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Filters a Image Enhancement and Smoothing Technique

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ABSTRACT

Image Processing today allow much wider range of applications. Basic problem in processing a image is noise. To use an image for any specified application we need a noiseless image. To remove noise and to enhance and smoothen the image Filters can be used.

1. Introduction

Image : To understand the importance of filters in image processing it is important to understand what is image and its application areas. An image as defined in the "real world" is considered to be a function of two real variables, for example, a(x,y) with a as the amplitude (e.g. brightness) of the image at the real coordinate position (x,y). A digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are called picture elements, image elements, and Pixel. Digital image processing is the use of computer algorithms to perform image processing on digital images.

Digital image processing is concerned primarily with extracting useful information from images. Ideally, this is done by computers, with little or no human intervention. Image processing algorithms may be placed at three levels.

- At the lowest level are those techniques which deal directly with the raw, possibly noisy pixel values, with de-noising and edge detection being good examples.
- In the middle are algorithms which utilise low level results for further means, such as segmentation and edge linking.
- At the highest level are those methods which attempt to extract semantic meaning from the information provided by the lower levels, for example, handwriting recognition.

2.What can be done by Image Processing ?

- Geometric transformations such as enlargement, reduction, and rotation.
- Color corrections such as brightness and contrast adjustments, quantization, or
 conversion to a different color space.
- Registration (or alignment) of two or more images.
- Combination of two or more images, e.g. into an average, blend, difference, or image composite.
- Interpolation and recovery of a full image from a RAW image format.
- Segmentation of the image into regions.
- Image editing and Digital retouching.
- Extending dynamic range by combining differently exposed images.

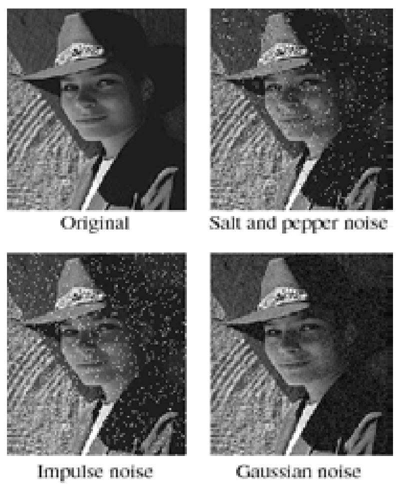
3.Applications

Image Processing finds applications in the following areas:

- Photography and Printing
- Satellite Image Processing
- Medical Image Processing
- Face detection, Feature detection, Face identification
- Microscope image processing

4.Image acquisition

Image acquisition is the process of obtaining a digitized image from a real world source. Each step in the acquisition process may introduce random changes into the values of pixels in the image. These changes are called noise. many potential sources of noise are their. image get affected by noise during the acquisition process. Different types of noises are their, ex. Salt and pepper noise, impulse noise, Gaussian noise.



5.Image enhancement

In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display. Examples include contrast and edge enhancement, pseudo coloring, noise filtering, sharpening and magnifying. Image enhancement is useful in feature extraction, image analysis and visual information display.

6. Filter In Image Processing

Based on the understanding that an image comprises a collection of frequency components the next step is to determine how image filtering can be implemented. In image processing filters are mainly used to suppress either the high frequencies in the image, i.e. smoothing the image, or the low frequencies, i.e. enhancing or detecting edges in the image. An image can be filtered either in the frequency or in the spatial domain.

$$\sum_{(s,t)\in S_{xy}} = \text{Summation of pels in the } (m \times n) \text{ window}$$

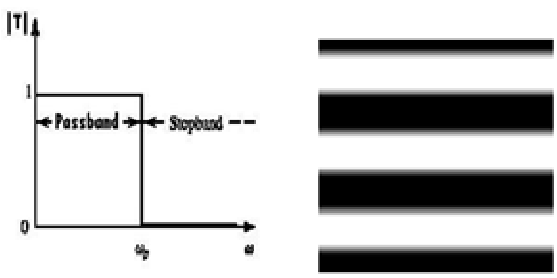
Sxy = set of coordinates in a rectangular subimage window (neighborhood) of size (m x n) centered at point (x,y).

The first involves transforming the image into the frequency domain, multiplying it with the frequency filter function and re-transforming the result into the spatial domain. The filter function is shaped so as to attenuate some frequencies and enhance others.

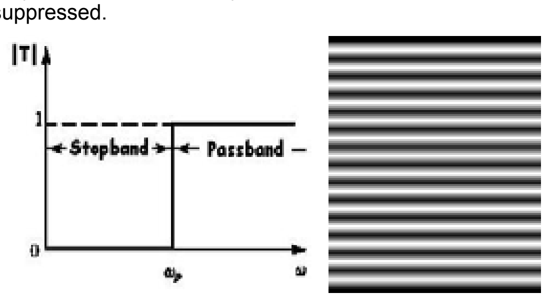
Figure : (a) low contrast image original image; (b) image after enhancement.

6.1 Types of filters
There are basically three different kinds of filters:

6.1.1 low-pass filters. A low-pass filter attenuates high frequencies and retains low frequencies unchanged. The result in the spatial domain is equivalent to that of a smoothing filter; as the blocked high frequencies correspond to sharp intensity changes.



6.1.2 high-pass filter on the other hand, yields edge enhancement or edge detection in the spatial domain, because edges contain many high frequencies. Areas of rather constant graylevel consist of mainly low frequencies and are therefore suppressed.



6.1.3 A bandpass attenuates very low and very high frequencies, but retains a middle range band of frequencies. Bandpass filtering can be used to enhance edges (suppressing low frequencies) while reducing the noise at the same time (attenuating high frequencies).

6.2 Moving Window Operations
The form that filters usually take is as some sort of moving window operator. The operator usually affects on pixel of the image at a time, change its value by some of a “local” region of pixels. The operator “moves” over the image to affect all the pixels in image. Some common types are:

6.2.1 Neighbourhood-averaging filters: these replace the value of each pixel, a[i,j]say, by a weighted average of the pixels in some neighborhood around it, i.e. a weighted sun of a[i+p,j+q]. The weights are non-negative. If all the weights are equal then this is a mean filter.

* Mean filter is usually thought of as a convolution filter. It is based on a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean. 3*3 square kernel is used, although larger kernels ie 5*5 can be used for more sever smoothing.

The 3x3 neighborhood of a pixel (x,y) is shown:

$$\hat{f}(x,y) = \frac{1}{m \cdot n} \sum_{(s,t)} g(s,t) \qquad \in S_{xy}$$

* Median filters, like mean filter, considers each pixel in the image turn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel values with the mean of neighbouring values, it replaces it with the median of those values.

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

Median filter can eliminate noise spikes in image while preserving the edges, but it will round the corner on objects as well as eliminate very fine lines.

The median filter has two main advantages over the mean filters:

1. the median is more robust average then the mean and so a single very unrepresentative pixel in a neighbourhood will not effect the median value significantly.
2. since the median value must actually be the value of one of the pixel in the neighbourhood, the median filter does not create new unrealistic pixel value when the filter straddles an edge.

The disadvantage of the median filter :
Although median filter is a useful non-linear image smoothing and enhancement technique. It also has some disadvantages. The median filter removes both the noise and the fine detail since it can’t tell the difference between the two. Anything relatively small in size compared to the size of the neighbourhood will have minimal affect on the value of the median, and will be filtered out. In other words, the median filter can’t distinguish fine detail from noise.

***Adaptive Median Filtering**
the adaptive median filtering has been applied widely as an advanced method compared with standard median filtering. The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbour pixels. The size of the neighbourhood is adjustable, as well as the threshold for the comparison. A pixel that is different from a majority of its neighbours, as well as being not structurally aligned with those pixels to which it is similar, is labelled as impulse noise. These noise pixels are then replaced by the median pixel value of the pixels in the neighbourhood that have passed the noise labelling test.

7.Conclusion:
All the described filtering techniques can be used in isolation to enhance the viewing quality of images, or they can be used processing steps to derive better result from subsequent processing steps. Filtering techniques are available as part of most entry level image processing software packages.

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