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A Fast and Robust Hybridized Filter for Image De-Noising

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Abstract - In this research, we will work on the development of a new method for the removal of salt & pepper noise by creating a new hybridized filter using existing and/or new noise removal filters. The proposed filter will remove the noise with no or minimum image quality degradation. Salt & pepper noise degrades the quality of the image by hiding the details of objects in the image and also causes damages to the colour quality of an image. The noise has to be removed to obtain the good quality image after removing the salt and pepper noise. But the existing salt & pepper noise removal filter like median filter are not capable of reproducing object details in image with higher accuracy. We propose the development of an advanced salt & pepper noise removal filter using effective statistic and image processing methods to remove the noise along with support vector machine (SVMs) that will effectively do the job by reproducing the deep image details after removing the noise, which will enhance the quality of image than the existing filters.

Keywords – *salt and peper noise, median filter, SVM, PSNR, MSE, RMSE.*

1. Introduction

Image processing is the study of any algorithm that takes an image as input and returns an image as output. 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. The digital image is processed by a computer to achieve the desired result. Image enhancement improves the quality (clarity) of images for human viewing. Removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations. For example, an image might be taken of an endothelial cell, which might be of low contrast and somewhat blurred. Reducing the noise and blurring and increasing the contrast range could enhance the image. The original image might have areas of very high and very low intensity, which mask details. An adaptive enhancement algorithm reveals these details. Adaptive algorithms adjust their operation based on the image information (pixels) being processed. In this case the mean intensity, contrast, and sharpness (amount of blur removal) could be adjusted based on the pixel-intensity statistics in various areas of the image.

An image may be described as a two-dimensional function

$$I=f(x, y)$$

Where x and y are spatial coordinates. Amplitude of f at any pair of coordinates (x, y) is called intensity I or gray value of the image. When spatial coordinates and amplitude values are all finite, discrete quantities, the image is called digital image. Digital image processing may be classified into various sub branches based on methods whose:

- Inputs and outputs are images.
- Inputs may be images where as outputs are attributes extracted from those images.

Digital images are form of visual information captured or transmitted using camera or other imaging system. The received image might be corrupted due to the presence of noise. Image noise reduction without structure degradation is perhaps the most important low-level image processing task. Faulty sensors, optic imperfectness, electronics interference, and data transmission errors may introduce noise to digital images. In considering the signal-to-noise ratio over practical communication media, such as microwave or satellite links, there can be degradation in quality due to low received signal power. Based on trichromatic color theory, color pixels are encoded as three scalar values, namely, red, green and blue (RGB color space). Since each individual channel of a color image can be considered as a monochrome image, traditional nonlinear image filtering techniques often involved the application of scalar filters on each channel separately. However, this disrupts the correlation that exists between the color components of natural images. As such the color noise model should be considered as a 3-channel perturbation vector in color space. Image noise is the random variation of brightness or colours information in images 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. Although these unwanted Fluctuations became known as "noise" by analogy with unwanted sound they are inaudible and such as dithering.

The types of Noise are following:-

- Amplifier noise (Gaussian noise)
- Salt-and-pepper noise
- Speckle noise etc.

Salt and pepper noise also called as an impulse noise. It is also referred to as intensity spikes. Mainly while transmitting data we will get this salt and pepper noise. It has only two possible values, 0 and 1. The probability of each value is typically less than 0.1. The corrupted pixel values are set alternatively to the maximum or to the minimum value, giving the image a "salt and pepper" like appearance as salt looks like [13]white(one) and pepper looks as black(zero) for binary ones.

Pixels which are not affected by noise remain unchanged. For an 8-bit image, the typical value for pepper noise is 0(minimum) and for salt noise 255(maximum). This noise is generally caused in digitization process during timing errors, malfunctioning of pixel elements in the camera sensors, faulty memory locations. A digital filter is a system that performs mathematical operations on a sampled. There are two types of filters that are used to remove different type of noises from digital images.

Linear filters are used to remove certain type of noise. Gaussian or Averaging filters are suitable for this purpose. These filters also tend to blur the sharp edges, destroy the lines and other fine details of image, and perform badly in the presence of signal dependent noise. Non-linear filters have quite different behaviour compare to linear filters. For non-linear filters, the filter output or response of the filter does not obey the principals of scaling and shift invariance. In this project I use Average filter, and Median filter. Average filter is linear filters and a median filter is a non-linear filter.

Image de-noising is an vital image processing task i.e. as a process itself as well as a component in other processes. There are many ways to de-noise an image or a set of data and A method exists. The important property of a good image de-noising model is that it should completely remove noise as far as possible as well as preserve edges. Traditionally, there are two types of models i.e. linear model and non-liner model. The benefits of linear noise removing models is the speed and the limitations of the linear Models are the models are not able to preserve edges of the images in a efficient manner i.e the edges, which are recognized as discontinuities in the image, are smeared out. On the other Hand, Non-linear models can handle edges in a much better way than linear models.

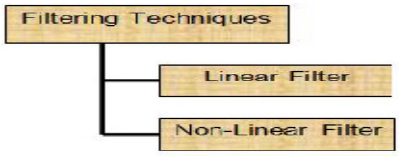

Figure: 1 Types of Filter

A median filter comes under the class of nonlinear filter. The best known order statistics filter is the median filter that replaces the value of a pixel by the median of their neighbourhood pixels. Median Filters are very effective in removing impulse noise at low density levels. The median filter follows the moving window principle for filtering. A 3 × 3, 5 × 5 or 7 × 7 kernel of pixels is scanned over pixel matrix of the complete image. The median of the pixel values within the window is computed, and therefore the center pixel of the window is replaced with the computed median. Median filtering is completed by, initial sorting all the pixel values from the surrounding neighbourhood into numerical order so substitution the pixel being considered with the centre pixel value. Note that the median value must be written to a separate array or buffer in order that the results are not corrupted because the method is performed.

The below process illustrates the methodology of median filtering. 5x5 mask and the pixel values of image in the neighbourhood of considered noisy pixel are

Table: 1 Median Values in the Neighbourhood Of 140

125	147	175	111	150
120	115	150	108	118
122	132	**140**	107	112
112	152	128	134	112
134	155	155	198	145

2. Literature Review

Om Prakash Verma et.al. (2013) have presented a fuzzy based impulse noise filter for both gray scale and color images. He has proposed an approach based on boundary discriminative noise detection. The proposed method is a multi-tier process comprising detection, filtering and color correction stages. C. Srivastava et.al.

(2013) have surveyed various noises like Speckle noise, Gaussian noise, Salt and pepper noise. He has stated it as a difficult task to separate noise from an image while maintaining the desired information and quality of an image. Zhang Jianjun et.al. (2012) have worked on the color image processing in the subject of extensive research recently. Many of the techniques used for color noise reduction are direct modification (component wise or marginal filters) of the methods used for gray scale imaging. In this effective two-phase approach is proposed for removing salt-and-pepper noise in color images. Tzu-Chao Lin et.al. (2012) have represented a novel decision-based filter based on supported vector machine (SVMs) that preserves image details. The filter employs on SVM impulse dector to judge whether an input pixel is noise. If a noise pixel is detected, a noise free Lower-Upper-Middle (LUM) filter is triggered replace it. Otherwise it remains unchanged. Vinod Kumar et.al. (2012) have presented that image de-noising is the basic problem in digital image processing. Removing Noise from the image is the main task to denoise the image. Salt & pepper (Impulse) noise and the additive white Gaussian noise are the types of noise that occur during transmission and capturing.

3. Problem Statement

There are several types of noises exist in the image data. The popular types of image noises are Amplifier noise (Gaussian noise), Salt-and-pepper noise , Shot noise (Poisson noise) and Speckle noise. Usually the impulse noises occur during the data transmissions. In this research, we will work on the development of new method(s) for the effective removal of the salt & pepper noise from the images without quality degradation. This noise caused bad results which hide the details of object present in image and clarity of an image. Salt and pepper noise is a type of impulse noise. It is also referred to as intensity spikes. Mainly while transmitting data we will get this salt and pepper noise. It has only two possible values, 0 and 1. The probability of each value is typically less than 0.1. The corrupted pixel values are set alternatively to the maximum or to the minimum value, giving the image a "salt and pepper" like appearance as salt looks like white(one) and pepper looks as black(zero) for binary ones. Pixels which are not affected by noise remain unchanged. For an 8-bit image, the typical value for pepper noise is 0(minimum) and for salt noise 255(maximum). This noise is generally caused in digitization process during timing errors, malfunctioning of pixel elements in the camera sensors, faulty memory locations.

4. Existing Algorithm

Mathematically the image noise can be represented with the help of these equations below:

$$V(x, y) = g[u(x, y)] + \eta(x, y) \quad (1)$$

$$g[u(x,y)] = \iint h(x, y; x', y')u'(x', y')dx'dy' \quad (2)$$

$$\eth(x, y) = f[g(u(x, y))]\, \eta 1(x, y) + \eta 2(x, y) \quad (3)$$

Here u(x, y) represents the objects (means the original image) and v(x, y) is the observed image. Here h (x, y; x', y') represents the impulse response of the image acquiring process. The term ŋ(x, y) represents the additive noise which has an image dependent random components f [g(w)] ŋ1 and an image independent random component ŋ2. A different type of noise in the coherent imaging of imaging, however, the unified definition of such a model still remains arguable. Yet, there exist a number of possible formulae whose probability was verified via their practical use.

Median Filter is a simple and powerful non-linear filter which is based order statistics. It is easy to implement method of smoothing images. In this filter, we do not replace the pixel value of image with the mean of all neighboring pixel values, we replaces it with the median value. Then the median is calculated by first sorting all the pixel values into ascending order and then replace the pixel being calculated with the middle pixel value. If the neighbouring pixel of image which is to be consider contain an even numbers of pixels, than the average of the two middle pixel values is used to replace the noise.

Algorithm 1: Median Filter

1. *Step 1. Select a two dimensional window W of size 3*3. Assume hat the pixel being processed is Cx,y.*
2. *Step 2. Compute Wmed the median of the pixel values in window W.*
3. *Step 3. Replace Cx,y by Wmed.*
4. *Step 4. Repeat steps 1 to 3 until all the pixels in the entire image are processed.*

Advantages:

- It is easy to implement.
- Used for de-noising different types of noises.

Disadvantages:

- Median Filter tends to remove image details while reducing noise such as thin lines and corners.
- Median filtering performance is not satisfactory in case of signal dependant noise. To remove these difficulties different variations of median filters have been developed for the better results.

5. Proposed Model

In this research, we will work on the development of a new method for the removal of salt & pepper noise by creating a new hybridized filter using existing and/or new noise removal filters. The proposed filter will remove the noise with no or minimum image quality degradation. Salt & pepper noise degrades the quality of the image by hiding the details of objects in the image and also causes damages to the colour quality of an image. The noise has to be removed to obtain the good

quality image after removing the salt and pepper noise. But the existing salt & pepper noise removal filter like median filter are not capable of reproducing object details in image with higher accuracy. We propose the development of an advanced salt & pepper noise removal filter using effective statistic and image processing methods to remove the noise along with support vector machine (SVMs) that will effectively do the job by reproducing the deep image details after removing the noise, which will enhance the quality of image than the existing filters.

6. Methodology

The research work will start with the literature review. A significant number of relevant research papers and books will be studied to understand the algorithm flow and structure of the existing noise removal algorithms. The existing algorithms will be thoroughly analyzed through a variety of experimentation. After the experimentation, the merits and demerits of the existing algorithms would be listed to prepare a base for the new algorithm design. The new algorithm will be designed to work with all of the advantages of the existing algorithms and to eliminate the disadvantages of the existing algorithms.

The proposed algorithm will be programmed using MALTAB environment. A thorough experimentation will be performed to analyze the performance of the proposed algorithm. The final results would be compared with the existing algorithm results. The finalization of the algorithm will be done after the completion of the performance evaluation task.

7. Conclusion and Future Work

In this research, we will work on the development of a new method for the removal of salt & pepper noise by creating a new hybridized filter using existing and/or new noise removal filters. The proposed filter will remove the noise with no or minimum image quality degradation. Salt & pepper noise degrades the quality of the image by hiding the details of objects in the image and also causes damages to the colour quality of an image. The noise has to be removed to obtain the good quality image after removing the salt and pepper noise. But the existing salt & pepper noise removal filter like median filter are not capable of reproducing object details in image with higher accuracy.

We propose the development of an advanced salt & pepper noise removal filter using effective statistic and image processing methods to remove the noise along with support vector machine (SVMs) that will effectively do the job by reproducing the deep image details after removing the noise, which will enhance the quality of image than the existing filters.

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