Mathematics for Digital Image Processing

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Abstract:-

Generally Mathematical tools can be defined as a functional technique that are used for computation. A systematic or concept based methods or principles used for computations. Images represents to carry out different processes using this mathematical tools. With the help of these mathematical tools, we can have various image processing, some of them are...... noise removal, filtering, masking, enhancing ,mixing two images, color transformation etc.

Introduction :-

We goes to market and buy camera or mobile phone as per their configuration and configuration of these devices based on resolution and pixels. what is the resolution of particular camera and what pixel values that camera hold.

Term Resolution consists how many number of elements does a picture contains. Images in the form of a matrix, that matrix basically N X M. Matrix must contain some elements. Resolution is actually the number of elements contained in particular image, then those elements are pixel. So, there are the two definitions resolution and pixel. There is one more term called as gray level, what is the gray level actually it is the value of that particular pixel, whatever the value is given to that pixel whether it is 0,1,2 or whatsoever. The value is in numerical domain that is said to be the gray level of that particular pixel. Now, with the help of all these terms, the flowchart or the block diagram of digital image processing can be understand.

we know mathematical tools i.e addition, subtraction, logical arithmetic, these are all operations are normal operations, these normal operation are used in signal formations and in image processing system too. What are the operations operating in our disclaimers?

- **Array Vs Matrix operations ,**
- **Linear Vs nonlinear operations,**
- **Arithmetic operations,**
- **Set and logical operations and**
- **Spatial Operation**

There are different categories of operating in digital image processing. The first one is address and matrix operations to see here our image generally consider as an array or matrix. So, there are four types of operations Array Operations and array or matrix operations. But suppose, We are taking two images in the form of arrays.

Let us consider two images as follows

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$$

Array product is given by

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} = \begin{bmatrix} a_{11}b_{11} & a_{12}b_{12} \\ a_{21}b_{21} & a_{22}b_{22} \end{bmatrix}$$

Now Matrix product is given by

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} =$$

$$\begin{bmatrix} a_{11}b_{11} + a_{12}b_{21} & a_{11}b_{12} + a_{12}b_{22} \\ a_{21}b_{11} + a_{22}b_{21} & a_{21}b_{12} + a_{22}b_{22} \end{bmatrix}$$

In other Arithmetic operations for suppose there are two images, let us consider one images f(x,y) second image g(x,y) if we combine these two (two dimensional image) we will get a new image that is S (x,y),

$$S(x,y) = f(x,y) + g(x,y)$$
$$S(x,y) = f(x,y) - g(x,y)$$
$$S(x,y) = f(x,y) * g(x,y)$$
$$S(x,y) = f(x,y) / g(x,y)$$

Now, we subtract the image one from image two to form new image. Image outputs come away from image of objects then we will get a new image. This is normal representation. An addition subtraction likewise, there is product, If we product

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two images then also we got a new image and the last one is dividing. If we divide one image with another image, we will get another new image now, we have to find out what are the applications of these images.

Application :

The addition operation is generally useful frequently for image enhancement, Enhancement is nothing but highlighting of our image. So, enhancing develop with highlighting parts. But suppose We concerned here there is a galaxy, galaxy is combination of incidents of different planets and stars whatever it is. There are six images.

FIGURE 2.26 (a) Image of Galaxy Pair NGC 3314 corrupted by additive Gaussian noise. (b)-(f) Results of averaging 5, 10, 20, 50, and 100 noisy images, respectively. (Original image courtesy of NASA.)

The first image A is image capture by normal satellite cameras that is image of galaxy pale. Using averaging process We can be reduce the noise And by adding a number of noisy images and taking the average figure B. If we have more clearly and compare with the first one, this is very clear some water highlights. We are highlighting that image. So that with our ratings, what is average internally inherently there is addition operation. So, adding all the elements, all the images and by taking the total number of images that is part of it, likewise we are inverting highlighting process. So, the addition operation is generally used to highlight or enhance the image.

The Subtraction operation is also an enhancement application, but here the operation is different, we are taking a difference not adding. We have to consider two images, two images, two different images. So, here considering A and B, C's resulting.
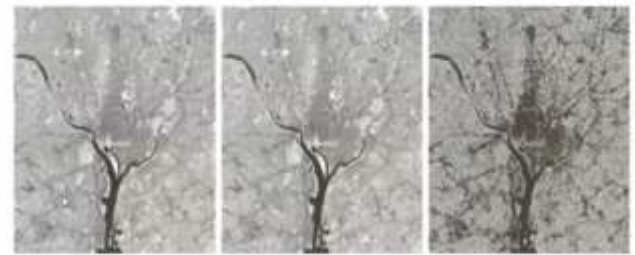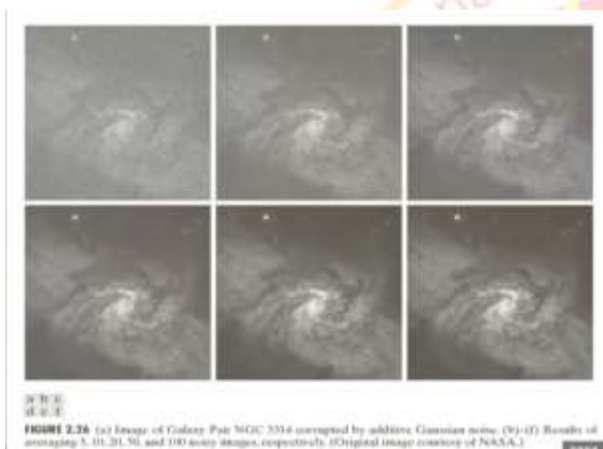

FIGURE 2.27 (a) Infrared image of the Washington, D.C. area. (b) Image obtained by setting to zero the least significant bit of every pixel in (a). (c) Difference of the two images, scaled to the range [0, 255] for clarity.

1. Infrared image of the Washington D.C. area
2. Image obtained by setting to zero the least significant bit of every pixel in A
3. Difference of two images, scaled to the range [0.255] for clarity.

The same image is by setting the each pixel value to zero. So, here image obtained by setting to zero the least significant bit of every pixel. But suppose in first image, there is a one pixel or one dot and if that dot is converts into the binary, it is having some most significant bit. Suppose, least significant all the pixel values having least significant bits. those pixel values are set to zero the image will be like this second one was visual image, the same age image is modified by setting the least significant bit of each pixel value in first image. So, we must create second image. first two images captured by normal camera, but second images transferred modified with changing that bit value of significant declare it as zero, then, we have available two images image one image two. If we take the difference of Image A and Image B. Image A and B here difference of the two images, then scale it to that range [0.255] for clarity, there are light particles, dark particles. So, there are lead particles or particles, but here transferred from [0.255] scale values, then images very highlighted. So, by subtracting also we can enhance the image to visibility after by the human caregivers.

In Multiplication process, we want to highlight a particular part and remaining thing should be blank. if anyone suffering from tooth decay or damaged? What happened when we go to the dentist, they're asking for X ray. So but suppose if there is any damage in tooth, or any infections, so those are highlighted by X ray, but we don't want to use remaining tooth. We want only a particular damaged tooth. ROI mask for isolating teeth with feelings. The reason there are two tooth's that are damaged. So

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here using two masks, the resultant image will becomes. Except these everything is black, it is like an operating image that means a mask one mask two. We using two masks, since there are two damages. By using these two masks, we can highlight the particular damage to the infected tooth. the application of the common use of image multiplication is masking also called as region of interest, As we don't want the remaining part only a region of interest or masking.

Linear and Non Linear Operation in Images :

To carry out this in image we need to check whether it obeys the, additive property and homogeneity property.

Set operations:- To understand let us consider ,
A={a1,a2,a3.....}
B={b1,b2,b3.....}
To carry out image process we can use set operations such as Union, Intersection, Complement, Difference

Logical operations:- Following logical operations used in image processing

1 OR
2 AND
3 NOT
4 AND NOT
5 XOR

Spatial Operations:-

Spatial operations are performed directly on the pixel that it is directly on the image pixel for that for individual processing of a particular pixel we will be prefer spatial operation. So, the spatial operation is classified into three broad categories.

i) Single pixel operation,
ii) Neighborhood operation
iii) Geometric spatial transformation.

Conclusion:-

The addition operation is generally useful frequently for image enhancement, Enhancement is nothing but highlighting off our image. Enhancing develop with highlighting parts. Addition operation agenda led to enhancing it. These application areas in contrast modification, changing the contrast of the image, change the brightness of the image, the enhancements in this area the proper based operation is use. We all come across various image processing operations. So, like probability based operations, we have come across next set operation, logical operations, we have come across Array Operations, matrix operations.

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