A Study Of Types Of Noise And De-Noising Techniques In Digital Image Processing

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Abstract— **Digital image processing is playing a key role in variety of application areas like medical image processing, pattern recognition, image restoration etc. Captured image quality may vary with factors like noise, light, temperature etc. Removing noise is one important step in image processing. Without knowing the types of noise and different noise removal techniques in digital image processing it is difficult to proceed further for any researcher. The objective of the paper is to study and represent conceptual study of various types of noise in brief. The study also aims to represent different noise removal techniques in a brief manner. Paper also provides a comparative study of few noise removal techniques.**

Keywords : formatting; Noise, De-Noising, Filters, CT, MRI

I. INTRODUCTION

Due to the advancement in technology image capturing techniques are also getting improved day by day. Noise removal and image improvement are two important steps in digital image processing. Digital images may be captured through various instruments. The different imaging modalities are also used in medical field like X-Ray, CT(Computed Tomography), Ultrasound (US), MRI(Magnetic Resonance Imaging) etc. Noise is an unwanted signal or information which destroys image quality and causes degradation in image quality[1].The source of noise may be at image acquisition or image transmission. Following diagram represents variety of noise that may occur in a digital image.
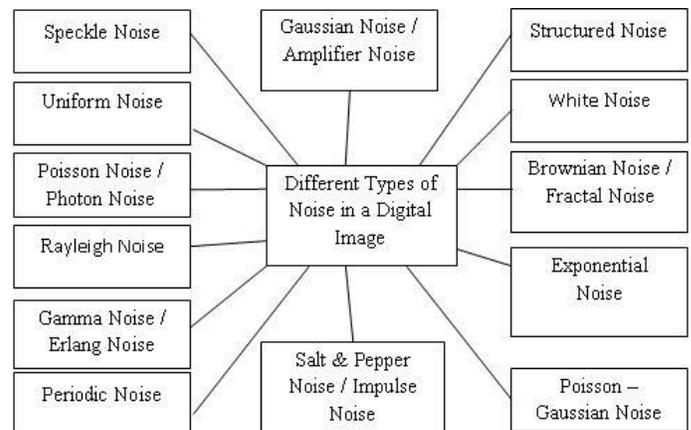

Figure 1 : Different types of noise in digital image

Following table provides summarized information about some of the types of noise.

Sr. No.	Name of the Noise	Description
1	Gaussian Noise / Amplifier	- Defined as the noise with a Gaussian amplitude distribution[2] - Modeled as Additive White Gaussian Noise(AWGN) - A statistical noise, characterized by Probability Density Function (PDF) of the normal distribution. - It may arise in amplifiers or detectors hence known as "electronic noise" also. - It may be generated during film exposure, or at the time of image acquision due to poor illumination and/or high

		temperature and/or transmission[3]			restoration algorithms.
2	Salt and Pepper Noise / Impulse	- looks as white or black (or both) pixels are scattered over the image -generally it occurs because of sharp and sudden disturbances in the image signal[2]. - may be generated due to dead pixels, errors at the time of analog to digital conversion or bit errors in transmission. - type of "Impulsive Noise" - Also known as "Data Drop Noise" , "Spike Noise" - May happen due to faulty memory locations, failure of camera's sensor cells functioning, synchronization errors in image digitizing or transmission.	5	Poisson Noise / Photon Noise / Quantum Noise / Shot Noise	- caused due to electromagnetic waves like X-Ray, visible light and gamma ray. - is caused when sufficient number of photons are not detected to provide statistical information
			6	Rayleigh Noise	- Typically Rayleigh Noise is contained by radar range and velocity images. - Modeled by Rayleigh distribution.
			7	Gamma Noise / Erlang Noise	- It is generally found in the laser based images. - It obeys the Gamma distribution.
3	Speckle Noise	- Mainly degrades the active radar, Synthetic Aperture radar (SAR), Ultrasound images. -caused due to lucid processing of backscattered signals from multiple targets [2].	8	Periodic Noise	- Electronics interference is responsible to generate this noise especially in power signal during image acquisition [1]. - in a video stream it may be produced due to electrical or electromechanical interference during video acquisition or transmission[1] - has spatial dependency and sinusoidal nature at multiples of specific frequency.
4	Uniform Noise / Quantization Noise	- Is produced while quantizing the pixels of a sensed image to a number of discrete levels. - It follows the uniform distribution. - uniform distribution of a grey level value in a image in specific range generates uniform noise - used to reduce the image quality to evaluate image	9	Structured Noise	- May be periodic, aperiodic, stationary, non stationary, detector stripping and detector banding in nature.

10	White Noise	- is a random signal with a constant power spectral density [1] - is analogous to white light.
11	Brownian Noise / Fractal Noise / Pink Noise / Flicker Noise / 1/f Noise	-Robert Brown discovered Brownian motion. - Brownian motions happen because of random movement of suspended particles in fluid. - its spectral density is inversely proportional to its square of frequency [1]

II. IMAGE DE-NOISING

Based on type of image different noise removal techniques may be applied. No doubt that the de-noising technique that removes the noise with preserving the details is preferred one. Linear de-nosing methods do not preserve the details of image but they are fast. Nonlinear methods do preserve the details of image along with noise removal. Different filters that are used in noise removal are broadly categorized as Averaging filter, Order Statistics filter and Adaptive filter

Mean filters are further improved as Arithmetic Mean Filter, Contra-Harmonic Mean Filter, Harmonic Mean Filter, Yp Mean Filter, Geometric Mean Filter, average filter[5] etc. The variants of median filter are like Standard Median Filter, Switched Median Filter, Progressive Switched Median Filter, Adaptive Median Filter, Trimmed Median Filter, Un-symmetric Trimmed Median Filter etc. More list of filters may include Minimum Filter, Maximum Filter, Midpoint Filter, Alpha-Trimmed Mean Filter, Wiener Filter, Wavelet Transform Filter, Curvelet Transform Filter etc.[6]

Following table gives a brief comparison of few popular filters used in image de-noising.

Sr. No.	Name of the Filter	Remarks
1	Mean Filter	-unreprenstative values in less number(one) of pixels may affect highly the mean value of pixel -linear filter, easy to implement
2	Median Filter	-more useful in signal processing and time series processing -useful to eliminate input noise with large magnitude -may be expensive and some time slow in computation.
3	Gaussian Filter	- popularly used in graphics software -threat of losing some data
4	Wiener Filter	-The additive noise is removed and the blurring is inverted simultaneously using this filter.[4] - useful for images degraded by additive noise and blurring[2]
5	Average Filter	-it reduces sharpness and flattens the local differences[5]

Many image enhancement techniques are used like histogram equalization, contrast enhancement etc. Filters are used effectively to improve the quality of image.

III. CONCLUSION

Noise is an important part of image. It causes a degradation of image quality. Hence study of different types of images and the image removing techniques becomes a crucial part in image processing. Irrespective of an application of image processing , the study of noise removing techniques is also an important area. A lot of noise removal techniques are already developed that helps the researchers to proceed. Ideally scope remains for improvement in every area. Without having the knowledge about these models it is nearly impossible to remove the noise from the image and perform denoising actions.[7].

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