Digital Image Processing Homework III

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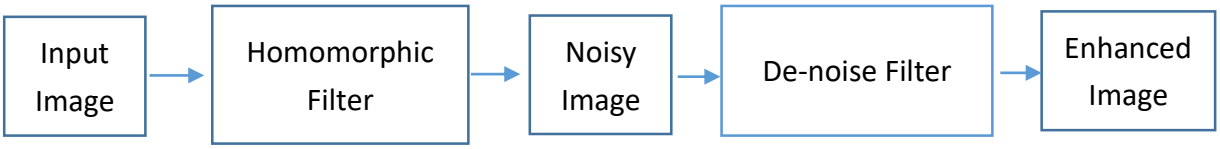
I. Abstraction:

In this homework, image enhancement methods will be implemented. For the given inputs, one observes that restorations of the details on the low-luminosity parts are needed. After restoration, noise cancellation should be applied because the salt-and-pepper noise is generated during the restoration process. In this report, we will compare the output of different implementations on same purpose and choose the best optimized one.

II. Algorithm Description:

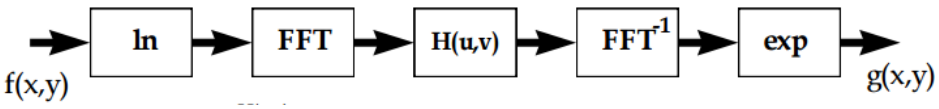
We can roughly divide the whole process into two main part: restoration on details and noise cancellation. The whole architecture of the system is as following figure, Figure 1.



▲**Figure 1.** The Enhancement Process

A. Restoration on details:

For the restoration part, homomorphic filter (Figure 2) is applied because most of details (high-frequency components) are hidden under the low-luminosity condition (low-frequency components). Thus, we will choose H (u, v) as a high pass filter to filter out the low-frequency components and enhance the high-frequency ones.



▲ **Figure 2.** Homomorphic Filter

One will firstly choose Gaussian filter as H (u, v),

$$H(u,v) = \frac{1}{2\pi\sigma^2} * e^{\frac{-((u-u_{center})^2+(v-v_{center})^2)}{2\sigma^2}} + a$$

For the fine-tuned parameter, $(\sigma, a) = (5, 0.25)$. The term ***a*** is added because we still

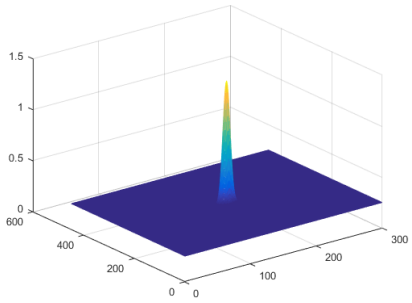
wish to preserve some so the low-frequency parts rather filter them all. If ***a*** is not added, the output image will only have the contour of the objects on it. The output image is on Figure 3. We can notice that there is salt-and-pepper noise in it. Therefore, we will try to de-noise them.

▲Figure 2. Input Image

▲Figure 3. Image processed by homomorphic filter

Here, one also tried histogram equalization. The result seems almost as same as bilateral equalization.

▲Figure 3. Input Image processed by histogram equalization



▲Figure 4. Gaussian Filter

B. De-noise:

In this part, we will try to de-noise the homomorphic filter result. Here, three candidate filters are chosen: median filter, mean filter, and bilateral filter. For median filter, some colorful dots are still on the image. For the 3-by3 mean filter, the image will turn to a little bit blur, same as the bilateral filter. One has tried to sharpen the image, but the noise will come out again. Finally, I will choose mean filter because the computation complexity is way less then bilateral filter but achieve similar results.

▲Figure 5. Image processed by median filter

▲Figure 6. Image processed by mean filter

▲Figure 7. Image processed by bilateral filter

III. Experiment Results:

The results for input1, input2, and input4 are as follow. We will compare the original image and enhanced image in this part.

▲Figure 8. Input1 Image

▲Figure 9. Enhanced Input1

▲Figure 10. Input2 Image

▲Figure 11. Enhanced Input2

▲Figure 12. Input4 Image

▲Figure 13. Enhanced Input4