Denoising the Noisy Image by using Histogram Filter

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Abstract: Preprocessing is an inevitable step in image processing applications. A noise is always associated with the images because of many reasons like the hardware failures, errors in collecting the data, errors in loading the data, etc. Generally any random error in the data is called as noise and is general in images due to the above said reasons. To improve the quality of the image processing application results it is necessary to remove the noise. In this paper we are presenting histogram filter and is giving better results compared to mean and medial filters.

Key Words: Histogram filter, media filter

1. I. INTRODUCTION

The enormous devices in today's market help us in capturing and permanently storing the data in various formats like, relational database, text, image, etc. As the time progresses the cost of the data collecting devices like internet, sensors, satellites, scanners, etc, is decreasing rapidly and as a result of this the cost of storing the data is also decreases significantly.

In today's market we have also devices to capture the data and store in image formats, and people are using these images for various applications, for example the police department is using the images captured by CCTVs for crime investigation, banking technology is using it for security purpose, etc. But to do these applications the quality of image is a critical in applications like, in education (visualization), medicine (understanding X-Rays, CT scans, robotic and industrial automation (robotic vision), forensic criminology (face recognition, finger print identification, etc.), MRI scans, etc.), meteorology, and as well as in geography (satellite imagery).

A large number of pre-processing techniques like, normalizing the data, removing the noise, eliminating the outliers, etc., are developed for processing the raw data and placing the data in a useful format as an input any image processing algorithm. A vast number of machine learning and data mining techniques, pattern recognition techniques, soft and evolutionary algorithms, and artificial intelligence techniques are developed to extract the hidden knowledge from the data.

Pre-processing is the main step in any area where analytics is involved, either in data mining, machine learning, pattern recognition, etc., image analysis is also not an exception in this case. The intention of image preprocessing [2] is to enhance the quality of image before applying any mining algorithm. Many data cleaning and normalizing techniques are applied to reduce/remove the noise or improve the quality of image by enhancing its resolution [3] [4]. Mean filter or averaging filter [2] is the simplest and easy implementable linear filter. Other popular filters used in preprocessing techniques are median filter, Wiener filter, etc.

In this paper we present an approach for removing the noise from the image and our approach uses the histogram technique to remove the noise from the noisy image and we compare our approach with the mean filter and median filter.

2. II. RELATED WORK

The quality of image mining techniques is decreased by the noise in the images; a noise is a random error in the image, so that the image is pre-processed using denoising technique to smoothen the images. In order to improve the algorithm, the filters are introduced to eliminate unrelated neighbourhoods and other noisy pixels from the weighted average used to denoise each image pixel. These filters are based on average gray values as well as gradients. Part of the ongoing efforts includes the investigation of image characteristics that provide good context classifications for image denoising [1].

Mean filter or averaging filter is a simple linear filter and easy implementation method of smoothing images. Average filter is used to reduce the variation of one pixel with the other pixel. The average of the nearest k number of pixels is taken and is

replaced with all the pixels in a square window [5, 6, 7]. Median filter works in similar to mean filter, but instead of taking the mean value it takes the median of the nearest k pixels [8. 9].

Wiener filters are other category of filters used for removing the noise. The important use of wiener filter [10, 11, 12] is to reduce the amount of noise present in an image by comparison with an estimation of the desired noiseless signal. It is based on a statistical approach. Wiener filters are characterized by three important factors. One is Assumption: The stationary linear stochastic processes of image and noise with known spectral characteristics or known autocorrelation and cross-correlation. The second one is Requirement: the filter must be physically realizable/causal. The third one is performance criterion: minimum mean-square error (MMSE). Discrete Wavelet Transformers are the mostly used techniques for preprocessing the images [13, 14, 15].

A. Denoising the Noisy Image

The figure-1 shows the basic steps in preprocessing the given noisy image. In this procedure we are presenting a method for denoising the given image using the technique called histogram.

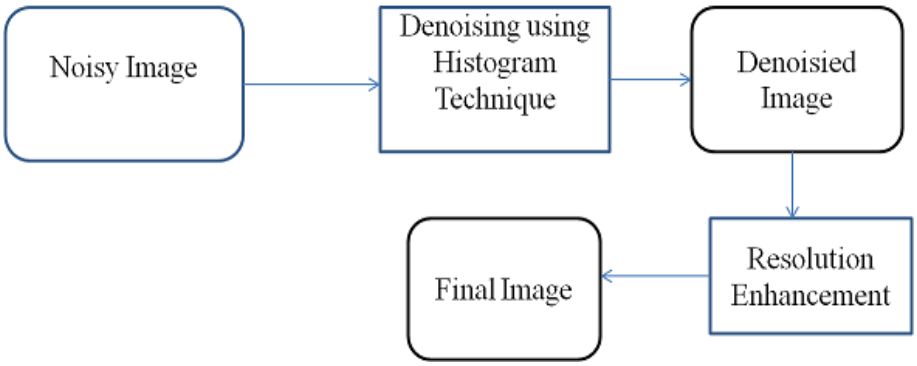

Figure-1: Preprocessing steps in image processing

B. Histogram Filter

Histogram Filter works similar to mean filter or median filter. In our work initially we divide the given image into approximately *n* two dimensional units. For each unit a histogram is constructed for all pixels fallen within the unit by using the pixel intensities (i.e, normally it ranges from zero to 255 for most of the image formats).

C. Histogram construction

Consider the size of the image is m X n. To construct the histogram the given image is divided into n units, such that each unit is not less than p X q size; where p >= m/x and q >= n/y, where x and y are the user specified thresholds. For example if the image size is 520 X 522 (Assume it a gray scaled image in the format of pgm, the pixel intensities are from 0 to 255), and x = 52, y = 52. Then the image is divided into the following units:

Except the last unit, every unit has 2704 elements; the last unit of every row has 2802 elements.

$$\begin{pmatrix} 52 \text{ X } 52 & 52 \text{ X } 52 & \ldots\ldots & 52 \text{ X } 54 \\ 52 \text{ X } 52 & \ldots\ldots\ldots\ldots\ldots\ldots & & 52 \text{ X } 54 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & & & \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & & & \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & & & \\ 52 \text{ X } 52 & & & 52 \text{ X } 54 \end{pmatrix}$$

Histogram is constructed based on the following procedure:

a. The total number of bars in the histogram is 256.
b. Each bar is a representative for each pixel intensity (i.e., 0 to maximum intensity, if it is a colour pixel then 3*256 bars are constructed)
c. The length of the bar which is a representative for pixel intensity 0 is the total number of pixels with intensity 0 in the considered unit.

D. Denoising the image

a. Sort the histograms based on the frequency of each bar.
For example, assume that the maximum resolution value is 6, and then six bars are constructed in a histogram. Assume the unit size is 8X8. Consider the following values:

Pixel intensity	Frequency
1	2
2	18
3	12
4	16
5	4
6	12

Histogram for the above data

Table: 1 Data for constructing histogram

Pixel intensity	Frequency	Width	Height (%)
1	2	1	3.125
2	18	1	28.125
3	12	1	18.75
4	16	1	25
5	4	1	6.25
6	12	1	18.75

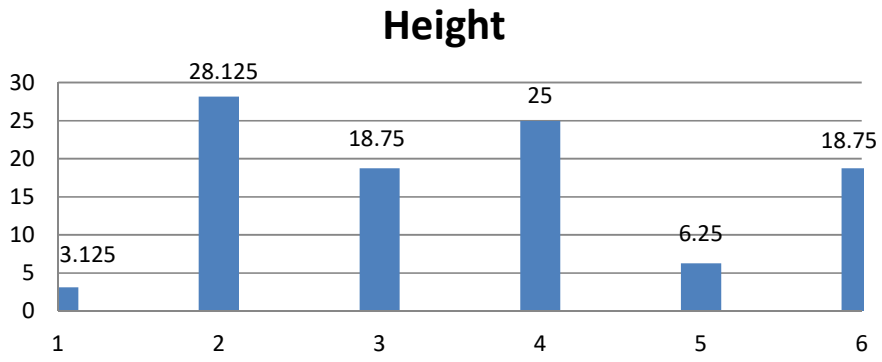

Figure-2: Histogram

b. Identify the first 25% of the bars and all these are declared as noisy pixels.
From the example the pixels which have the intensity 1 are all declared as noisy pixels and are considered for smoothing.

c. Somthened these pixels with the nearest pixel in the 75% of the bars.
All these pixels intensities are replaced with the nearest pixels intensities which are in the 75% of the pixels.

E. Comparison with mean and media filters

In mean and medial filters the every pixel is replaced with the mean or median of the nearest k number of pixels, but in histogram filter we replace only those pixels which are identified as noisy pixels. This intuition guarantees that histogram filter outperforms both the mean and median filters in smoothing the images.

3. III. RESULTS

We tested on the following image (figure-2) and we compared our result with the mean and median filters and our filter shows the 6% improvement (with respective mean square erroe (MSE) in most of our experiments.

Figure-2: Input Image

Figure- 3: Denoised Images a) mean filter b) median filter c) histogram filter

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