International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org, editorijaiem@gmail.com
Volume 2, Issue 11, November 2013 ISSN 2319 - 4847

SURVEY ON VARIOUS NOISES AND TECHNIQUES FOR DENOISING THE COLOR IMAGE

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ABSTRACT

Images are often degraded by noises. Noise can occur during image capture, transmission, etc. Noise removal is an important task in Image processing. In general the results of the noise removal have a strong influence on the quality of the image processing technique. Several techniques for noise removal are well established in color image processing. The nature of the noise removal problem depends on the type of the noise corrupting the image. In the field of image noise reduction several linear and non linear filtering methods have been proposed.
Denoising of image is very important and inverse problem of image processing which is useful in the areas of image mining, image segmentation, pattern recognition and an important preprocessing technique to remove the noise from the naturally corrupted image by the different types of noises. The wavelet techniques are very effective to remove the noise also use of its capability to confine the power of a signal in little convert of energy values. This Paper reviews on various noises like Salt and Pepper noise, Gaussian noise etc and various techniques available for denoising the color image.

Key Words: Noises, Filters, Wavelets.

1. INTRODUCTION
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 original meaning of "noise" was and remains "unwanted signal"; unwanted electrical fluctuations in signals received by AM radios caused audible acoustic noise ("static"). By analogy unwanted electrical fluctuations themselves came to be known as "noise". Image noise is, of course, inaudible.
The magnitude of image noise can range from almost imperceptible specks on a digital photograph taken in good light, to optical and radio astronomical 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).

2. TYPES OF NOISE IN IMAGE
2.1 Gaussian noise
Principal sources of Gaussian noise in digital images arise during acquisition e.g. sensor noise caused by poor illumination and/or high temperature, and/or transmission e.g. Electronic circuit noise.
The standard model of this noise is additive, independent at each pixel and independent of the signal intensity, caused primarily by Johnson–Nyquist noise (thermal noise), including that which comes from the reset noise of capacitors ("kTC noise").Amplifier noise is a major part of the "read noise" of an image sensor, that is, of the constant noise level in dark areas of the image. 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.

2.2 Speckle noise
Speckle noise is a granular noise that inherently exists in and degrades the quality of the active radar and synthetic aperture radar (SAR) images. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area. Speckle noise in SAR is generally more serious, causing difficulties for image interpretation. It is caused by coherent processing of backscattered signals from multiple distributed targets. In SAR oceanography , for example, speckle noise is caused by signals from elementary scatters, the gravity-capillary ripples, and manifests as a pedestal image, beneath the image of the sea waves.

2.3Salt-and-pepper noise

Fat-tail distributed or "impulsive" noise is sometimes called salt-and-pepper noise or spike noise. An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission, etc. It can be mostly eliminated by using dark frame subtraction and interpolating around dark/bright pixels.

2.4 Poisson noise

Poisson noise or shot noise is a type of electronic noise that occurs when the finite number of particles that carry energy, such as electrons in an electronic circuit or photons in an optical device, is small enough to give rise to detectable statistical fluctuations in a measurement

2.5 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 exposure level. This noise is known as photon shot noise. Shot noise has a root-mean-square value proportional 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 sometimes known as "dark shot noise" or "dark-current shot noise”. Dark current is greatest at "hot pixels" within the image sensor. The variable dark charge of normal and hot pixels can be subtracted off (using "dark frame subtraction"), leaving only the shot noise, or random component, of the leakage. If dark-frame subtraction is not done, or if the exposure time is long enough that the hot pixel charge exceeds the linear charge capacity, the noise will be more than just shot noise, and hot pixels appear as salt-and-pepper noise.

2.6 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. Though it can be signal dependent, it will be signal independent if other noise sources are big enough to cause dithering, or if dithering is explicitly applied.

2.7 Film grain

The grain of photographic film is a signal-dependent noise, with similar statistical distribution to shot noise. If film grains are uniformly distributed (equal number per area), and if each grain has an equal and independent probability of developing to a dark silver grain after absorbing photons, then the number of such dark grains in an area will be random with a binomial distribution. In areas where the probability is low, this distribution will be close to the classic Poisson distribution of shot noise. A simple Gaussian distribution is often used as an adequately accurate model.

Film grain is usually regarded as a nearly isotropic (non-oriented) noise source. Its effect is made worse by the distribution of silver halide grains in the film also being random.

2.8 Anisotropic noise

Some noise sources show up with a significant orientation in images. For example, image sensors are sometimes subject to row noise or column noise.

3. RELATED WORK

3.1. Technique used to remove noise:

In selecting a noise reduction algorithm, one must weigh several factors:

- The available computer power and time available: a digital camera must apply noise reduction in a fraction of a second using a tiny onboard CPU, while a desktop computer has much more power and time
- whether sacrificing some real detail is acceptable if it allows more noise to be removed (how aggressively to decide whether variations in the image are noise or not)
- The characteristics of the noise and the detail in the image, to better make those decisions

3.1.1 Chroma and luminance noise separation

In real-world photographs, the highest spatial-frequency detail consists mostly of variations in brightness ("luminance detail") rather than variations in hue ("chroma detail"). Since any noise reduction algorithm should attempt to remove noise without sacrificing real detail from the scene photographed, one risks a greater loss of detail from luminance noise reduction than chroma noise reduction simply because most scenes have little high frequency chroma detail to begin with. In addition, most people find chroma noise in images more objectionable than luminance noise; the colored blobs are considered "digital-looking" and unnatural, compared to the grainy appearance of luminance noise that some compare to film grain. For these two reasons, most photographic noise reduction algorithms split the image detail into chroma and luminance components and apply more noise reduction to the former. Most dedicated noise-reduction computer software allows the user to control chroma and luminance noise reduction separately.

3.1.2 Linear smoothing filters

One method to remove noise is by convolving the original image with a mask that represents a low-pass filter or smoothing operation. For example, the Gaussian mask comprises elements determined by a Gaussian function. This convolution 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 possible set of weights.

Smoothing filters tend to blur an image, because pixel intensity values that are significantly higher or lower than the surrounding neighborhood would "smear" across the area. Because of this blurring, linear filters are seldom used in practice for noise reduction; they are, however, often used as the basis for nonlinear noise reduction filters.

3.1.3 Signal combination

Two measurements of the same physical quantity often exhibit different noise levels in different frequency ranges. Therefore, a single high-fidelity signal can be constructed by combining the low-noise parts of the signals in Fourier space. The strength of noise reduction by signal combination is that we do not see the loss of information that occurs in other noise-suppression approaches such as filtering or smoothing.[11] Noise reduction by signal combination has found applications in in-car microphone systems, single molecule biophysics, and chemo metrics among other disciplines.

3.1.4 Anisotropic diffusion

Another method for removing noise is to evolve the image under a smoothing partial differential equation similar to the heat equation which is called anisotropic diffusion. With a spatially constant diffusion coefficient, this is equivalent to the heat equation or linear Gaussian filtering, but with a diffusion coefficient designed to detect edges, the noise can be removed without blurring the edges of the image.

3.1.5 Non-local means

Another approach for removing noise is based on non-local averaging of all the pixels in an image. In particular, the amount of weighting for a pixel is based on the degree of similarity between a small patch centered around that pixel and the small patch centered around the pixel being de-noised.

3.1.6 Nonlinear filters

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;[12] 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.

3.1.7 Mean Filter

We can use linear filtering to remove certain types of noise. Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. This filter is also called as average filter. Certain filters, such as Gaussian filters or averaging filter,are appropriate for this purpose. For example, an averaging filter is useful for removing grain noise from a photograph. Because each pixel gets set to the average of the pixels in its neighborhood, local variations caused by grain are reduced. Conventionally linear filtering Algorithms were applied for image processing. The fundamental and the simplest of these algorithms is the Mean Filter as defined in. The Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. The Mean Filter is poor in edge preserving This filter is also called as average filter.[12] The Mean filter is defined by:

$$\text{Mean filter}(x_1 \ldots x_N) = \frac{1}{N} \sum x_i$$

N i=1

Where (x_1 ….. x_N) is the image pixel range.

Generally linear filters are used for noise suppression.

3.1.8 Median Filter

The main idea of the median filter is to run the signal entry by entry, replacing each entry with median of neighboring entries. Note that if window has an odd number of entries, then median is simple to define: The Median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because under certain conditions, it preserves edges whilst removing noise. The median filter is a robust filter. Median filters are widely used as smoothers for image processing, as well as in signal processingrocessing. A major advantage of the median filter over linear filters is that the median filter can eliminate the effect of input noise values with extremely large magnitudes. (In contrast, linear filters are sensitive to this type of noise - that is, the output may be degraded severely by even by a small fraction of anomalous noise values) [6]. besides the one-dimensional median filter described above, there are two-dimensional filters used in image processing. The output y of the median filter at the moment t is calculated as the median of the input values corresponding to the moments adjacent to t: $y(t) = median((x(t-T/2),x(t-T_1+1),\ldots,x(t),\ldots,x(t\ T/2))$. where t is the size of the window of the median filter Normally images are represented in discrete form as two-dimensional arrays of image elements, or "pixels" - i.e. sets ofnon-negative values B_{ij} ordered by two indexes - $i = 1,\ldots, N_y$ (rows) and $j = 1,\ldots,N_y$ (column). Where the elements B_{ij} are scalar values, there are methods for processing color images, where each pixel is represented by several values, e.g. By its "blue, green, red", values determining the color of the pixel

3.1.9 Wiener Filter

The Wiener filter is to filter out the noise that has corrupted a signal. Typical filters are designed for a desired frequency response. The Wiener filter approaches filtering from a different angle. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the LTI filter whose output would come as close to the original signal as possible Wiener filters are characterized by the following[12]:

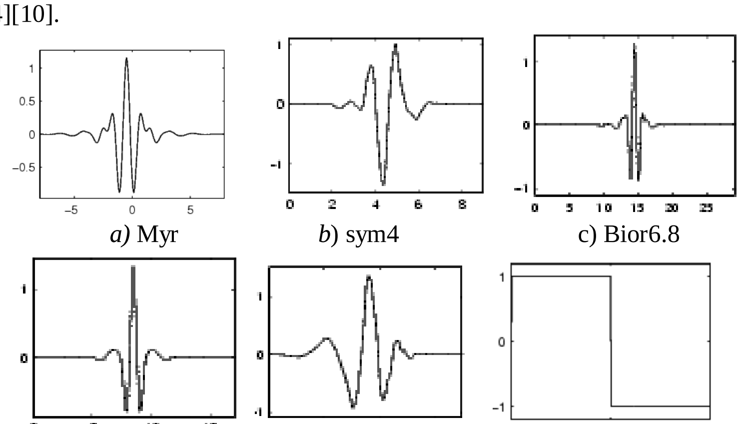
a. Performance criteria: minimum mean-square Error

b. Assumption: signal and (additive) noise are Stationary linear random processes with Known spectral characteristics.

c. Requirement: the filter must be physically Realizable, i.e. causal (this requirement can be Dropped, resulting in a non-causal solution)

4. SELECTION OF WAVELET FAMILIES FOR IMAGE DENOISING

In wavelet based image denoising the selection of wavelets is essential which decides the of image performance quality. There are several great choices of wavelets which depend on the selection of wavelet function. Thus selection of wavelet family depends on the size and resolution. Therefore, the best selection of wavelet depends on the particular images to be denoised.In wavelet based image denoising, the (SNR) signal to noise ratio performance mostly dependent on selection of wavelet. This paper analyses, various wavelet function families like Meyer, Daubechies, Coiflets, Symlets, Haar and Biorthogonal [13] [14][10].



a) Myr *b*) sym4 c) Bior6.8

d) Coif5 e) db4 f) haar

Fig 1. The Wavelet Families introduced in our study

Figure 1. Shows all the different waveforms which can be treated to indicate the complete parts of the image .Daubechies can be seen as the star in the world of research of Wavelet which is called as compactly supported orthonormal Wavelets

with biorthogonality and six coefficients. The names of the Daubechies family wavelets are written dbN, where N is the order, and db the surname of the wavelet.. Haar wavelet is one of the simplest and old wavelet which has the compact maintenance that means it disappears outer surface of a finite interval. Therefore the discussion of the wavelets is with Haar which is discontinuous in nature and bears a resemblance to a step function [14].

The Daubechies, bior and Coiflets are compactly supported orthogonal Wavelets [14]. The Meyer wavelet families are symmetric in shape. The choices of wavelets are based on their shape and their ability to denoise the image in a particular environment and application. The Coiflet has 2M moments is equal to zero and the scaling function has 2M-1 moments is equal to zero. Biorthogonal Wavelet family shows the property of linear phase, which is needed for image and signal reconstruction. By using two wavelet families, the properties can be derived on the basis of decomposition and reconstruction in place of the same single one [7].

5. CONCLUSION

In this paper we have studied about what is a Noise in an image and Different types of noises available in an image. The first phase of this paper is about the noises that are available in an image and the different types of efficient technique to denoise that image or to remove the noise from an image. The Second phase is about the different types of filters and wavelets available to remove the noise from and image different filter has different result for an image as same with the wavelets that can be used to improve the quality of a corrupted image. In Internet communications, wavelets have been used to compress images to a greater extent than is generally possible with other methods

6. SCOPE FOR FUTURE WORK

There are many different areas in which we can improve on. Our area of improvement would be to develop a better optimality criterion. The future work of research would be to Hybridization of wavelets in Wavelet Domain, applying the methods to denoise the image by applying hybrid wavelets and then performing image segmentation.

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