NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

School of Electronic Engineering and Computer Sciences

Digital Image Processing (EE 433)

ASSIGNMENT # 2

SUBMITTED TO:

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Date of Submission: 25th February 2019

Question: 3.3:

The given transformation is the application of bit slicing. To produce an image of 7^{th} bit plane, we set pixel value to zero for those in range of 0 – 127 and similarly we set the pixel value to 255 for those in range of 128 – 255. The only values now in the picture will be 0 or 255, so we can say that it's the binary image of the 7^{th} bit plan. To produce an image of 6^{th} bit plane, we set pixel value to 0 for those in range of 0 – 63 or 128 – 191 and similarly we set 6^{th} bit to 1 for the pixel values in range of 64 – 127 or 192 – 255. The transformation for the 5th bit plane alternates between eight ranges of byte values. The transformation for the 4^{th} bit plane will alternate between 16 ranges, for 3^{rd} bit it will alternate between 32 ranges, for 2^{nd} bit it will alternate between 64 ranges, for 1^{st} bit it will alternate for every two values (128 ranges) and for the 0^{th} bit plane will alternate between 0 and 255. In short, this transformation alternates between 128-byte value ranges.

Question: 3.14:

Let there is golden image for comparison. And there are different images of the current assembly, to detect the change, we must subtract every image from the golden image and if the resultant image falls beyond the specific threshold we can say that the change is detect. The conditions for this method to work can be as follow:

1) **Corresponding Element Difference:** We must take the element-wise difference of the corresponding pixels of golden image and the assembly image so that resultant image is not accepted in case there is a difference, or the resultant image should not be rejected if there is no difference.
2) **Noise Control:** We must control the noise level in the images. We must ensure that noise content is as low as possible so that comparison between input and golden images are not affected.
3) **Brightness of illumination:** We must control the intensity of brightness and illumination as they can change the results drastically.

Question: 3.18:

One of low pass spatial filter we studied was 1/9 for every entry in 3x3 filter. Its general for was as follow:

$$R = \frac{1}{9}\sum_{i=1}^{9} w_i f_i$$

$\boldsymbol{w_i}$ represents the filter pixel and $\boldsymbol{f_i}$ represent the image pixel. Each time this filter is applied image pixels are scaled down by a factor of 9. Filtering image twice will scale down the image pixels by 91, filtering it thrice will scale down image pixels by 243. We can say that filtering the image for **n** time will scale down the image pixels by $\mathbf{1/9^n}$. For sufficiently large value of **n** the resultant image will contain all zeros or resultant image will be black. This is the limiting effect of repeatedly applying the 3x3 low pass spatial filter.

Question: 3.26:

Unsharp mask is basically the high boost filtering with A = 1 for the following equation:

$$f_{hb} = Af(x,y) \pm \nabla^2 f(x,y)$$

Table 1: High Boost Filter

-1	-1	-1
-1	A+8	-1
-1	-1	-1

Table 2: Unsharp filter putting A =1

-1	-1	-1
-1	9	-1
-1	-1	-1

Question: 3.27:

We must show that that:

$$\boldsymbol{f(x,y) - \nabla^2 f(x,y) \propto f(x,y) - \bar{f}(x,y)}$$

In above equation left hand side correspond to the subtraction of Laplacian from image while right hand side correspond to the unsharp masking or high boost filtering with A = 1.

From equation 3.7 – 4 (from question):

$$\nabla^2 f(x,y) = f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)$$

$$f(x,y) - \nabla^2 f(x,y) = f(x,y) - [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)]$$

We must find the average of the last 5 terms, so I am going to add first and last term

$$f(x,y) - \nabla^2 f(x,y) = 5f(x,y) - [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1)]$$

Now I am going to add and subtract the function representing the picture.

$$f(x,y) - \nabla^2 f(x,y) = 6f(x,y) - [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) + f(x,y)]$$

Now, to find average of last 5 terms I must take 5 as common from the whole equation

$$f(x,y) - \nabla^2 f(x,y) = 5\left[1.2f(x,y) - \frac{1}{5}\,[f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) + f(x,y)]\right]$$

$$\boldsymbol{f(x,y) - \nabla^2 f(x,y) = 5[1.2f(x,y) - \bar{f}(x,y)]}$$

So, from the last equation we can easily deduce the result

$$\boldsymbol{f(x,y) - \nabla^2 f(x,y) \propto f(x,y) - \bar{f}(x,y)}$$

Which shows that subtracting the Laplacian from an image is proportional to unsharp masking or high boost filtering with A = 1.

Question: 3.29:

In the question it is stated that the range of illumination stays in the linear portion of the camera response range. Also, we are not given with any specific range. We can only set standard for illumination when daylight is not present which is the only variable. Let $f_a(x, y)$ is the image taken under artificial illumination. This is the standard through which all other images will be normalized. There are some areas in the image which are likely to change due to moving object and such areas should be excluded from illumination correction. We can apply histogram equalization transformation to assign constant illumination to subareas of $f_a(x, y)$ which are not affected by moving objects. In day light we can obtain the histogram of the pictures through histogram equalization. After that, we can use histogram matching technique to obtain the illumination values (intensity values) for the artificial lightening. The key assumption behind this method is that all images stay within the linear operating range of the camera. Another assumption is that moving objects comprise of a relatively small area, otherwise it can disturb the results.