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THE MANAGEMENT AND REDUCTION OF DIGITAL NOISE IN VIDEO IMAGE PROCESSING BY USING TRANSMISSION BASED NOISE ELIMINATION SCHEME

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Abstract

Digital noise is an image defect that is approximately close to the pixel size and differs in brightness or color from the original image. Noise reduction plays an important role in the transmission, processing and compression of video footage and images. There are a large number of methods for removing noise from images, and they can be used not only by special processing programs, but also in some photo and video cameras. Despite this, there is still no universal filtering algorithm, because when processing an image, there is always a need to choose between preserving small details with properties such as size and noise to eliminate unwanted effects. In this paper, a management and reduction of digital noise in video image processing was discussed in the basis of transmission based noise elimination. In addition, that the proposed scheme easily overcomes the various types of noise. It will identify the spoil the image with another type of noise. Hence the noise affected part will eliminated and reduce the effects of noise.

Keywords:

Digital Noise, Pixel Size, Brightness, Color, Original Image, Transmission, Processing

1. INTRODUCTION

External effects such as cracks, scratches, bruises may appear on the film. These artifacts do not have uniform structure, and determining their shape and location is often beyond mathematical analysis. These types of defects can only be overcome by manual image processing; Therefore, they are not considered in this work. There are a large number of methods for removing noise from images, and they can be used not only by special processing programs, but also in some photo and video cameras [1]. Despite this, there is still no universal filtering algorithm, because when processing an image, there is always a need to choose between preserving small details with properties such as size and noise to eliminate unwanted effects. In addition, an algorithm that easily overcomes one type of noise will only spoil the image with another type of noise. A simple idea for noise removal is to average pixel values over a spatial neighborhood. Since noise varies from pixel to pixel individually, noise from adjacent pixels cancels each other out when added [2]. A rectangular window is specified, which is superimposed on each pixel of the image. The value of the central pixel is calculated based on the analysis of all neighboring pixels falling within the window area. Accordingly, if a larger window is taken, a higher average value will eventually be obtained, leading to a stronger blurring effect [3].

In the simplest version, the analysis of neighboring pixels is to find their arithmetic mean. To reduce the influence of pixels that do not belong to the same area under consideration (for example, a dark outline on a light background), you can enter a certain numerical threshold and take into account only the difference of neighbors when calculating. From the center pixel does not exceed this limit. The higher the threshold value, the stronger the averaging will take place. The considered option is complicated by introducing weight coefficients for each neighboring pixel, which depends on their distance to the center of the considered area [4]. This method can also be used in the time domain, averaging each pixel over adjacent frames of the video stream (each pixel is averaged over pixels at the same position in adjacent frames). This method is very simple, but it does not give a good result, and at the same time it leads to a strong blurring of the details of the image.

The Gaussian filter has the same working principle as the previous method and also includes the number of smooth filters. However, noise reduction using a linear averaging filter has a significant drawback: all neighbors of the processed pixel have the same effect on the result, regardless of their distance [5]. The Gaussian filter averages the central pixel and its neighbors in a certain area, which only happens according to a certain law, which is set by the Gaussian function. It replaces each pixel in the image with the average of neighboring pixels taken in a region of a certain radius. In this case, not all points in the radius are considered, but only points whose value differs from the central pixel by some predetermined value (threshold). These blurs areas of uniform color rather than the sharp edges of the object. This reduces the amount of noise in the image while keeping the fine details intact [6]. An approximate image of illumination can be obtained using low-pass filtering - in other words, simply blurring the original image, for example, with a Gaussian filter.

2. RELATED WORKS

Linear algorithms are very effective in suppressing Gaussian noise when neighboring pixels, even if they have certain random values, remain within a certain mean value characteristic of the area they belong to. However, sometimes you have to deal with images corrupted by other types of interference. An example of such interference is impulse noise, which manifests itself in the presence of randomly scattered points of uneven brightness in the image. Averaging in this case “smears” each such point into neighboring pixels, leading to image quality degradation [7]. A fixed window of odd size is set, which is sequentially superimposed on each pixel of the image. Among all the pixels within the considered region, including the central region, the mean value is sought, which is eventually assigned to the central pixel of the region. In this case, the median is the middle element of the array of ordered pixel values belonging to the region. An odd window size is precisely chosen to ensure the existence of an average pixel [8]. A median filter can be used to suppress white Gaussian noise in the image. However, a study of noise suppression using median filtering shows that its effectiveness in solving this problem is less than that of linear filtering [9].

Median filtering is not without an inherent flaw in most noise-cancellation filters - increasing the mask size to improve noise suppression leads to blurring of image clarity and its contours. However, negative effects can be minimized by performing median filtering with dynamic mask size (additive median filtering). Its principle remains the same, only the size of the sliding filtering window can change depending on the brightness of neighboring pixels [10]-[13]. In such cases, it is necessary to use "smart" color correction, which can equalize the lighting in the image, processing the light areas to a lesser extent than the dark areas. These requirements are met by a single-scale based on the principles of retinal receptor design [14]. The main goal of the algorithm is to divide the image into components responsible for lighting and detail. Since the problems in the picture are related to the lighting of the scene, after obtaining a component responsible for the lighting, it is possible to separate it from the picture, thereby significantly increasing its quality [15].

3. PROPOSED MODEL

The sharpness of the image depends on the magnitude of the difference in brightness between the areas that make up its contours (*W*) and the sharpness of the change in this difference (*H*). The unsharp masking technique was originally used to process film photographs. The method adapted for digital image processing differs slightly from the original one: a so-called "unsharp mask" is subtracted from the image - its blurred and inverted copy. The result is a new image containing only the light outlines of the original. Darker outlines can be obtained by simply inverting the result. If in the future you subtract dark outlines from the original image and add light images, you will get a significant increase in each difference in brightness. It can use any of the denoising filters, such as a Gaussian filter, to blur the original to get an "unsharp mask". Video noise can occur for several reasons shown in Fig.1:

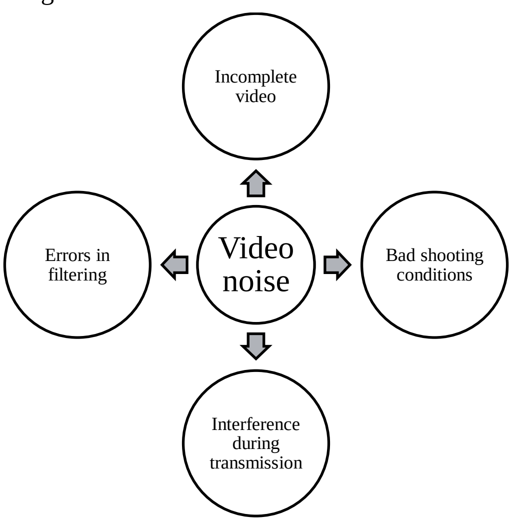

Fig.1. Reasons for video digital noise

- Incomplete video capture equipment.
- Bad shooting conditions - for example, night photo / video shooting, shooting in bad weather.
- Interference during transmission through analog channels - interference from sources of electromagnetic fields, inherent noise of active components (amplifiers) of the transmission line. An example is a television signal.
- Errors in filtering when extracting luminance and color-difference signals from analog composite signal, etc.

Depending on the nature of the uneven distribution of noise in the image, there are different types of noise. In practice, the following types are most common shown n Fig.2:

- ***White Gaussian noise***: One of the most common noises is Gaussian noise, which is characterized by adding values for each pixel in an image with a normal distribution and zero mean. The term "additive" refers to the addition of this type of noise to the effective signal. Occurs when signal reception is poor.
- ***Digital Noise***: The cause of digital noise is often related to the peculiarities of the equipment used for shooting - usually insufficient light sensitivity of the matrix. This type of noise is characterized by the replacement of certain pixels in the image with fixed or random values. If the brightness of the dots is roughly equal, digital noise is also called "stimulation". If the intensity of the spots varies from black to white, this noise is called salt and pepper noise. Typically, this type of noise affects only a small number of pixels in an image.
- ***Combined Noise***: When the image at the same level is noisy with Gaussian noise and the random pulses are much less visible. This set is called integrated noise. The amount of noise in an image can range from almost imperceptible in a well-lit digital photograph to astronomical images, where the noise obscures useful information that can only be obtained through painstaking image processing.

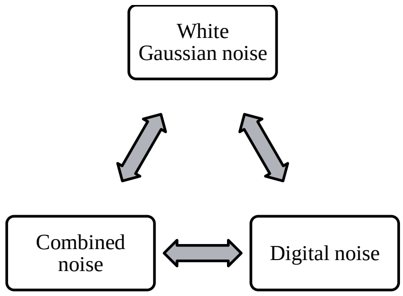

Fig.2. Different Types of Noises

The A parameter provides the normalization where the y parameter sets the amount of blur. Consequently, the central pixel of the considered region will have the highest value corresponding to the peak of the Gaussian distribution. As the distance from the center increases the values of the remaining elements have less and less influence. The matrix filter calculated according to the indicated formula is called Gaussian; the larger its size, the stronger the blur (with constant y). Since this filter is separable, it can be specified as:

$$X(a,b) = d_1(a) * d_2(b) \tag{1}$$

Convolution can therefore be performed sequentially by rows and columns, leading to significant acceleration of the method for large filter sizes. Unsharp masking is a technique that improves the visual perception of an image by increasing the contrast between tones. In fact, the sharpness remains at the same level, because, in principle, it is impossible to restore the lost image details, but improving the contrast between areas of different brightness leads to the image being perceived clearly.

The processing of the image by the convolution operation is as follows: the central element of the matrix, called the "anchor", is successively superimposed on each pixel of the image. The new value of the considered pixel is calculated as the sum of the values of the neighboring pixels multiplied by the corresponding coefficients of the convolution mask. The resulting effect depends on the chosen convolution kernel. The center of a contrast-enhancing filter has a value greater than 1 at the point (0, 0), so that the sum of all values equals 1. For example, a contrast-enhancing filter is a filter with kernels. The filter emphasizes the difference between the intensities of adjacent pixels; the effect of enhancing contrast is achieved by removing these intensities from each other. This effect is stronger, the larger the value of the center period of the fetus. Convolution-based linear contrast-up filtering results in a visible color halo around the edges of the image.

4. RESULTS AND DISCUSSIONS

The proposed transmission-based noise elimination scheme (TBNES) was compared with the existing A Fuzzy Rule Based Directional Approach (FRBDA), Phase noise compensation (PNC), Image Quality improvement approaches (IQIA) and Split-Bergman Iteration Scheme (SBIS)

4.1 MEDIAN FILTERING

A standard way to suppress impulse noise is median filtering. This non-linear image processing technique removes outliers, but, unlike linear averaging algorithms, monotonic pixel arrays remain constant. Because of this, transitional filters can maintain without distortion the contours of objects and the differences between areas of different brightness, while effectively suppressing uncorrelated noise and small-scale details. This was shown in following Table.1,

Table.1. Comparison of Median filtering

Images	FRBDA	PNC	IQIA	SBIS	TBNES
100	73.78	64.73	65.07	58.91	90.82
200	73.67	64.75	64.90	58.64	90.32
300	73.56	64.77	64.73	58.37	89.82
400	73.45	64.79	64.56	58.10	89.32
500	73.34	64.81	64.39	57.83	88.82
600	73.23	64.83	64.22	57.56	88.32
700	73.12	64.85	64.05	57.29	87.82

4.2 IMAGE SHARPENING

All methods of suppressing noise in the image lead to its blurring, as a result, small details are lost, and the image is difficult to understand. An image sharpening filter can partially compensate for this negative effect, restoring lost edge contrast and color shifts. Sharpness can depend on many factors - the quality of the lens, the aperture used the thickness of the anti-moiré filter found in the matrix of most digital cameras, which blurs the image to varying degrees. Also, after reducing their size, the sharpness of the images must often be increased, because it inevitably loses some information and with it the clarity of the contours. This was shown in following Table.2,

Table.2. Comparison of Image sharpening

Images	FRBDA	PNC	IQIA	SBIS	TBNES
100	73.65	65.63	65.63	58.94	80.44
200	76.75	68.46	68.97	62.45	83.67
300	79.85	71.29	72.31	65.96	86.90
400	82.95	74.12	75.65	69.47	90.13
500	86.05	76.95	78.99	72.98	93.36
600	89.15	79.78	82.33	76.49	96.59
700	92.25	82.61	85.67	80.00	99.82

4.3 CONVOLUTION OPERATION

Convolution operation is often used in image processing. In addition to sharpening, it is used for blurring, increasing brightness, lightning, etc. Image transformation is an operation that calculates a new value for a given pixel, taking into account the values of surrounding neighboring pixels. In a general sense, this term refers to certain actions performed in each part of the film. The main element of convolution is the convolution mask - a matrix (of arbitrary size and aspect ratio). This mask is often referred to as a filter, kernel, pattern, or window. The values of matrix elements are usually called coefficients. Often, a square matrix is used as the convolution kernel. This was shown in following Table.3,

Table.3. Comparison of Convolution operation

Images	FRBDA	PNC	IQIA	SBIS	TBNES
100	77.95	69.78	69.70	63.77	84.05
200	78.56	70.61	70.59	64.31	84.62
300	78.97	71.01	70.67	64.61	84.32
400	79.51	71.70	71.29	65.07	84.60
500	80.02	72.31	71.78	65.49	84.74
600	80.53	72.93	72.26	65.91	84.87
700	81.04	73.54	72.75	66.33	85.01

4.4 ILLUMINATION DIFFERENCE COMPENSATION

Image exposure problems often occur when windows, the sun, or other unregulated light sources enter the frame. This situation is called "over-lighting" and due to very bright buttress lighting, details and color of objects located in the background of excessively bright objects are lost and difficult to distinguish. A lack of light is also common. This can be caused by shooting in dark rooms with poor lighting and low sensitivity of video equipment. When trying to brighten an image by increasing the brightness of each pixel by a certain fixed value, initially bright areas can be completely blown out. This was shown in following Table.4,

Table.4. Comparison of Illumination difference compensation

Images	FRBDA	PNC	IQIA	SBIS	TBNES
100	71.51	71.93	70.50	70.99	82.53
200	71.62	71.91	70.67	71.26	83.03
300	71.64	71.03	69.94	70.96	82.91
400	71.72	70.72	69.81	71.04	83.20
500	71.79	70.27	69.53	71.03	83.39
600	71.85	69.82	69.25	71.01	83.58
700	71.92	69.37	68.97	71.00	83.77

4.5 GAUSSIAN FILTER

Because the logarithm of the signal does not change frequency, and because of the properties of the logarithmic function (the logarithm of the product is equal to the sum of the logarithms of the factors), it can be difficult to separate the product of signals. It simplified to the problem of dividing sums of signals. After that, all that is left is to take an exponential from the received signal back to the original amplitude scale. The resulting high-frequency component can be added to the dim and bright original image, acting as a new light model. The effect obtained by equalizing the illumination can be very strong (dark areas become uniform in brightness of light). To reduce the effect, you can blend the original image by a certain ratio. This was shown in following Table.5,

Table.5. Comparison of Gaussian filtering

Images	FRBDA	PNC	IQIA	SBIS	TBNES
100	68.54	68.20	66.60	67.45	89.68
200	67.34	66.88	65.87	66.13	89.30
300	66.14	65.56	65.14	64.81	88.92
400	64.94	64.24	64.41	63.49	88.54
500	63.74	62.92	63.68	62.17	88.16
600	62.54	61.60	62.95	60.85	87.78
700	61.34	60.28	62.22	59.53	87.40

4.6 GAMMA CORRECTION

The original purpose of gamma correction was to compensate for differences in the colors displayed by different devices' output so that the image would look the same when viewed on different monitors. Due to the non-linear nature of the applied power function, gamma correction allows you to increase the contrast of the dark areas of the image, without exaggerating the bright details and without losing the contrast of the edges of the objects in the image. Brightness information is stored non-linearly in analog form in television and in digital form in most common graphic formats. The brightness of a pixel on a monitor screen can be considered proportional. This was shown in following Table.6,

Table.6. Comparison of Gamma correction

Images	FRBDA	PNC	IQIA	SBIS	TBNES
100	66.73	66.05	64.98	65.59	88.73
200	66.32	65.65	64.90	65.29	89.03
300	65.91	65.25	64.82	64.99	89.33
400	65.50	64.85	64.74	64.69	89.63
500	65.09	64.45	64.66	64.39	89.93
600	64.68	64.05	64.58	64.09	90.23
700	64.27	63.65	64.50	63.79	90.53

5. CONCLUSION

At each point in the image, the slope vector is in the direction of the greatest increase in brightness, and its length corresponds to the magnitude of the change in brightness. This data allows us to make an assumption about the probability of finding the point under consideration on the boundary of a particular object and the orientation of this boundary. At a point in the region of constant brightness, the result of the operation of the Sobel operator will be a zero vector, and at a point on the border of areas of different brightness - a vector that crosses the border in the direction of increasing brightness. The Sobel filter selects object boundaries based on their brightness. Since the color component is not taken into account, the images must first be converted to grayscale. A Sobel filter is applied sequentially to each pixel and calculates an approximate value of its brightness gradient. The gradient (brightness function) for each point in the image is a two-dimensional vector whose components are the horizontal and vertical derivatives of the image brightness.

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