Image noise removal using different median filtering techniques – A review

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Abstract

Today is the epoch of modern technology and science, everyone in the globe focusing to the quality with minimum human interface, most of the organizations required most of the modern techniques so that they can able to rectify the quality concerns this may also influence the quality of digital images. Although technology is rapidly changing day by day, whatever so the tool required to maintain quality that must be an economical as well user friendly. In the present review of the most of the authors, their main focus is to remove the noise of the image using different techniques. Digital image was developed through black and white gray scale image to the RGB color image, but color image was also facing the problem of noise, noise is categorized into different types. In this paper ours attention is to studying the removal of the impulsive noise in the color images by using the median filtering techniques. In the median filtering technique, signals are processed through line by line to detect the noise. Median filtering algorithm works on the principle of the median. This study shows us how the filter rectifies the median of the processed signal's pixel's around the whole area. Median filter can remove the noise from 1-D gray scale image, but their extension to colour images are not direct due to vector ordering of pixels, it is quite difficult. The most adapted four classical algorithms of median filtering techniques are Vector median filter (VMF), Basic vector directional filter (BVDF), Directional distance filter (DDF), Bit-mixing filter (BMF), for colour images with their experimental results [6].

Keywords: Median filter, image noise, colour image, vector filters, spatial filter.

1. Introduction:

Digital image processing is the processing of image by means of computer. An image is the two dimensional function that represents the characteristics color and brightness it is the projection from three dimensional scene to two dimensional projection plane. Image is of two types, first is an Analog image and second is the digital image. An analog image is the range of intensity value which is varies continuously, while the digital image is composed form of picture element known as pixels. Digital image is two dimensional discrete signals which is represented by N × N array. [1]. Digital image processing is the very important technique which is useful for the access to technical data in digital and multiple wavelength environments. Speed of processing the data and the possibilities of big storage. Several things can take the benefit of it such as technical diversity and maintaining the accuracy of the original data.

Digital image is represented in two types of domain Spatial domain and frequency domain. In spatial domain output pixel is the weighted sum of the neighborhoods pixels while frequency domain is the space in which image value at image position F that represents the intensity variations with the corresponding variable distance. An image noise is any unwanted variations in the image parameters like intensity and brightness. Noise is removable using several filtering techniques. These filtering techniques are categorized into two main categories linear filter and nonlinear filter. Linear filtering is works on the principle of Mean. Form new image whose pixels are a weighted sum of original pixel values, using the same set of weights at each point. Another one is Median filter. This nonlinear filter is applied to images to Preserve edges and details and remove impulsive and Gaussian noise [7].

2. Median filter

Median filter is a simple Non-Linear filter which is useful in removal of impulsive noise in both types of images that is gray scale image and Color images. It is observed that median filter can successfully removes impulsive noise in gray scale image without affecting to the edges or blurring them [2]. But their extension to color images is cannot be traced directly. The main problem is that color image's pixel's are not naturally ordered and its vector directional nature[3][4]. median filter works as like a A{x} image first and B{x} is second image,

$$median[A(x) + B(x]) \neq median[A(x)] + median[B(x)]$$

In this paper we are describing four classical approaches in color median filtering And also we are briefly discuss the with their experimental results[6].

Algorithm description

The median filter is to run through the signal one by one, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", these window slides, entry by entry, over the whole signal. For 1D signals the simple solution window is just the first few previous and next entries, For 2D or higher-dimensional signals such as images, more complex window patterns like "box" or "cross" patterns are exist. If the window is with odd and even number of entries then the median is just the middle value after all the entries in the window are sorted numerically and there may be more than one possible median

Example 1 :-Compute the median value of the marked pixel

$$\begin{pmatrix} 9 & 3 & 6 \\ 2 & 4 & 5 \\ 5 & 7 & 1 \end{pmatrix}$$

Step 1- Firstly we have to write the no in ascending order

1 2 3 4 5 5 6 7 9

Step 2- The median value is computed as follows,

~~1~~ ~~2~~ ~~3~~ ~~4~~ (5) ~~5~~ ~~6~~ ~~7~~ ~~9~~

Thus the median value is calculated as 5, thus the original pixel valu of 4 will be replaced by the computed median vale 5.

The new mask is,

1 2 3 **5** 5 5 6 7 9

$$\begin{pmatrix} 9 & 3 & 6 \\ 2 & (4) & 5 \\ 5 & 7 & 1 \end{pmatrix} \longrightarrow \begin{pmatrix} 9 & 3 & 6 \\ 2 & \boxed{5} & 5 \\ 5 & 7 & 1 \end{pmatrix}$$

Original data After median filtering

After applying the median filter to the image the pixels values which are different than their neighboring pixels being change with their median [1].

3. Types of median filtering techniques

Median filters are mainly the vector median filter used for the high dimensional color images. This section is focuses on the three main categories of vector median filter with their extension to color image and A bit mixing filter that shows the mixing of the pixels value with for preference to the higher amplitude value. This filters are spatially adapted filters [6]. The spatial domain is the normal image space, in which a change in position in images I directly projects to a change in position in scene S. Distances in I in pixels correspond to real distances S like distance in meters. A typical class of vector median filters employs the distances between input vectors; the vector directional filter (VDF) family operates on the direction of the image vectors, aiming at omitting vectors with typical directions in the vector space. To acquire its objective VDF measures the angle between the image vectors to arrange vector inputs inside a processing window. It resulting into a set of input vectors with roughly the same direction in the vector space is produced as the output set. As the vectors in this set are around collinear, in a second step by

magnitude processing we can produce the required filtered output. while a class of vector directional filters operates on the vector directions. we can say it as angles, directional distance filters class is combines the properties of both properties of vector distances and angles[8].

4. Vector Median Filtering

- Represent each control point pair by a 2D displacement vector
- Median vector is the vector that has the least summed distance to other points
- Finds the correct median if $\left|\frac{N}{2}\right|$ pairs are accurate
- Modified to get the k nearest vectors to the median
- As k increases provides more control points, but there may be more inaccurate pairs
- A natural choice is to select,

$$k = \left|\frac{N}{2}\right|$$

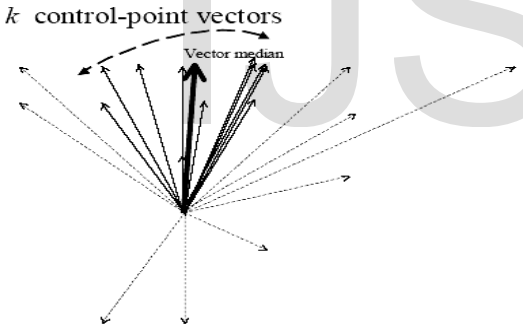


Fig. Vector Median Filter [9].

A distance measure D_x concern with vector V_x

$$Dx = \sum_{y=1}^{N} || Vx - Vy || L \quad \ldots\ldots(1)$$

For x= 1,2……N, Ref. [8].

Where,
$|| Vx - Vy || L$ is the distance between vector V_x V_y with respect to L norms then the vector median value is given by,

$$VMF(W) = V_M \quad \ldots.(2)$$

Thus distance D_M x=1,2….N Dx[6].

5. Vector Directional Filters

Vector directional filter is the ranked ordered non linear filter which is used for distance criteria within two adjacent vectors from the vector of the median filter from equation (1). The vector directional filter specifies the angular increment corresponds to the vector ordering and their adjacent angles. The scalar measures are,

S of angle βx with respect to vector Vx

$$\beta_x = \sum_{y=1}^{N} S(Vx, Vy) \quad \ldots.(3)$$

Where, x = 1, 2…….N
& $S(Vx, Vy)$ is measure of angle between vector Vx & Vy.
Thus vector directional filter value is ,

$$VDF(W) = V_M \quad \ldots.(4)$$

Such that βM =min x=1,2….Nβx[6].

6. Directional distance filter

A scalar Sx is the combination of the distance and measure of angle between the vectors Vx

$$Sx = Dx^{1-\omega}.\beta_x{}^{\omega} \quad \ldots.(5)$$

For x = 1, 2…….N

Thus,

$$Sx = \left(\sum_{y=0}^{N} || Vx - Vy || L\right)^{1-\omega} . \left(\sum_{y=1}^{N} S(Vx, Vy)\right)^{.\omega} \quad \ldots.(6)$$

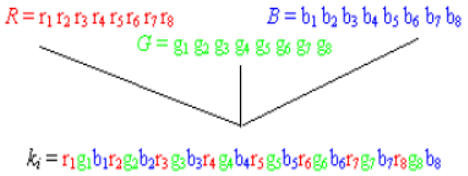
Where, ω power value ranging from 0 to 1 that modules the relative influence Dx & βi
Thus, the directional filter value is

$$DDF(W) = V_M \quad \ldots.(7)$$

Such that Sx = $Min_{x=1.....N}$. Sx[6].

7. Bit mixing filter

A Bit mixing filter is useful when no ordering of the color vectors are given that is for gray scale images. Gray scale median filters are required the total order of the median value.In such a conditions if there is no existence of the Color vector a Bit mixing strategy is used to represents the series on a window W.let us consider the scalar S_i is associated with each color vector Vi of window W[6].



Example: Vi are the RGB vectors indicating 3-bytes and Si is the integer value which is arranged in ordered. Afterwards vector Vi is arranged in ordered to get the set of ordered vectors Xi. Then the bit mixing filter filter value is given by,

$$BMF(W) = V_M \quad \ldots\ldots(8)$$

8. Conclusion:

This review paper shows that few filtering techniques namely bilateral filter, median filter, wavelets, wiener filter, ROF Filter, Fuzzy Filters are few of those which led to the evolution of number of other filters. Also, these filters are applied to the number of images and various imaging systems over the years and have been used in wide range of applications

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