International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 2 Issue: 12 3799 – 3802

Fast filter Based Noise Removal in Digital Images

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Abstract— Images play a major role in today's world. It provides a lot of information in the field of medicine in diagnosing the disease, removing the defected area and also in traffic observations, surveillance systems, navigation etc. Often images are corrupted by noise due to various factors which cannot be avoided. Image denoising is done to detect the corrupted pixels and then correct them by the original pixel of the image. Filtering techniques are applied in images to filter out various types of noise. In this paper fast filters including mean, median, minimum, maximum, background subtraction are employed for removing the noise in images. ImageJ platform is employed for obtaining the results.

Keywords- *Fast filters, noise removal,mean,median,background subtraction,ImageJ*

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I. INTRODUCTION

Digital images are prone to a variety of types of noise. Unlike analog cameras, digital cameras work with a sensor instead of film. Sensors receive light and process it into electric charge through tiny photo diode whose outputs are reflected as pixels in final digital image. These electrical charges tell the sensor what color each corresponding pixel is meant to be and other information which will create the digital image. A Each square of the image sensor matrix is a photosite, usually with one light sensor painted on it. A photosite generally corresponds to one pixel in your digital image. When light strike the image sensor, electrons are produced. These photoelectrons give rise to analog signals which are then converted into digital pixels by an Analog to Digital (A/D) Converter. 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. Image noise is occurred during the process of capturing of images transmission of images acquiring of images. It is the digital equivalent of film grain for analogue cameras. Noise increases with the sensitivity setting in this camera, length of the exposure, temperature and among different camera models. Image denoising involves the detection of corrupted pixels and then corrects them by the original pixel in the image. The main objective behind these techniques is to suppress noise while preserving important features of the image.

All standard paper components have been specified some results [1] it deals with the use of adaptive filter to identify pixels which are likely to be contaminated by noise and the image is restored using a specialized regularization method that applies only to those selected noise candidates. [2] it presents a new efficient algorithm for removal of impulsive noise from corrupted images while preserving the details and is based on the alpha-trimmed mean, which is a special case of the order statistics filter only for impulsive noise detection instead of pixel value estimation [3] it presents a new nonlinear non iterative multidimensional filter, the peak and valley filter for impulsive like noise reduction based on order statistics and a minimal use of background information [4] it is based on the minimum absolute value of four convolutions obtained using one dimensional laplacian operators [5] it deals with a soft-switching noise-detection scheme to classify each pixel to be uncorrupted pixel, isolated impulse noise, non isolated impulse noise or image object's edge pixel, standard median(SM) filter is developed fuzzy weighted median (FWM) filter will then be employed according to the respective characteristic type identified [6] it deals with a class of signal dependent noise models it is uniquely defined by the variance of the zero mean random noise and by the gamma exponent which rules the dependence of the signal. Our paper is organized as follows, in section II noise and filtering techniques including mean, median, background subtraction, minimum, maximum are summarized, section III deals with the methodology implanted for noise removal, section IV shows results and discussion, Section V presents the conclusion.

II. NOISE AND FILTERS

Noise is an unwanted signal or degradation in an image signal caused by external disturbance during the transmission of image from one place to another place through satellite, wireless and network cable. There are a number of sources of noise contamination. Heat generated might free electrons from the image sensor itself thus contaminating the "true" photoelectrons. These "thermal electrons" give rise to a form of noise called thermal noise or dark current. Another type of noise is more akin to the 'grain' obtained by using a high ISO film. When we use a higher ISO, we are amplifying the signal we receive from the light photons. Unfortunately, as we amplify the signal, we also amplify the background electrical noise that is present in any electrical system. In low light, there is not enough light for a proper exposure and the longer we allow the image sensor to collect the weak signal, the more background electrical noise it also collects. In this case the background electrical noise may be higher than the signal. Digital cameras produce three kinds of noise in common they are random noise, fixed pattern and banding noise. Some random noise is identified by the intensity and the color fluctuations slightly high and low than the actual image intensity. Banding noise is considered as camera dependent, this type of noise occurs when it reads data from the digital sensor. Speckle noise is those modeled by random values

multiplied by the pixel values of an image. Periodic noise looks like noise in appearance where signal gets subjected to a periodic, apart from a random disturbance. The two type of noise to be removed is discussed below:

1. Salt and Pepper noise:

Salt-and-pepper noise is a form of noise sometimes seen on images. This is also known as impulse noise which is caused by sharp and sudden disturbance in the image signal and its appearance is randomly scattered pixels either black or white over the image. It presents itself as sparsely occurring white and black pixels. The noise is caused by errors in the data transmission. The corrupted pixels are either set to the maximum value (which looks like snow in the image) or have single bits flipped over. In some cases, single pixels are set alternatively to zero or to the maximum value, giving the image a `salt and pepper' like appearance. Unaffected pixels always remain unchanged.

2. Gaussian noise:

It is caused by random fluctuation in the signal. It is modeled by the random values added to an image. A type of statistical noise that is having a probability density function equal to that of the normal distribution which is indicated as Gaussian distribution. The values at any pair of times are identically distributed and statistically independent. Sources like poor illumination high temperature leads to Gaussian noise. In other words it is called ideal filter because it reduces the magnitude of high spatial frequencies in an image proportional to their frequencies trying to reduce the magnitude of higher frequencies more.

III. METHODOLOGY

The following sequence of operation is carried out in removing the noise. The basic image processing including image enhancement is performed to restore the original operations are performed in the image initially and filtering technique is applied to those images in effectively removing the noise. First an RGB image has been converted to an 8 bit gray scale image ranging from 0 to 256. Image enhancement technique is applied to obtain a clear image and then it is filtered.

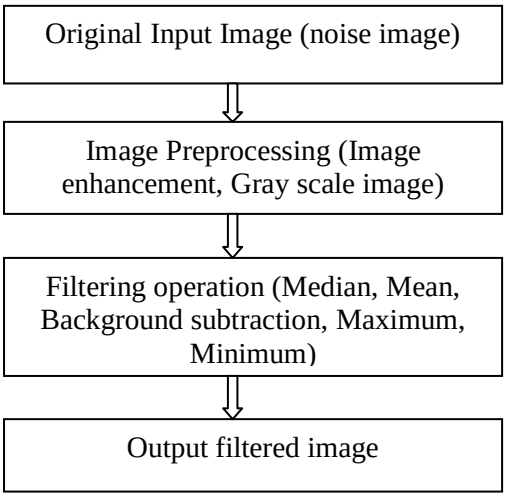

Fig: 1: Sequence of Operations

a. Image Preprocessing:

Every digital image is preprocessed before it is used for further operation. This operation is performed before all others. It generally increases the reliability of an optical inspection. During image acquisition it is often degraded by several factors preprocessing involves correction, distortion and noise introduced in the image. It is lowest level of abstractions whose ultimate aim is the improvement of the image data that suppress degradation and noise.

b. Median filter:

Median filtering is one kind of smoothing technique, as is linear Gaussian filtering. All smoothing techniques are effective at removing noise in smooth patches or smooth regions of a signal, but adversely affect edges. It is important to reduce the noise in a signal and to preserve the edges. Edges are of critical importance to the visual appearance of images. In this type of filter the current pixel is replaced by the mid element of its neighboring pixel. The pixel is replaced with the median of pixel within a window centered at that pixel. In case built in median the weight of border pixels is the same as those inner pixels. The main idea is to smooth the rough areas in scanned images that have a grainy appearance. It simplifies the colors or shades in an image by reading the brightness of adjacent pixels of noise and averaging out the differences.

c. Mean filter:

Average over n*m pixels, in this the out of the image pixel gets replaced by the nearest border pixel. It is image averaging and the value at a pixel is the output which is set to the average of values within a circular window centered at the pixel in the input. While performing average the window size is used to determine the neighborhood size.

d. Background subtraction:

Background subtraction includes background from minima and background from maxima. It does not output the result of the filter operation but rather the original image minus the result of filter operation plus an offset. The offset is needed except for 32-bit float images to keep the result in the range of the image type. (8- bit grayscale and 8- bit/channel RGB). Subtract filtered often results in a high pass filter with median it highlight outliers, with the minimum and maximum filters. Subtract filtered is a kind of edge detection and with other filters it provide various types of background subtraction.

e. Minimum filter:

In case of minimum filter the current pixel will be replaced by minimum pixel value of its neighboring pixels. It is minimum over n*m pixels and enhances dark values in the image by increasing its area. The darkest pixel then becomes the new pixel value at the center of the window. It assigns each cell in the output grid the minimum value in a moving window centered on each grid cell which is essentially an erosion operation.

ISSN: 2321-8169
3799 – 3802

f. Maximum filter:

In this type of filters the current pixel will be replaced by maximum value of its neighboring pixel. It is maximum over n*m pixels, makes the lighter pixels larger and shrinks the darker ones. The Maximum filter enhances bright values in the image by increasing its area. Similar to a dilate function each 3x3 (or other window size) is processed for the brightest surrounding pixel. That brightest pixel then becomes the new pixel value at the center of the window.

III Results and Discussion

A test input image is taken here for processing. Initial preprocessing operations are done in the image. First step involves the conversion of an RGB(color) image into an 8-bit gray scale image which will be used for filtering operation. Salt and pepper noise and Gaussian noise is applied to the images. ImageJ platform (powerful image analysis platform) is used for removing the noise in the image. Fast filters including mean, median, minimum, maximum, background subtraction is applied to the noisy images and the result is produced. The output image is compared with the original 8-bit image after noise removal.

Fig: 2: Original Image

Fig: 3: Gray image (8-bit)

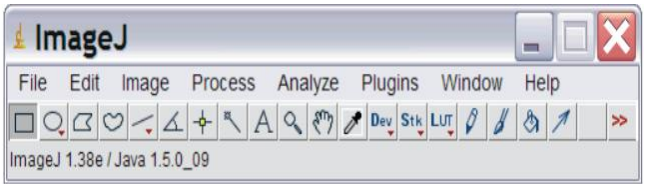

Fig: 4: ImageJ platform

Fig: 5: Salt and Pepper noise

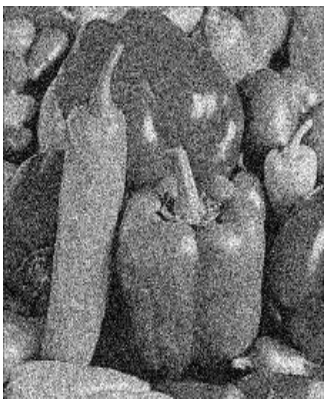

Fig: 12: Gaussian noise

Fig: 6: Mean filter

Fig: 13: Mean filter (G)

Fig: 7: Median filter

Fig: 14: Median filter (G)

 ISSN: 2321-8169
3799 – 3802

Fig: 8: Minimum Filter

Fig: 15: Minimum Filter (G)

Fig: 9: Maximum Filter

Fig: 16: Maximum Filter (G)

Fig: 10: Background Minima

Fig: 17: Background Minima (G)

Fig: 11: Background Maxima

Fig: 18: Background Maxima (G)

The above images show the filtered output obtained using the fast filters. From the output image we can infer that Median filter is used effectively in removing the salt and pepper noise and Gaussian noise when comparing to the other filters. It process the image in the running window with specified radius and the transformation makes the target pixel luminosity equal to the mean value in the running window. In case of mean filters as the window size is increased, more noise is removed, but at the same time the image is blurred more. The maxima and minima outputs show the darkest and brighter pixel in the image. All these filters have effectively removed the noise.

IV Conclusion

In this paper we have discussed the removal of both noise (salt and pepper, Gaussian noise). Apart from median and mean filter additional four filters have been used for removing the noise which shows a better resolution of images. Simulations results for both noise shows promising performance especially edges are preserved and uniform regions have been smoothed. However, in case of minimum and maximum filters further improvisation in future will lead to a better noise removal.

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