Image Processing and Computer Vision

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ENHANCEMENT USING ARITHMETIC/LOGIC OPERATIONS

- It involves operations performed on a pixel by pixel basis between two or more images (excluding NOT, which is performed on single image)
- Any logical operators can be implemented by using only 3 basic functions(*AND, OR & NOT)*.
- The *AND* and *OR* operations are used for *masking*; i.e. for selecting subimages in an image. light represents binary1 and dark represents binary 0.

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IMAGE SUBTRACTION

The difference between two images f(x,y) and h(x,y) expressed as

$$g(x,y) = f(x,y) - h(x,y)$$

The key usefulness of subtraction *is the enhancement of differences between images*. Difference is taken between corresponding pixels of ‘f’ and ‘h’.

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Fig1: image1 Fig2: image1 Fig3: result of subtraction

The above figure 1 &2 indicates the image taken for subtraction and the figure3 indicates the result of subtraction of image1 with itself.

IMAGE AVERAGING

The purpose of image averaging is *noise removal.*

Consider a noisy image g(x,y) formed by the addition of noise n(x,y) to an original image f(x,y); i.e.

$$g(x,y) = f(x,y) + n(x,y)$$

If the noise satisfies the constraint (*uncorrelated at every coordinate (x,y)*), then averaged image is given by

$$\bar{g}(x,y) = \frac{1}{K}\sum_{i=1}^{K} g_i(x,y)$$

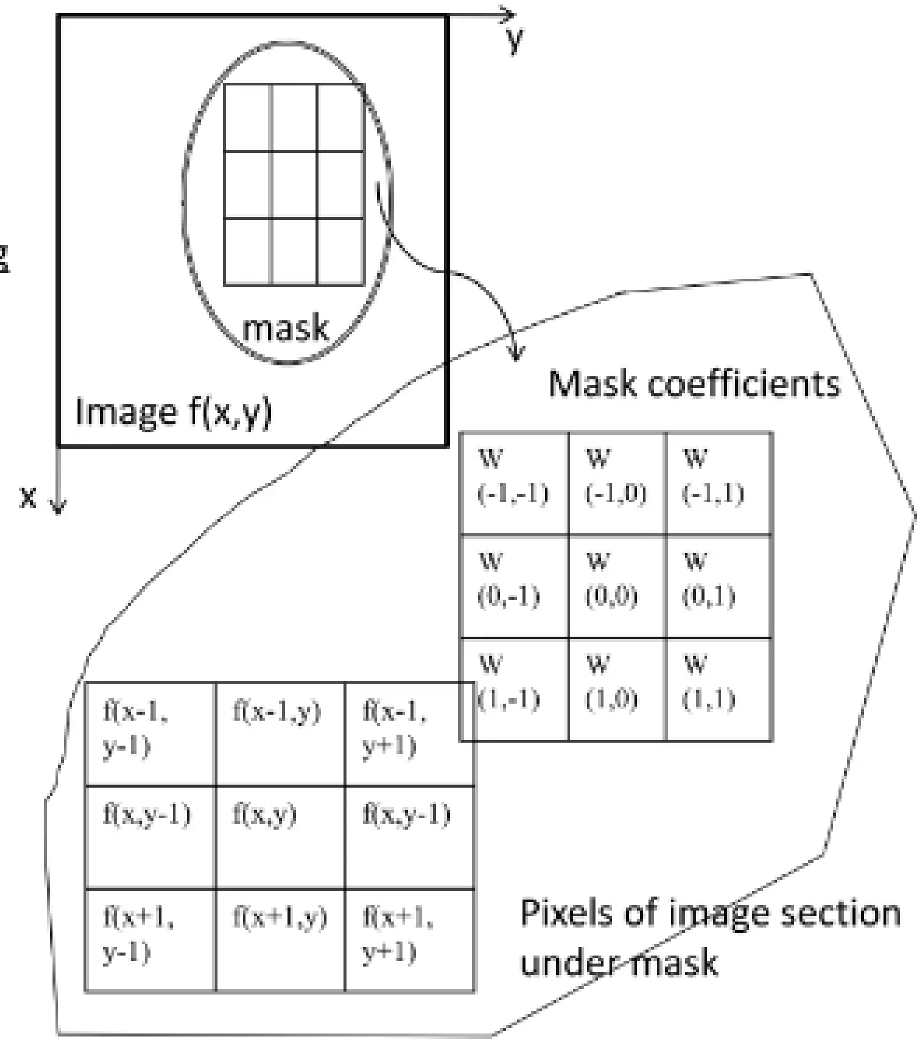
then it follows that,

$$E\{\bar{g}(x,y)\} = f(x,y)$$

i.e. *it is expected the averaged image approaches to the original image as the number of noisy images used in the averaging process increases.*

BASICS OF SPATIAL FILTERING

Fig: mechanics of spatial filtering



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- The process consists of moving the filter mask from point to point an image.
- For linear spatial filtering, the response is given by a sum of products of the filter(mask) coefficients and the corresponding pixels directly under the mask as:

$$R = w(-1,-1)\, f(x-1,y-1) + w(-1,0)\, f(x-1,y) + \ldots\ldots +$$
$$w(0,0) f(x,y) + \ldots + \ldots\ldots\ldots + w(1,0) f(x+1,y) + w(1,1) f(x+1,y+1).$$

- In general, linear filtering of an image f of size MxN with a filter mask of size mxn is given by the expression,

$$g(x,y) = \sum_{s=-a}^{a} \sum_{t=-b}^{b} w(s,t) f(x+s, y+t)$$

where, a=(m-1)/2 and b=(n-1)/2

- The process of linear filtering is similar to a frequency domain concept called *convolution.* for this reason, linear spatial filtering often is referred to as "*convolving a mask with an image*". Filter masks are sometimes called *"convolution masks" or "convolution kernel".*

<u>LOCAL ENHANCEMENT</u>

- The histogram processing method are *global*, i.e. *the pixels are modified by a transformation function based on the gray level content of an entire image.*
- When there is a case to *enhance details over small areas in an image*, there will be a problem.
- The solution is to devise a transformation functions based on the gray level distribution or other properties in the neighborhood of every pixel in the image. *The procedure is to define a square or rectangular neighborhood & move the center of this area from pixel to pixel.*
- At each location, the histogram of the point in the neighborhood is computed & either a *histogram equalization* or *histogram specification* transformation function is obtained. This function is finally used to map the gray level of the pixel centered in the neighborhood.