**Digital Image Processing Homework III**

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1. **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.

1. **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.

Enhanced Image

De-noise Filter

Noisy Image

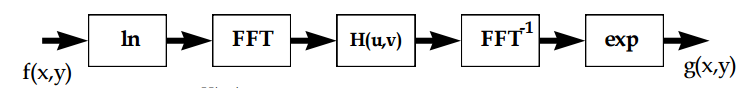
Homomorphic Filter

Input Image

▲**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),

For the fine-tuned parameter, . 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.

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| ▲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.

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| ▲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.

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| C:\Users\DeanYeh\Desktop\DIP_hw3\Image_Median.bmp  ▲Figure 5. Image processed by median filter | C:\Users\DeanYeh\Desktop\DIP_hw3\Image_Mean.bmp  ▲Figure 6. Image processed by mean filter |
| C:\Users\DeanYeh\Desktop\DIP_hw3\Image_BFLT.bmp  ▲Figure 7. Image processed by bilateral filter |  |

1. **Experiment Results:**

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

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| ▲Figure 8. Input1 Image | C:\Users\DeanYeh\AppData\Local\Microsoft\Windows\INetCache\Content.Word\Image_Median.bmp  ▲Figure 9. Enhanced Input1 |
| ▲Figure 10. Input2 Image | C:\Users\DeanYeh\AppData\Local\Microsoft\Windows\INetCache\Content.Word\Image_Mean.bmp  ▲Figure 11. Enhanced Input2 |
| ▲Figure 12. Input4 Image | ▲Figure 13. Enhanced Input4 |