Introduction to Numerical Methods and Applications Homework #3

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2. Einstein-Monroe illusion

a. (10%)

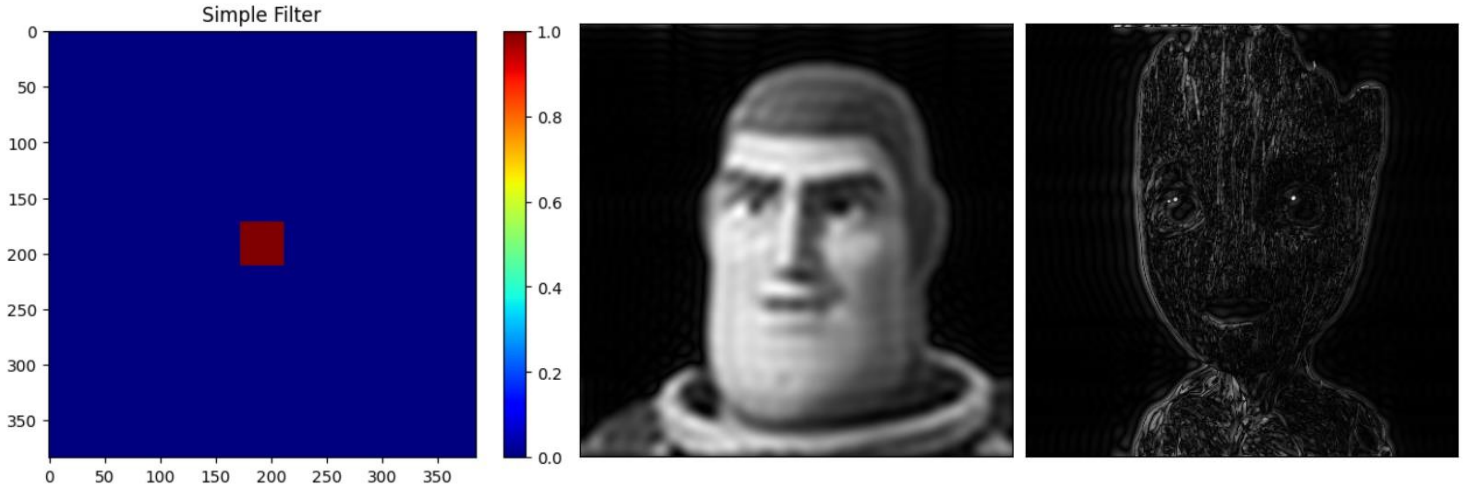

Figure 1 $I_{1,Low}$ and $I_{2,High}$ by Simple Filter

I design a Simple Filter, a small square value is 1 in center and other value is 0, to let the low frequency spectrum pass. CenterRemain is pass-in value for creating the Simple Filter, and I set the default value is 40. On the other hand, I set a Matrix that value is all 1 and subtract the Simple Filter above, as the HPF.

Follow I use numpy module to calculate image Fourier Transform, get the frequency spectrum and passing to Filter to let specific frequency remain. Finally, use Inverse Fourier Transform to get Low and High Spectrum picture.

b. (20%)

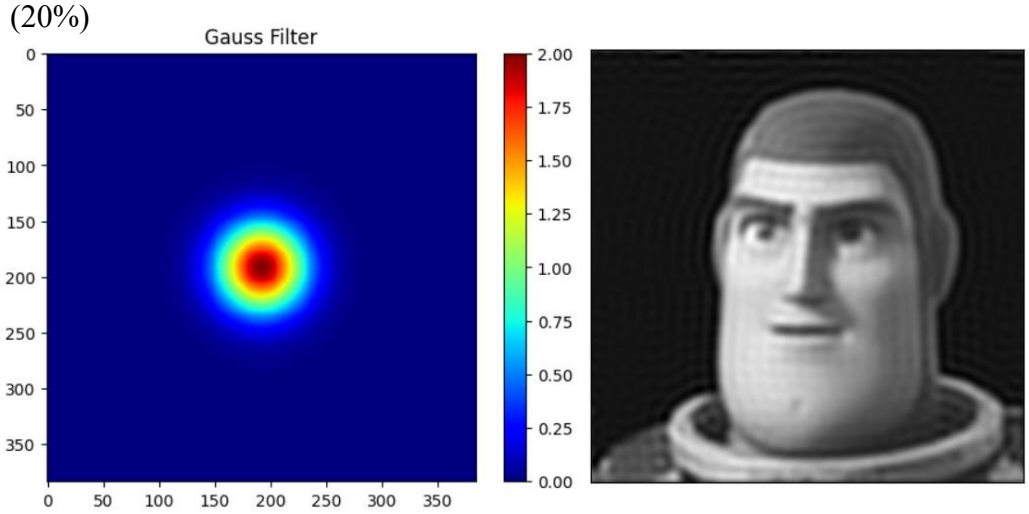

Figure 2 $I_{1,Low}$ by Gaussian Filter

Right above is a 2D Gaussian Filter which FWHM is by default set 64. I use formula $FWHM = 2\sqrt{2ln2}\sigma$(from wiki FWHM) to find the $\sigma^2 = \frac{FWHM^2}{8ln2}$. Then by

formula $G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$, we can create a 2D Gaussian Filter. However, I found that all of elements in the filter is much smaller than 1, almost nothing passing from this filter. Thus, I divide the whole filter with filter center value to normalize it. But actually, most of this filter still much smaller than 1. Finally, I set variable CenterWeight, default is 2, to adjust the whole value of 2D Gaussian Filter. The last step is same as part a, let the low frequency spectrum pass the filter and get the result $I_{1,Low}$ in Figure 2.

c. (15%)

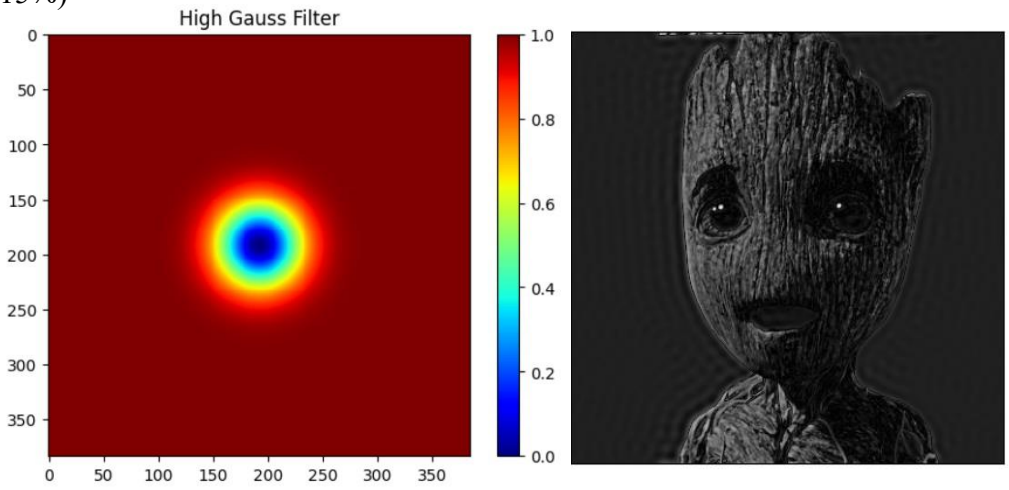

Figure 3 $I_{2,High}$ by High Pass Gaussian Filter

I design the HPS by subtract a full value filter from the 2D Gaussian Filter. The full value filter should weight the variable CenterWeight in part c. Besides, I normalize it to 0~1, if it had not been normalizing, part of high frequency would be weighted by CenterWeight, which made the picture shape.

d. (30%)

Figure 4 3-9, 6-5, 8-6 illusion with simple and Gaussian

Figure 4 has 3 illusion results, X-Y illusion means that X is from low frequency spectrum and Y is from high frequency spectrum. In this case, I use simple filter in X and Y is from High Pass Gaussian filter, and I add the two parts to get above results.

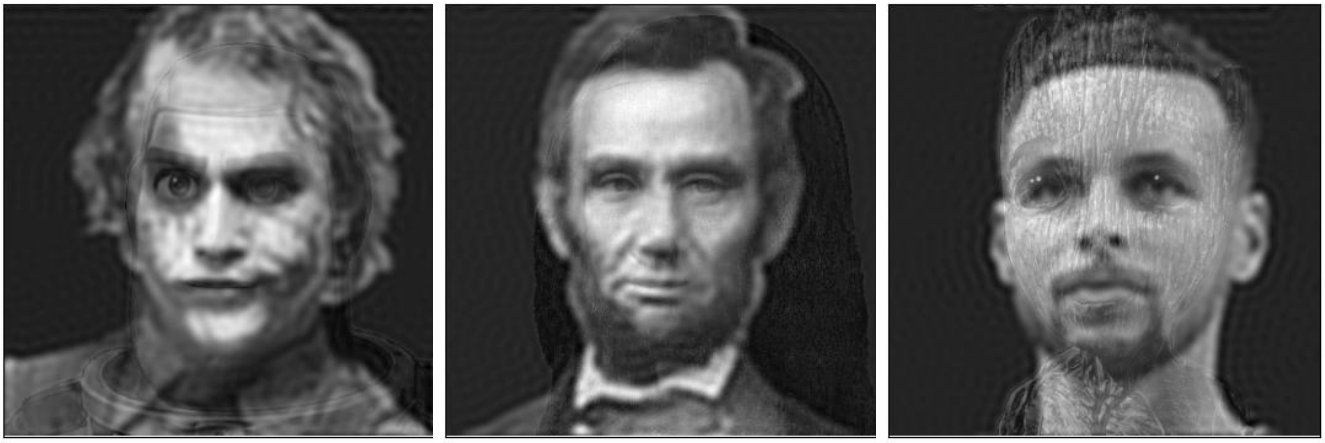

Figure 5 3-1, 5-4, 8-4 illusion with both Gaussian

Figure 5 also has 3 results, but those low frequency spectrums are from Gaussian Filter. Although I tried to design a 2D Laplace Filter as High Pass Filter, the filter values distributed oddly, and I don't use it in this Homework.

e. (5%)

The results from Figures 4 & 5 may not look perfectly, I think the result is that I set the weight of low frequency spectrum too high, which lead to high frequency spectrum can only substitute some specific feature such as eye or facial skin, thus I should adjust the weight of low frequency. Another observation is that all illusion related to DemoIMG_7 is trouble, because Woody's face is a narrow face, features on his face always go wrong(Figure 6). If I want to fix it, I should adjust their face to same scaler before I add them.

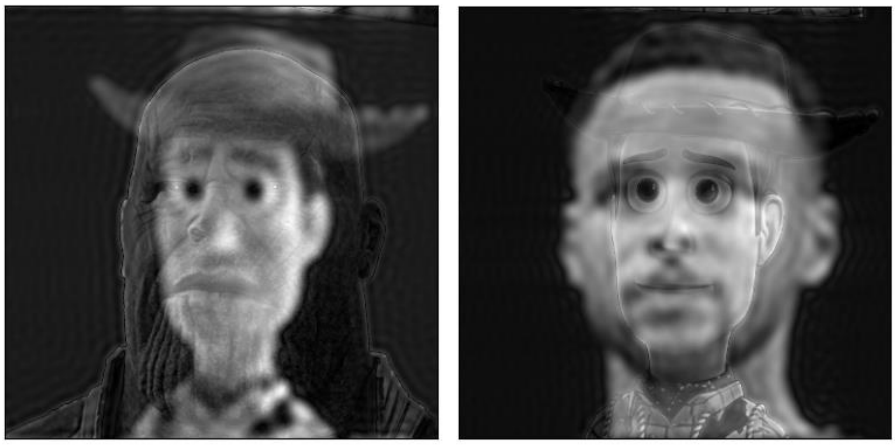

Figure 5 illusion with Woody

Attach File under picture directory is about result of all imagePool: pictures in Sample directory are results of part a; pictures in Gaussian directory are results of part b & c; pictures in Sim&Gau illusion directory are results of part d-1; pictures in Gaussian illusion illusion directory are results of part d-2.