IJDCST @ May-June-2021, Issue- V-7, I-1, SW-12
ISSN-2320-7884 (Online)
ISSN-2321-0257 (Print)

Analysis of Noise Models on Digital Images

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Abstract: Abstract: In image processing, noise contraction and restoration of image is normal to improve the qualitative inquiry of an image and the performance criteria of quantitative image analysis approach Digital image is inclined to a variety of noise which affects the quality of image. The main ambition of de-noising the image is to restore the detail of original image as much as available. The criteria of the noise removal problem depends on the noise type by which the image is noxious .In the field of reducing the image noise several type of linear and non linear filtering techniques have been expected . Different approaches for reduction of noise and image enhancement have been considered, each of which has their own check andadvantages.

Keywords: Linear smoothing filter, Median filter, Adaptive filter.

1. Introduction

Noise is the result of errors in the image acquisition process that results in pixel values that do not follow the true concentration of the real scene. Noise reduction is the process of removing noise from a signal. Noise reduction techniques are conceitedly very similar regardless of the signal being handled, however a priori knowledge of the attribute of an expected signal can mean the implementations of these approach vary greatly depending on the type of signal. The image apprehend by the sensor undergoes filtering by different smoothing filters and the aftermath images. All recording devices, both analogue and digital, have traits which make them affected to noise. The fundamental problem ofimage convert is to reduce noise from a digital color image. The two most frequently occurring types of noiseare i) Impulse noise, ii) Additive noise (e.g. Gaussian noise) [2] and iii) Multiplicative noise (e.g. Speckle noise). Impulse noise is usually characterized by some portion of image pixels that are depraved, leaving the remaining pixels unchanged [1]. Examples of impulse noise are fixed-valued impulse noise and anyway valued impulse noise. We talk about additive noise when value from a certain

circulation is added to each image pixel, for example, a Gaussian distribution. Multiplicative noise is generally more difficult to remove from images than additive noise because the anxiety of the noise varies from the signal anxiety (e.g., speckle noise)[4][12]. [1] Represents a survey of 48 filters for abrupt noise removal from color images and also analyzed different distance measures such as Minkowski, Angular anddirectional-distance.

2. Image and ITSTypes

An image may be well-defined such as a two-dimensional function F(a, b).Where a and b are dimensional (plane) coordinate, and the amplitude of F at any pair of coordinates (a, b) is called the intensity or gray level of the image at that point. When a,b and the breadth values of are all predetermined discrete quantity, we will call the image as digital image. A digital image is assortment of a finite number of elements, in which each element has a certain value and location. These elements of digital image are known as image elements, picture elements, pels, and pixels. Pixel is the word mostly used refer to the elements of a digital image [1]. Types of Digital Images: Binary: In binary image the value of each pixel is either black or white. The image have only two achievable values for each pixel either 0 or 1, we need one bit per pixel.

ISSN-2320-7884 (Online)
ISSN-2321-0257 (Print)

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 absolutely of one byte. Other grayscale ranges can be used, but usually they are also power of2

True Color or RGB: Each pixelin the RGB image has a particular color; that color in the image is described by the abundance of red, green and blue value in image. If each of the ingredient 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 perform 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 3values.

Indexed: Mostly all the colors images have a subset of more than sixteen million achievable colors. For ease of storage and handling of file, the image has an analogous 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 itgive an index to the color in map. It is acceptable for an image if it has 256 colors or less. The index values will lack only one byte to store each. Some image file arrangement such as GIF which allow 256 color only.

3. Digital Image FileTypes

BMP:

Bmp stands for Bitmap. Every picture on a computer appear to be a BMP. In Windows XP the Paint program save its images naturally in bitmap format, however in Windows Vista images are saved now into JPEG format. Bitmap is the basis podium for many other file types.Benefits: High quality image, Easy to change and edit, No loss in image through process Downfalls: Difficulty while displayable on internet and large in file size. JPG, JPEG: JPEG stands for Joint Photographic Experts Group .Jpeg format is mainly used for color photographs. It is not good with sharp edges and it tends to blur the image a bit. This format became trendy with the addition of the digital camera. Digital cameras mostly download photos to our computer as a Jpeg format. Digital camera manufacturers obviously see the value in high quality images that eventually take up less space. Benefits: Small size image, easily viewable from internet, Use millions of colors, and perfect for many type of images Downfalls: High squeezing loses quality of image, every time a JPG image is saved, it loses more and more quality of the picture.

GIF: GIF stands for Graphics Interchange Format. This format is best suited for text, drawing line screen shots, animations and cartoons. Gif arrangement is limited to total number of 256 colors or it can be less. It is mostly used for loading the fast web pages. It also help to makes great banner and logo for different webpage. Different type of animated pictures are savedin GIF format. For example, the flashing banner would be saved as a Gif file format.Benefits: It is backed mostly by all web browsers, it is very small file size, Easy to load, Benefit for Transparencies, and animations and Imagemaps

Downfalls: We caused only basic colors, Complex pictures look abhorrent, No details of images are allowed.PNG:PNG stands for Portable NetworksGraphic. This is one of the best image format, still it was not always well-suited with all web browsers and image software. This is the best image format to use for the website. It is also used for logo's and screenshots.

TIFF:

TIFF stands for Tagged Image File Format. This format has not been reshuffled since 1992 and is now owned by Adobe. It can store an image and data (tag) in the one file. This file is commonly used for scanning the data, faxing, word processing etc. It is no common file format that can be use with our

digital photos.Benefits: The image is perfect, Never loss any image. Downfalls: Due to massive file size there is difficulty in transferring of the file, not able

ISSN-2320-7884 (Online)
ISSN-2321-0257 (Print)

to view on the internet, only some specialized program can view it.

III. Sources of Noise in Digital Images Noise usually quantified by the percentage of pixels which are corrupted. Corrupted pixels are either set to the maximum value or have single bits. There are several ways that noise can be introduced into an image, depending on how the image has been created. Forinstance:

- If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise may also be the result of damage to the film, or be introduced by the scanner itself.

- If the image is acquired directly in a digital format, the mechanism for gathering the data (such as a CCD detector) can introducenoise.

- Electronic transmission of image data can make noise.

IV. Types of NOISES

Noise to be any deterioration in the image signal caused by extraneous disturbance [8]. If an image is being sent electronically from one place to someone else via satellite or wireless communication or through networked cables, we may await errors to occur in the image signal. These errors will arrive on the image output in different ways build upon on the type of disturbance in the signal. Usually we know what type of errors to await and the type of noise on the image, hence we consider some of the standard noise for defeat or reducing noise in color image [11].Image Noise is classified as Amplifier noise (Gaussian noise), Salt-and-pepper noise (Impulse noise), Shot noise, Quantization noise (uniform noise), Film grain, on-isotropic noise, Speckle noise (Multiplicative noise) and Periodic noise.

4.1 Amplifier Noise (Gaussian noise): The accepted model of amplifier noise is additive, Gaussian, defenseless at each pixel and dependent of the signal intensity, caused chiefly by Johnson–Nyquist noise (thermal noise), including that which comes from the reset noise of capacitors ("kTC noise"). It is an glorify form of white noise, which is caused by random variation in the signal [8]. In color cameras where more amplification is used in the blue color channel than in the green or red channel, there can be more noise in the blue channel. Amplifier noise is a dominant part of the noise of an image sensor, that is, of the consistent noise level in dark areas of the image. In Gaussian noise, each pixel in the image will be bartered from its original value by a (usually) small amount. A histogram, a plot of the amount of exaggeration of a pixel value against the density with which it occurs, shows a normal circulation of noise. While other disposal are possible, the Gaussian (normal) distribution is usually a good model, due to the central limit theorem that says that the sum of different noises tends to access a Gaussiandistribution.

4.2 Salt-and-Pepper: Noise (Impulse Noise) Salt and pepper noise is sometimes called inclination noise or spike noise or random noise or independent noise. In salt and pepper noise (sparse light and dark disturbances), pixels in the image are very different in color or concentration unlike their surrounding pixels. Salt and pepper abasement can be caused by sharp and sudden confusion in the image signal. Generally this type of noise will only affect a small number of image pixels. When viewed, the image accommodate dark and white dots, hence the term salt and pepper noise [13]. Typical sources combine flecks of dust inside the camera and overrated or faulty (Charge-coupled device) CCD elements. An image enclose salt-and-pepper noise will have dark pixels in bright district and vice versa. This type of noise can be generate by dead pixels, analog-todigital proponent errors and bit errors in transmission.

4.3 Shot Noise the Dominant noise: In the lighter parts of an image from an image sensor is typically that caused by statistical quantum fluctuations,that is, variation in the number of photons sensed at a given disclosure level; this noise is known as photon shot noise. Shot noise has a rootmean-square value reciprocal to the square root of the image intensity, and the noises at different pixels are independent of one another. Shot noise

follows a Poisson distribution, which is usually not very different from Gaussian. In addition to photon shot noise, there can be additional shot noise from the dark leakage current in the image sensor; this noise is otherwise known as "dark shot noise" or "dark-current shot noise".

4.4 Quantization Noise (Uniform Noise): The noise caused by quantizing the pixels of a sensed image to a number of discrete levels is known as quantization noise; it has an approximately uniform distribution, and can be signal may vulnerable, though it will be signal independent if other noise sources are plenty that cause dithering, or if ditheringis absolutelyapplied.

4.5 Film Grain: The grain of photographic film is a signal-dependent noise, related to shot noise. That is, if film grains are uniformly appropriated (equal number per area), and if each grain has an equal and independent anticipation of developing to a dark silver grain after captivating photons, then the number of such dark grains in an area will be random with a minimal distribution; in areas where the contingency is low, this distribution will be close to the classic Poisson distribution of shot noise; nevertheless a simple Gaussian distribution is often used as an authenticmodel.

4.6 Non-Isotropic Noise: Some noise sources show up with a significant orientation in images. For example, image sensors are frequently subjected to row noise or column noise. In film, blemish is an example of non-isotropic noise. While we cannot altogether do away with image noise, it can assuredly reduce some of it. Corrective filters are yet another device that helps in reducing imagenoise.

4.7 Speckle Noise (Multiplicative Noise): While Gaussian noise can be modeled by random values added to an image, speckle noise can be modeled by arbitrary values multiplied by pixel values hence it is also called multiplicative noise. Speckle noise is a major problem in some radar applications. 3.8 Periodic Noise If the image signal is subjected toa intermittent rather than a random disturbance, we obtain an image depraved by periodic noise. The effect is of bars over the image.

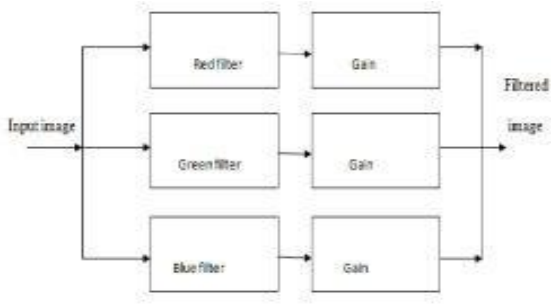

Figure1. Filtering the three primaries separately

V. Removing Noise from Images by Filtering

Image noise is an unavoidable side-effect occurring as a result of image capture, more simply appreciated as inaudible, yet inevitable variation. In a digital camera, if the light which enters the lens misaligns with the sensors, it will create image noise. Even if noise is not so certainly visible in a picture, some kind of image noise is bound to exist. Every type of electronic device accept and transmits some noise and sends it on to what it is creating. When the images are broadcast over channels, they are corrupted with impulse noise due to noisy channels. This impulse noise consists of large positive and negative spikes [7]. The positive spikes have values much larger than the background and thus they appear as bright spots, while the negative spikes have values smaller than the background and they come out as darker spots. Both the spots for the positive and negative spikes are visible to the human eye. Also, Gaussian type of noise influence the image. Thus, filters are required for removing noises before processing. There are lots of filters in the paper to remove noise. They are of many kinds as linear smoothing filter, median filter, wiener filter and Fuzzy filter. In this filtering technique, the three primaries(R, G and B) are done separately. It is followed by some gain to compensate for depletion resulting from the filter. The filtered primaries are then combined to form the colored image [9]. This process is very simple. This approach is shown in figure1.

5.1. LinearFilters:

Linear filter used to remove certain types of noise. Averaging or Gaussian filters are convenient for this purpose. Linear filters also tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise [10]. 4.11 Linear smoothing filters One method to remove noise is by convolving the original image with a mask that perform a low-pass filter or smoothing operation. For example, the Gaussian mask comprises elements determined by a Gaussian function. This complexity brings the value of each pixel into closer harmony with the values of its neighbors. In general, a smoothing filter sets each pixel to the average value, or a weighted average, of itself and its nearby neighbors; the Gaussian filter is just one achievable set of weights. Smoothing filters tend to blur an image, because pixel intensity values that are somewhat higher or lower than the surrounding neighborhood would "smear" across the area. Because of this blurring, linear filters are scarcely used in practice for noise reduction; they are, however, often used as the basis for nonlinear noise devaluation filters. 4.12 Adaptive Filter The wiener function applies a Wiener filter (a type of linear filter) to an image adaptively, tailoring itself to the local image variance. If the variance is large, wiener complete little smoothing. If it is issmall, wiener complete more smoothing. This approach often production better results than linear filtering. The adaptive filter is more selective thana proportionate linear filter, preserving edges and other high-frequency parts of an image. In addition, there are no design tasks; the wiener2 function handles all preparatory computations and implements the filter for an input image. wiener2, however, does require more computation time than linear filtering. Wiener works best when the noise is constant-power ("white") additive noise, such as Gaussian noise. Another method for removing noise is to evolve the image under a smoothing partial differential equation similar to the heat equation which is called anisotropicdiffusion.

5.2. Non-Linear Filters Inrecent years, a variety of nonlinear median type filters such as weighted median, rank conditioned rank selection, and relaxed median have been developed to overcome this shortcoming.

5.2.1 MedianFilter:

A median filter is an example of a non-linear filter and, if properly designed, is very good at preserving image detail. To run a median filter: 1. consider each pixel in the image 2. sort the neighboring pixels into order based upon their intensities 3. replace the original value of the pixel with the median value from the list A median filter is a rank-selection (RS) filter, a particularly harsh member of the family of rank-conditioned rank-selection (RCRS) filters; [4] a much milder member of that family, for example one that selects the closest of the neighboring values when a pixel's value is external in its neighborhood, and leaves it unchanged otherwise, is sometimes preferred, especially in photographic applications. Median and other RCRS filters are good at removing salt and pepper noise from an image, and also cause relatively little blurring of edges, and hence are often used in computer vision applications. Median filtering is similar to using an averaging filter, in that each output pixel is set to an average of the pixel values in the neighborhood of the corresponding input pixel. However, with median filtering, the value of an output pixel is determined by the median of the neighborhood pixels, rather than themean. The median is much less sensitive than the mean to extreme values (called outliers). Median filtering is therefore better able to remove these outliers without reducing the sharpness of the image.

5.2.2 FuzzyFilter:

Fuzzy filters provide promising result in image-processing tasks that cope with some drawbacks of classical filters. Fuzzy filter is capable of dealing with vague and uncertain information [5]. Sometimes, it is required to recover a heavily noise corrupted image where a lot of uncertainties are present and in this case fuzzy set theory is very useful. Each pixel in the image is represented by a membership function and different types of fuzzy rules that considers the neighborhood information or other information to eliminate filter removes the noise with blurry edges but fuzzy filters perform both

the edge preservation and smoothing .Image and fuzzy set can be modeled in a similar way [6]. Fuzzy set in a universe of X is associated with a membership degree. Similarly, in the normalized image where the image pixels ranging from {0, 1, 2... 255} are normalized by 255, the values obtained are in the interval [0, 1]. A fuzzy set is a class of points possessing a continuum of membership grades, where there is no sharp boundary among elements that belong to this class and those that do not. We can express this membership grade by a mathematical function called membership function or characteristic function μA (xi). This function assigns to each element in the set a membership grade in the interval [0,1]. If X is a collection of objects denoted generically by x, then a fuzzy set A in X is defined as a set of ordered pairs: A= {(x, μA(x))/x ε X} (1) Where μA(x) is called the membership function for the fuzzy set A. The membership maps each element of X to a membership grade between 0 and 1. In this way, the image is considered as a fuzzy set and thus filters are designed[3].

Conclusion:

Enhancement of an noisy image is necessary task in digital image processing. Filters are used best for removing noise from the images. In this paper we describe various type of noise models and filters techniques. Filters techniques are divided into two parts linear and non-linear techniques. After studying linear and non-linear filter each of have limitations and advantages. In the hybrid filtering schemes, there are two or more filters are recommended to filter a corrupted location .The decision to apply a which particular filter is based on the different noise level at the different test pixel location or performance of the filter scheme on a filteringmask.

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