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Comparison of Morphological, Averaging & Median Filter

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Abstract: *Morphological & Averaging filter is proposed in this paper. A comparison between adaptive generalized morphological filter is proposed in this paper. With respect to the interference possibly encountered in image processing power system signal, detailed investigations are carried out through comparison which one is better than other. Morphological filtering are important methods to process and analyze images.*

I. Introduction to Morphological Filtering

Morphological filtering theory was created by French mathematicians G.Matheron ,J.Sarra and others in the early 80s. As a form of nonlinear filter, morphological filters have been widely applied in the field of digital signal processing. Based on geometric characteristics of signal, filter uses the pre-defined structuring element to match the signal and then achieves the purposes of extracting signal and suppressing noise. There are various forms of morphological filters that have evolved:

II. Morphological open – closing and close -opening filters

In order to suppress the positive and negative impulse noise in images simultaneously, P. Maragos has constructed a morphological open-closing and close-opening filters by using the structuring elements of same size and cascading opening and closing operations in different order [6]. Their definitions are:
Let $f(x)$ denote the input discrete signal and $g(x)$ denote the structuring element. The morphological open-closing (OC) and close-opening (CO) filters are defined respectively as:

$$Oc(f) = (f \circ g \bullet g)(x)$$

$$Co(f) = (f \bullet g \circ g)(x)$$

Morphological open - closing and close – opening filters have all natures of opening and closing operations. Although the morphological open – closing and close – opening filters can filter the positive and negative impulse noise in signal, the output range of open – closing filter will be small for the contractility of opening operation and the output range of close–opening filter will be large for the expansionary of closing operation. The two basic filters all have statistical bias phenomenon.

2.1 Generalized open - closing and close – opening filters

At present, the morphological filters adopted are mainly the morphological opening and closing operations and the cascade forms of them. Although these filters can suppress the positive and negative impulse noise synchronously, the statistical bias phenomenon will exist during the signal filtering process for the anti-expansion of morphological opening and the expansion of morphological closing. The bias phenomenon will go against the suppression of impulse noise and the filters cannot suppress the white noise effectively.

In order to overcome this drawback, literature [12] has constructed a sort of generalized open-closing and close-opening filters by using the structuring elements of different size and cascading opening and closing operations. Their definitions are:

Let $f(x)$ denote the input discrete signal and g_1, g_2 denote the structuring elements. It is further assumed that $g_1 \subseteq g_2$; The generalized open-closing and close-opening filters are defined respectively as:

$$GOC(f) = (f \circ g_1 \bullet g_2)(x)$$

$$GCO(f) = (f \bullet g_1 \circ g_2)(x)$$

2.2 Spatial Domain Filtering

Filtering operation that is performed directly on the pixels of the image is called spatial domain filtering. The process consists of simply moving the filter mask from point to point in an image. At each point (x,y) the response of the filter at that point is calculated using a predefined relationship.

In smoothing linear filters the output of a smoothing linear spatial filter is simply the average of the pixels contained in the neighborhood of the filter mask. These filters are sometimes called the **averaging filters** and also the low pass filters. Spatial averaging filter in which all the coefficients are equal are sometimes called a **box filter.**

Weighted average, in which pixels are multiplied by different coefficients, thus giving more importance to some pixels at the expense of others.

Order statistics filters are the nonlinear spatial filters whose response is based on the ordering the pixels contained in the image area encompassed by the filter and then replacing the value of the center pixel by the value determined by ranking result e.g. median filter.

Median filter replaces the value of pixel by the median of the gray levels in the neighborhood of that pixel. Median filters are quite popular for their effectiveness in case of impulse noise (salt or pepper noise) because of its appearance as black and white dots superimposed on an image.

Guassian noise:-

Gaussian noise is statistical noise that has a probability density function (abbreviated pdf) of the normal distribution (also known as Gaussian distribution). In other words, the values that the noise can take on are Gaussian-distributed. It is most commonly used as additive white noise to yield additive white Gaussian noise (AWGN). White means its power spectral density is independent of the operating frequency. White is used in the sense that white light contain all the frequency components.

BW=(0.75*BW3oc)+(0.3*BW3co);

III. Comparison of morphological, median and averaging filter

For an image containing noise i.e. 'gaussian', the results are obtained by using morphological, median and Averaging filters. These have different quality and also, their mean errors are different. This comparison is shown in Figure 4.10.

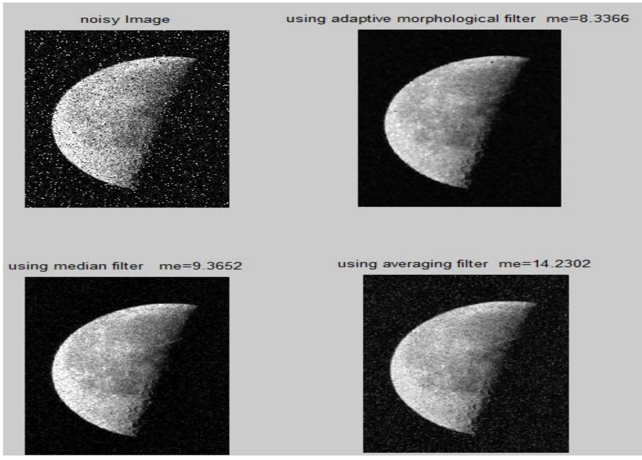

Fig 4.10 Comparison of results of morphological, median and averaging filters

IV. Conclusion

We have proposed filtering using mathematical morphology to improve the performance of detection of various noises in highly corrupted images. The proposed method is based on mathematical morphology. The morphological residue detector powerfully determinates the noises with a low percentage error. The simulation results indicate that the proposed filter performances better than median and averaging filtering techniques.

References

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