector median filtering is performed on pixels to remove the detected noisy pixels.

III. PROPOSED METHOD

Firstly determine the adaptive window size by continuously enlarging the window sizes until the maximum and minimum values of two successive windows are equal.The center pixel is regarded as noise candidate if it is equal to the maximum or the minimum values, otherwise, it is regarded as noise-free pixel.After noise detection, the noise candidate is replaced by the weighted mean value of the current window while the noise-free pixel is left unchanged.

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0	68	255	0	0	70	255
0	255	255	255	255	255	0
0	255	68	67	67	255	0
255	0	255	**66**	78	255	70
255	0	255	255	255	255	255
0	255	0	255	0	0	0
0	78	0	0	255	255	255

Fig. 1. A window case (AMF outputs 78 and AWMF outputs 66 for center pixel)

ALGORITHM

1) Initialize $w = 1, h = 1, w_{max} = 39$.
2) Compute $S_{i,j}^{min}(w)$, $S_{i,j}^{max}(w)$, $S_{i,j}^{mean}(w)$, $S_{i,j}^{min}(w+h)$ and $S_{i,j}^{max}(w+h)$.
3) If $S_{i,j}^{min}(w) = S_{i,j}^{min}(w+h)$, $S_{i,j}^{max}(w) = S_{i,j}^{max}(w+h)$ and $S_{i,j}^{mean}(w) \neq -1$, go to step 5); Otherwise, $w = w + h$.
4) If $w \leq w_{max}$, go to step 2); Otherwise, $z_{i,j} = S_{i,j}^{mean}(w)$, and stop.
5) If $S_{i,j}^{min}(w) < y_{i,j} < S_{i,j}^{max}(w)$, (i,j) is noise-free, $z_{i,j} = y_{i,j}$; Otherwise, (i,j) is noise candidate, $z_{i,j} = S_{i,j}^{mean}(w)$, and stop.

IV. EXPERIMENTAL RESULTS

$$\mathrm{PSNR}_t = 10 \log_{10} \frac{255^2}{\frac{1}{3HW}\sum_{x=1}^{H}\sum_{y=1}^{W}\|\mathbf{y}(x,y,t)-\mathbf{o}(x,y,t)\|_2^2}$$

$$\mathrm{MAE}_t = \frac{1}{3HW}\sum_{x=1}^{H}\sum_{y=1}^{W}\|\mathbf{y}(x,y,t)-\mathbf{o}(x,y,t)\|_1$$

$$\mathrm{NCD}_t = \frac{\sum_{x=1}^{H}\sum_{y=1}^{W}\|\mathbf{y}^{\mathrm{LAB}}(x,y,t)-\mathbf{o}^{\mathrm{LAB}}(x,y,t)\|_2}{\sum_{x=1}^{H}\sum_{y=1}^{W}\|\mathbf{o}^{\mathrm{LAB}}(x,y,t)\|_2}$$

1)Average PSNR values for traffic video sequences

Noise density %	VMF	AVMF	VAVDMF	Proposed approach
10	21.22	22.04	19.84	25.21
20	21.04	21.74	19.54	24.16
30	20.72	21.28	19.00	22.64
40	20.25	20.72	18.26	21.21
50	19.60	20.01	17.33	19.98

2)Average MAE values for traffic video sequences

Noise density %	VMF	AMF	VAVDMF	Proposed approach
10	11.28	6.11	10.44	4.37
20	11.68	7.06	11.22	5.89
30	12.42	8.37	12.51	7.85
40	13.55	9.93	14.18	9.02
50	15.22	12.60	16.45	11.87

3) Average NCD values for traffic video sequences

Noise density %	VMF	AVMF	VAVDMF	Proposed approach
10	0.0929	0.0304	0.0672	0.0309
20	0.0965	0.0442	0.0762	0.0434
30	0.1036	0.0587	0.0893	0.0602
40	0.1145	0.0753	0.1052	0.0794
50	0.1318	0.1032	0.1257	0.0962

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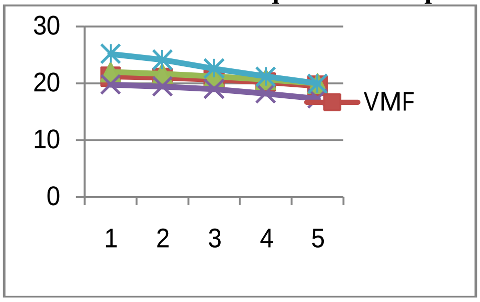
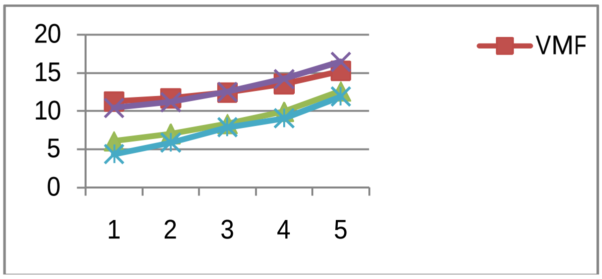
Comparison of various method for traffic video sequences corrupted by impulse noise





V. CONCLUSION

An efficient non linear filter has been developed based on adaptive median filter. it can perform better in restoring image corrupted by high level of SPN.It has much higher detection accuracy than AMF especially for high level SPN.Experimental tests show that our proposed method could perform better than many other existing filters.

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