STUDY OF VARIOUS IMAGE FILTERING TECHNIQUES IN VIDEO PROCESSING SYSTEM

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Abstract
Quality of a video plays an important role in video processing system for real time video surveillance. Noise always degrades the quality of video or image. Removing noise from a video frame is a challenging task. Noise can be added in the video frame or image during image or video capturing or transmission. Hence the removal of the noise can have good impact on the quality of the video. Many techniques have already been developed in the past for noise removal from the image or video frame. In this paper we present a survey on various image filtering techniques used in the literature. Image or video frame filtering is a crucial part of pre-processing as a first step in computer vision processing. Each filtering technique has its own merits and demerits. The main objective of this paper is to explore the benefits and limits of image filtering techniques.
Keywords: **Gaussian Filter, Median Filter, wiener filter, denoising, video surveillance etc.**

I. INTRODUCTION

Noise is unwanted information that degrades the quality of an image. Noise is a random variation (originally not present in the image) of intensities of image and it looks like grains, salt and pepper in the image. It is due to the effects of photon nature of light or thermal energy of heat in the image sensor [1].Noise in image may be added at the time of capturing or during transmission. Noise is basically the variation of intensity of pixels, means it shows the different pixels value instead of actual pixel value in the original image. Types of noise may be different for different types of noise and depends on how it was created for example satellite image contains the noise signal and produces the distortion in the image which is very difficult to study and analyse it. A number of noise filtering methods have been developed in past which remove or reduce the quantity of noise in the original image by smoothing the whole image except near the boundaries. Here are some general types of noise which can be in an image (a) Impulse Noise (salt & pepper noise) (b) Amplifier noise (Gaussian noise) (c) Shot noise (d)
Multiplicative noise (Speckle noise) (e) Periodic noise (f) Quantization noise (uniform noise) (g) Grain noise.[1] Different noise have their own benefits and drawback. Let us discuss each noise one by one in next section.

II. TYPES OF NOISE

A. Impulse Noise (salt & pepper noise)

Salt and pepper noise is also called impulse noise. Many others terms are also used for this type of noise such as spike noise, random noise or independent noise [2]. Effect of this noise appears like white and black dots in the image. In this type of noise, color and intensity of the pixels are very dissimilar compare to nearby pixels [3]. This noise contaminate image due to the sudden and sharp distribution in image signals. Image having this type of noise will have dark bright pixels in dark region and dark pixels in bright region. Cause of this type of noise may be bit error in transmission, analog to digital converter errors, dust particle occurred during image capturing process and may be due to

heating of component of image capturing devices. In this type of noise image is degraded by some extent. Image corrupted by salt and pepper noise can be quantified by the percentage of corrupted pixels. Figure 1 shows the effect of salt and pepper noise.

Figure 1 Original Image

Figure 2, Image having 20% salt and pepper noise.

B. Gaussian Noise (Amplifier Noise)

The Gaussian noise is also known as normal noise model. This noise model is additive [4] which means that each pixel in the noise image is calculated by summation of true pixel value and a random and support Gaussian distribution. The Gaussian noise is not depend on the intensity of the pixel value at each point. Gaussian noise is statistical noise and its probability density function is equal to the normal distribution which is also known as Gaussian distribution.

The Probability density function (PDF) of a Gaussian random variable is given by

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$$

Where PG(z) represents Gaussian distribution noise in image, z represents the grey level, μ the mean value and σ is the standard deviation.

Figure 3 Original Image

C. Shot Noise (Poisson Noise)

This is a type of electronic noise in image. Others terms of shot noise is Poisson noise or Photon noise. This is an elementary type of uncertainty connected with measurement of light essential to the quantized behavior of light and independent of photon detections. Poisson noise is noise which is due, when the number of photons sensed by the sensor is not enough to give the statistical information [5]. The noise of different pixels is different from each other. Poisson distribution is used for shot noise which is not different from Gaussian noise. Shot noise is represented by root mean-square value and it is directly related to the intensity of image which is given below:

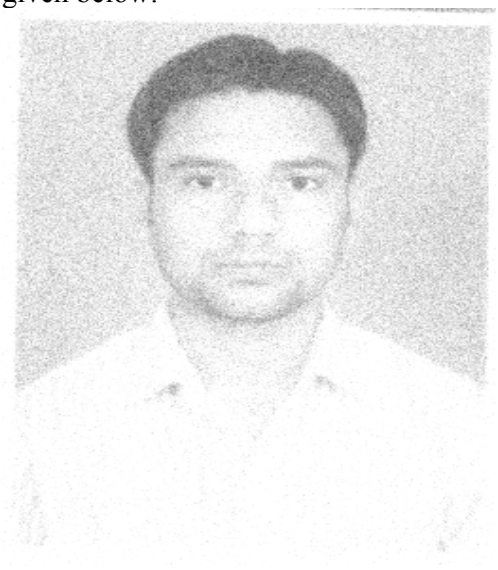

Figure 3 Image having 20 % Gaussian noise

SNR = √N

Where N is image intensity, when N is very large the signal to noise ratio is very large

.

Figure 4 Image having Poisson noise

D. Speckle Noise(Multiplicative noise)

Speckle noise is also known as multiplicative noise. Speckle noise is a granular noise which internally presents in and deteriorates the quality of active radar and synthetic aperture radar (SAR) image [5]. Gaussian noise can be calculated by adding random values in an image, while speckle noise can be implemented using random value multiplying with the pixel values of an image hence we call it as multiplicative noise. It can be define as

$S = I + n*I$

Where S is the speckle noise distribution of an image, I is the input image and n is the uniform noise image having mean o and variance v. Speckle noise is caused due to the random variation in the returning image form an object which is comparison to a single processing element. Speckle noise is very dangerous and creates many difficulties for image analysis.

Figure 5 Image having Speckle noise

E. Periodic Noise

This is a type of periodic in nature. In this image is contaminated by periodic noise rather than random disturbance. The outcome of this type of noise is bars in the image.

F. Quantization noise(Uniform noise)

This type of noise is generated when we do quantization to convert pixels of sensed noise into a discrete levels (analog to digital conversion) is called quantization noise. This type of noise has uniform distribution. Quantization noise is unavoidable during image acquisition due to the limitation of ADC conversion. In the ideal situation quantization noise is uniformly distributed at the time of image acquisition process. Due to this we call it as Uniform noise.

G. Film Grain Noise

Film Grain or granularity is the random optical texture of processed photographic film which is due to the existence small particles of a metallic silver or dye clouds, developed from silver halide that have received enough photons. The grain of photographic film is a signal dependent noise which means that if the film grains are distributed uniformly i.e. equal in number per area.

III. VARIOUS FILTERING TECHNIQUES

Image filtering task is very important preprocessing task for image analysis. Plenty of image filtering techniques are present today but best filtering techniques remove the noise entirely from the image and may preserve the details. Image filtering techniques may be linear or non-linear. Linear filtering methods are bit fast but these are not as much efficient to preserve the image details while nonlinear methods are quite capable to hold the image details completely. Image filter may be defined as follows:

- Average or Mean Filter
- Median Filter
- Wiener Filter
- Adaptive Filter

A. Average or Mean Filter

We may have applied linear filter for a particular type of noise. Some filter like Gaussian filter, average filter is also used for this purpose. For example grain type of noise is removed by average filter from the photograph. In this filter each pixel of the image are changed to the average value of the neighbor's pixels. The basic and simple way to implementation of this algorithm is mean filter defined in [6]. Mean filter is a type of linear filter which cover the each pixel in the signal. To make a single pixel in mean filter all the components of each pixel under mask are averaged. This filter is also known as average filter. This filter gives poor performance in edge preservation. The definition of the mean filter is

Mean Filter(x1 x2 x...xn) = -$\sum$ xi

B. Median Filter

Median Filter is nonlinear filter which is mainly used to eliminate noise. This filter shows good results for maintain the details. To implement the median filter:

- Select each and every pixel in the given image.
- Depending upon the intensity value sort the all pixels
- At last exchange the value of original pixel by the median value

A median filter exists in the categories of rank-conditioned rank selection (RCRS) filters [7].

C. Wiener Filter

Wiener filter is a type of linear filter. This filter is used to remove blur from the images due to the nonlinear motion. The main purpose of wiener filter is to filter the noise which has corrupted the signal. Many filters are prepared for a required frequency response. But this filter work from the different angle. It needs to have the details of original signal and noise signal and seeks the LTI filter whose output come as close to the original as possible [8].

The main features of wiener filters are:

- Assumption: signal and (additive) noise are stationary linear random processes with known spectral characteristics.
- Requirement: the filter must be physically realizable, i.e. causal (this requirement can be dropped, resulting in a non-causal solution)
- Performance criteria: minimum mean-square error

D. Adaptive Filter

The performance of adaptive filters is modified based on the statistical features of the image region, covered by the filter region. One of the adaptive filtering techniques is BM3D. This image filtering technique can be divided into three steps [9-10]:

1. Analysis: First of all similar image blocks are grouped then in each group block are stacked to make a 3-D data arrays, which are de-correlated using an invertible 3D transform.

2. Processing: The obtained 3-D group spectra are filtered by hard thresholding.

3. Synthesis. The filtered spectra are inverted, providing estimates for each block in the group. These block-wise estimates are returned to their original positions and the final image reconstruction is calculated as a weighted average of all the obtained block-wise estimates.

IV. CONCLUSION

In this paper we have discussed various types of noise that include in images at the time of acquisition or image transmission. we also discuss the number of reasons of noise occurrence and their main sources. In the next section we have discussed various image filtering techniques which is applied for de-noising for the images. Along with noise we have also shown the image affected by each of the noise.

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