

A Survey of Various Image Enhancement Methods on Different Types of Images

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Abstract— The main aim of this survey is to compare different image enhancement methods. The basic purpose of enhancement is to increase the interpretability of pixels in images so that a good quality image can produce as an output image. Removal of noise from an image using filtering is known as image enhancement. When we talk about human perception we can't say directly that which image is good or noisy because there is no slandered measurement through which we can measure the quality of good image. Image enhancement plays important role when we use enhanced image for further processing like for number plate recognition. This paper will provide idea about already existing enhancement techniques which are frequently used in these days. This paper will provide idea that which technique is better in which case.

Keywords— Noise, Filtering, Image Enhancement, Digital Image Processing

I. INTRODUCTION

The basic principal behind image enhancement is to process or change the dimensions or attribute of image to make that particular image more worthy for a particular task. During processing, one or multiple dimensions of image can be altered and the selection of dimensions is particular to problem. There are many techniques which are used for enhance and enhance images without any bumbling. The enhancement techniques can be divided into two categories:

1. Spatial Domain Methods
2. Frequency Domain Methods

In case of spatial domain method, we directly process image pixels for the enhancement [1]. All pixels values are controlled or handled to achieve good quality image. In frequency domain methods, image firstly channelized or converted into frequency domain. That means in frequency domain method we simply deal with the Fourier Transformation of image. All enhancement procedures are executed on Fourier transform of image and then Inverse Fourier transformation is applied to get resultant image. Enhancement only means, that an image 'x' is transformed into image 'y' with the help of T (T-> transformation). Now, let suppose the values of pixel in images 'x' and 'y' are represented as 'p' and 'q' respectively. So, the pixel values 'p' and 'q' formed relation i.e. [3],

$$p = T(q) \quad (1)$$

Here, T represents image pixel value 'p' into 'q'. The transferred output is represented into grey scale range i.e. (0,255) and same procedure will be applied on RGB images. The example of image enhancement of grey scale image as shown below [3]:

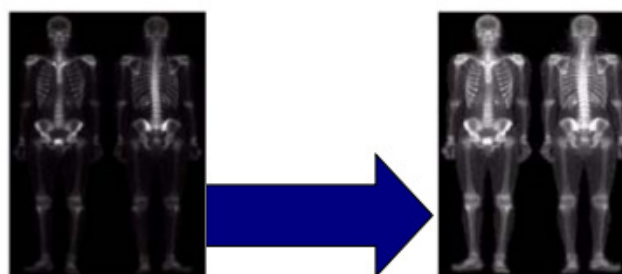


Figure 1 Effect of Image Enhancement

II. Spatial Domain Methods

MEDIAN FILTERING

This method is very simple and effective way to get rid of impulse noise (noise due to data loss or saturation) from digital images. Salt noise, pepper noise, salt and pepper noise, line drop all these noise are comes under impulse noise. This method includes two steps: The very first step in median filtering is that we have to find or observe impulse noise in the image. In this step, firstly noise pixel is identified and rests all pixels values are simply classified into two categories: "noise-free pixels" and "noisy pixel". Now, next step is to remove the noisy pixel (impulse noise) from an image means we only processed noisy pixel from an image to enhance that particular image. And on other hand "noise-free" pixels simply used in output image which will be final enhanced image. The actual implementation (removal of impulse noise) of median filtering is done in this step. However, the removal of impulse noise is many times reduce the good feature of image in terms of edges that means edges might be blurred and distorted after filtering. Hence, it is necessary to maintain the edges and

fine inside information during filtering. But this method shows better image quality in terms of visual aspect and quantitative measure. In this method we generally use one sliding window for filtering and that sliding window is always having odd number of items in it. When a corrupted image is there then you will want to improve its appearance or its visual aspects for specific application. Your median value is behaved as final calculated value where we classify the higher and lower part of sample. We can calculate median of given finite numbers by arranging all the values from lowest to highest and by selecting centre value, the centre values becomes median of number. For example:

The measurements are [3,7,2,1,8,9,4,3,6].

Firstly, we format these values in ascending order (lowest value to highest value).

[1, 2, 3, 3, 4, 6, 7, 8, 9]

Then middle one is picked. Here number of measurements is $n=9$, which is an odd number. The middle or center value is 4. So, the median is 4. But if the number of observations is even then in that case two middle observations will be picked up and mean operation has to be performed on that value. Like if middle values are 5 and 6 then averaging mean of these values gives 5.5. So, In that case median is 5.5. Median value is much like neighborhood. Median filtering is popular in removing salt and pepper noise and works by interchanging the pixel value with the median value in the locality of that particular pixel.

Median Filtering Implementation

Suppose noisy image is corrupted by salt-pepper noise. By taking 3×3 mask size most of the noise has been eliminated. But if we want more polish image then we can use large median filter and that is of 7×7 mask size where all the noisy pixels disappear but computational complexity will be increase. Let us take an example:

9	8	7
6	15	4
3	2	1

Figure 2 Unfiltered Values

By arranging the pixel value,

Ascending order: 1,2,3,4,6,7,8,9,15

Here, median value is 6(no of values are 9).

Now, the centre or middle pixel value is replaced by 4 as shown in figure3:

9	8	7
6	6	4
3	2	1

Figure 3 Median Filtered Value.

Let us take an example of Synthetic (artificial) Image, in this image let us consider 6×6 window size and we will take 3×3 mask size to find all the median value.

Now, the values of pixels in image as shown in figure4:

1	7	3	8	4	9
3	2	8	4	9	5
8	4	3	9	5	6
1	9	5	4	1	7
6	2	1	6	5	2
8	7	3	2	7	6

Figure 4 Synthetic Images.

Now, we have to find all the centre values using median filter i.e. from A to P as shown in figure5. Here, we have to find out all the median values using 3×3 mask size and replacing the original middle pixel value with new values that will calculate. Here, mask size means the size of matrix through which we have to perform median filtering on given synthetic image.

1	7	3	8	4	9
3	A	B	C	D	5
8	E	F	G	H	6
1	I	J	K	L	7
6	M	N	O	P	2
8	7	3	2	7	6

Figure 5 Synthetic Images.

In Figure 5:

To find A:

Ascending order:1,2,3,3,3,4,7,8,8

Median is 3.

To find B:

Ascending order:2,3,3,4,4,7,8,8,9

Median is 4.

To find C:

Ascending order:3,3,4,4,5,8,8,9,9

Median is 5.

In similar way, we have to find rest all values from D to P. Then final outcome means final synthetic image of 6*6 windows as shown in figure6.

1	7	3	8	4	9
3	3	4	5	6	5
8	4	4	5	5	6
1	4	4	5	5	7
6	5	4	4	5	2
8	7	3	2	7	6

Figure 6 Enhanced Synthetic Images Using Median Filtering.

Neighborhood Averaging Filters

This filtering method somewhat similar to median filter only difference is that instead of using median here we focus on average of intensity level of pixel value in the neighborhood. Basically, this method reduces shrill (high pitched) transitions in intensity levels. Generally, window size is square but it can be of any shape either rectangular, circular etc. it depends on size of the image. Each pixel in enhanced image is $f(x, y)$ which will obtain from average pixel value in neighborhood of (x, y) in given input image. In this method, average value will calculated until each pixel of image has been covered. For example:

The values are [7,5,6,8,1,3,8,5,4].

First, we have to find summation of all these values.

Sum= $7+5+6+8+1+3+8+5+4=47$.

Then, we have to find average. Now, here number of observations or values are 9 ($n=9$).

So, Average= $47/9=5.2$ (approx. 5)

Now, take same synthetic image as shown in figure4. And in same way we have to find all the values from A to P by using averaging filtering with 3*3 mask size. Now let us calculate for A and B:

To find A:

Ascending order:1,2,3,3,3,4,7,8,8

Averaging: $(1+2+3+3+3+4+7+8+8)/9$.

Averaging is 4.

To find B:

Ascending order :2,3,3,4,4,7,8,8,9

Averaging: $(2+3+3+4+4+7+8+8+9)/9$.

Averaging is 5.

In similar way values from C to P will be calculated as shown in figure5. Then after applying calculating all the pixel values the final output synthetic image is as shown in figure7:

1	7	3	8	4	9
3	4	5	6	7	5
8	5	5	5	6	6
1	4	5	5	5	7
6	5	4	4	4	2
8	7	3	2	7	6

Figure 7 Enhanced Synthetic Images Using Averaging Filtering.

So, this is final image output which is enhanced image by using averaging filtering method. Here, the size of this image is 6*6 means 6 pixel horizontally as well as vertically. Here, one grid (box) represents the one pixel of enhanced image which was earlier noisy and enhanced by using averaging filtering method.

Histogram Equalization

The goal of this method is to get uniform histogram for the final output image. That means histogram equalization is to distribute the gray level within an image so that each and every gray level is equally take place. Basically, this method increases the brightness and contrast of the image so that visibility of image will increase [4]. Histogram equalization is a mapping function which maps your input histogram function to the uniformly distributed output histogram function [2]. Histogram equalization is basically level the in intensity of pixel in such a way that histogram formed is equalized or must be in uniform in shape. In histogram equalization we have to find the value of probability of

occurrence of intensity level i.e. 'rk' in digital image is approximated by [5]:

$$\text{Probability (rk)} = nk/MN$$

Where, $k=0, 1, 2, 3, \dots, L-1$.

'MN' is the no. of pixel in image; 'nk' is the no. of pixel having intensity 'rk' and 'L' is the no. of possible intensity level in the image. Let us take same synthetic image as shown in figure9. Now, we have to calculate rk, nk and probability (rk). The intensity levels are integers in the range $[0, L-1] = [0, 9]$. Here, $MN= 6*6$ (pixel) =36 (pixel). With the help of these values, we can calculate 's' values.

$s = \text{number of intensity levels (L)} * P(\text{rk})$. Here (s) is output intensity level.

To find s0:

$$s0 = 9*0.0=0$$

$$s0=0$$

To find s1:

$$s1=9*(r0) +9*(r1)$$

$$s1=9*0.0+9*0.11=0.99$$

To find s2:

$$s2=9*(r0) +9*(r1) +9*(r2)$$

$$s2=9*0.0+9*0.11+9*0.17$$

$$s2=2.52$$

e	nk	P(rk)=nk/MN
r0	0	0.0
r1	4	0.11
r2	6	0.17
r3	5	0.14
r4	2	0.06
r5	4	0.11
r6	3	0.08
r7	3	0.08
r8	5	0.14
r9	4	0.11

Figure 8 Calculated values of rk, nk and P (rk).

To find s3:

$$s3=9*(r0) +9*(r1) +9*(r2) +9*(r3)$$

$$s3=9*0.0+9*0.11+9*0.17+9*0.14$$

$$s3=3.78$$

In similar way all other value will be calculated. And the final result of those values is as follows:

$$s4=4.32$$

$$s5=5.31$$

$$s6=6.03$$

$$s7=6.75$$

$$s8=8.01$$

$$s9=9$$

Since, these values are in decimal so we have to convert these values in to integer by rounding them to nearest integer. Hence, after applying round function the values comes out to be:

$$s0=0.0->0$$

$$s1=0.99->1$$

$$s2=2.52->3$$

$$s3=3.78->4$$

$$s4=4.32->4$$

$$s5=5.31->5$$

$$s6=6.03->6$$

$$s7=6.75->7$$

$$s8=8.01->8$$

$$s9=9->9$$

3	5	7	9	8	2
1	9	2	6	5	8
1	8	9	6	2	7
2	4	3	3	2	8
7	3	8	4	5	1
3	1	5	6	9	2

Figure 9 Synthetic Images.

Result Comparison

Both median and averaging filtering are used for same purpose that is to remove noise (salt & pepper noise) but both have different way to remove noise. Median filtering removes the noise (impulse noise) but also decrease the intensity of pixel means image will be much softer or sometimes there will be little bit color change in image as shown in figure9. But on other hand image improved with average filtering has same intensity level as original image but not clear as in case of median filtering. Figure9 include 3 images first image showing the noise effect (Salt & Pepper Noise), second image showing median filtering which is used on Salt & pepper noise and third image showing the effect of averaging filtering on same image. So, from the figure clearly you can see the effect of these methods on same image. Figure10 shows the variation due to histogram equalization effect. Histogram equalization method is basically used to increase or enhance the contrast means use where image are dark or having low brightness. So, figure10 shows how a dark image is enhanced with histogram equalization method.

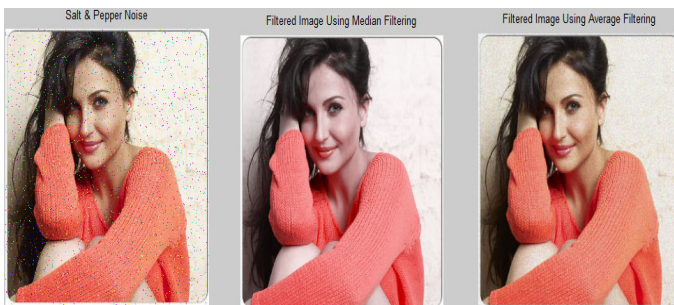


Figure 10 Median & Averaging Filtering.

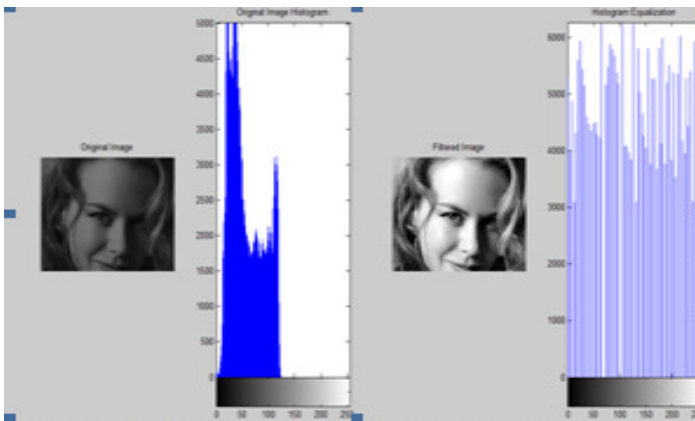


Figure 11 Histogram Equalization of Image.

Conclusion

This survey investigates that all method (median filtering, neighborhood averaging filtering and histogram equalization) can remove noise up to large extent. Impulse noise is removed using median filtering. Median filter is

somewhat like to means filter but it is better than mean filter because it preserve more useful pixel value of sharp edges than mean filter. Median filter is more robust than means filter because it does not create new pixel value but it gives the value of that pixel which is in the neighborhood of that particular pixel. And averaging filtering is used where image as blurring effect. Histogram equalization is applied where we want to increase the contrast of dark and blur images. Basically histogram uses those values which are most common intensity value in images and the very important point is that we can use histogram equalization if and only if where background and foregrounds color are both dark or black. But histogram equalization also has one disadvantage that at the time of processing without any care sometime it may lead to huge increase in contrast of background noise or unwanted signal due to some processing in useable pixel value which ultimately cause bad histogram result. But if we will use histogram method in a good manner that means by checking the parameter or characteristics of image then it will definitely give you good result in the form of enhanced image.

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