Noise Removal from Images Using an Innovative Algorithm

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Abstract: Image restoration deals with bringing back the degraded image to its original state i.e. it helps to restore the degraded image into more sharp and clear image. The purpose of image restoration is to “compensate for” or “undo” defects which degrade an image. Degradation comes in many forms such as motion blur, noise, and camera miss-focus. The various statistical measures are mean, mode, median, variance, standard deviations and covariance. This research paper provides various type of statistical measure in respect to image processing and simulated all of these. Main purpose is to highlight the application of these measures in the various fields of digital image processing like, image enhancement, image restoration, image de-noising, and edge detection at the basic level and ease the selection of statistical parameter for a specific image processing technique.

Keywords: Image-Restoration, Image-Filtering, Image Merging, Statistical Parameters, Mean, Median, Mode.

I. INTRODUCTION

Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. An image may be defined as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates, and the amplitude at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the amplitude values of f are all finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to processing digital images by means of a digital computer. Digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are referred to as picture elements, image elements and pixels.

Image Processing is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too.

A. Types

The two types of methods used for Image Processing are Analog and Digital Image Processing. (a) Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst. Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing.

Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre-processing, enhancement and display, information extraction.

B. Causes of Noise in Digital Images

Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, depending on how the image is created. For example:

- If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise can 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 introduce noise.
- Electronic transmission of image data can introduce noise.

To simulate the effects of some of the problems listed above, the toolbox provides the in noise function, which you can use to add various types of noise to an image. By adding different types of noise we have degraded the input image. Noise is added at any random patches then all the patches are merged together to obtain degraded image.

C. Types of Noise

(a) Gaussian Noise

Gaussian noise represents statistical noise having probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution.
Principal sources of Gaussian noise in digital images arise during acquisition eg. Sensor noise caused by poor illumination and/or high temperature, and/or transmission eg. Electronic circuit noise. In digital image processing, Gaussian noise can be reduced using a spatial filter, though when smoothing an image, an undesirable outcome may result in the blurring of fine-scaled image edges and details because they also correspond to blocked high frequencies. Conventional spatial filtering techniques for noise removal include:

- Mean (Convolution) filtering
- Median Filtering
- Gaussian Smoothing.

(b) Salt and Pepper Noise
Salt-and-pepper noise is a form of noise sometimes seen on images. It presents itself as sparsely occurring white and black pixels. An effective noise reduction method for this type of noise is a median filter or a morphological filter.

(c) Poisson Noise
Poisson noise, also known as Photon noise, is a basic form of uncertainty associated with the measurement of light, inherent to the quantized nature of light and the independence of photon detections. Its expected magnitude is Signal dependent and constitutes the dominant source of image noise except in low-light conditions. The number of photons N measured by a given sensor element over a time interval t is described by the discrete probability distribution:

\[ P(N|t) = \frac{\lambda^N e^{-\lambda}}{N!} \]

Where is the expected number of photons per unit time interval, which is proportional to the incident scene irradiance. This is a standard Poisson distribution with a rate parameter that corresponds to the expected incident photon count.

II. LITERATURE REVIEW

JAGADISH H. PUJAR, KIRAN S. KUNNUR[3] states in their paper that image restoration can be described as an important part of image processing technique. Image restoration has proved to be an active field of research in the present days. The basic objective was to enhance the quality of an image by removing defects and make it look pleasing. They claimed an image restoration algorithm in MATLAB which was based on the neighbourhood property of a pixel. They focus on a certain iterative process to carry out restoration. One such method described was the Nearest Neighbourhood Method.

CHARU KHARE AND KAPIL KUMAR NAGWANSHI[4] have proposed in their paper a novel approach to process the image using different filtering methods by Image Restoration. Their aim was to enhance the digital image, reconstruct it into the original form from the noisy image. They claimed effective algorithms that can be used for image restoration. Techniques were used on the basis of non-linear filters to restore the image. The performance of Histogram Adaptive Fuzzy (HAF) filter was examined and compared with other filters like, Weighted Fuzzy Mean (WFM) filter, Minimum-maximum Detector Based (MBD) filter, Adaptive Fuzzy Mean (AFMF) filter, Centre Weighted Mean (CWM) filter, and Min-max Exclusive Mean (MME) filter on the basis of (Peak Signal to Noise Ratio) PSNR.

ANAMIKA MAURYA, RAJINDER TIWARI[5] had claimed in their paper a concise overview of most useful restoration models. Different types of image restoration techniques like Wiener filter, inverse filter, regularized filter, Richardson-Lucy algorithm, neural network approach, wavelet based approach, blind deconvolution was described and strength and weakness of each approach were identified.

WENYI ZHAO, ART POPE[6] had claimed two techniques to improve the noise handling characteristics of a recently proposed variational framework for semi-blind image deblurring that is based on joint segmentation and deblurring. One technique uses a structure tensor as a robust edge-indicating function. The other uses non-local image averaging to suppress noise.

JYOTI RANI, SARABJEET KAUR[7] states a brief introduction about digital image processing. The paper was related to image restoration, different types of noises are introduced and different methods were used to remove noise was described. Different parameters were described to compare the results of different methods which was used. All the work was done on medical images.

VAIMIN RAVAL, PROF. LOKESH GAGNANI[8] writes a basic information about image restoration and noise in image. They showed comparison of various methods of image restoration. Each method has its own advantage and disadvantage. Every method tries to remove noise from image. Personal images captured by various digital cameras can easily be manipulated by a variety of dedicated image processing algorithms. Image restoration can be described as an important part of image processing technique.

III. PROPOSED ARCHITECTURE
**IV. METHODOLOGY**

**A. Statistical Model**

Although research has already been done on few of these measures at quite advance level, this research paper proposed a simple statistical model.

The proposed statistical model consists of the following steps:

1. Dividing input image into sub images: In this step we divide the input image into small patches of size NxN. (Normally we take N=8)(Fig 1)

2. Statistical analysis of input image, Ii(x, y): In this step statistical analysis of all the patches of input image is calculated using various measures like mean, mode, median, variance, standard deviation and covariance.

3. Degrading input image: In this step randomly different types of noise are added throughout the image, so as to obtain degraded image Id(x,y).

4. Statistical analysis of degraded image, Id(x, y): In this step statistical analysis of all the patches of degraded image is calculated using various measures like mean, mode, median, variance, standard deviation and covariance.

5. Image Restoration: In this step, by comparing the statistical parameter of the degraded patch with the original patch, the degraded patch is completely replaced by other patch which is present in the degraded image having the same set of statistical parameters.

6. Image Merging: In this step the restored patches are merged together to form a single output image.

7. Image Filtering: Image filtering is done using different types of filters, so as to enhance more information from the restored image.

Depending upon requirements, for the image filtering we choose from a very basic filter to any multi parameter complex filtering. This research paper suggest statistical analysis of an image using various statistical measures.

**B. Statistical Parameters**

The various statistical parameters are as follows:

(a) **PSNR**

Peak signal-to-noise ratio (PSNR), is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. PSNR is usually expressed in terms of the logarithmic decibel scale. PSNR is most commonly used to measure the quality of reconstruction of lossy compression codecs (e.g., for image compression). PSNR is defined via the Mean square error (MSE). Given a noise-free mn monochrome image I and its noisy approximation K, MSE is defined as:

\[ \text{MSE} = \frac{1}{mn} \sum \sum [(i,j) - K(i,j)]^2 \] \[1\]

\[ \text{PSNR} = 10 \log_{10} \left( \frac{\text{MAX}^2}{\text{MSE}} \right) \] \[2\]

Here, MAX is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. More generally, when samples are represented using linear PCM with B bits per sample, MAX is 2B1.

(b) **MSE**

The mean squared error (MSE) of an estimator is one of many ways to quantify the difference between values implied by an estimator and the true values of the quantity being estimated. MSE measures the average of the squares of the "errors." The error is the amount by which the value implied by the estimator differs from the quantity to be estimated.
(c) Standard Deviation

It is the most widely used measure of variability or diversity used in statistics. Standard deviation helps in measuring the variability of a mean. It is used in evaluating values in records set to the mean and measuring of dispersion. It helps understand the variability in a set of data.

(d) Mean

Mean is the most basic of all statistical measures. A mathematical representation of the typical value of a series of numbers, computed as the sum of all the numbers in the series divided by the count of all numbers in the series. Means are often used in geometry and analysis; a wide range of means have been developed for these purposes. In contest of image processing filtering using mean is classified as spatial filtering and used for noise reduction. Arithmetic mean is commonly referred to as ”average” or simply as ”mean”.

(e) Variance

Variance measures how far a set of numbers is spread out. A small variance indicates that the data points tend to be very close to the mean (expected value) and hence to each other, while a high variance indicates that the data points are very spread out from the mean and from each other. Variance is the square of standard deviation which is given by,

\[ \text{Variance } \sigma^2 = (S.D)^2 \]

B. Flow Chart

![Flow Chart Image](image_url)

**Figure 2:** Flowchart of the Algorithm of Proposed Model

CONCLUSION

This proposed algorithm can be implemented in real life to test the accuracy of the model. Enhanced version of GUI can be designed so that it will be more helpful to clean the image with the help of algorithm. This paper gives fundamental idea about the image restoration and noise in image. This research paper also suggests various methods for image restoration by removing noise from image. There may be several methods exist for image restoration by removing noise, this paper contains some of them, so future work can be done on rest methods.

REFERENCES