Project 1 Writeup

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Instructions

The project aims to hybrid two images into one. The crude idea is to apply lowpass and highpass filter on iamges.
Implement two function: myimfilter and genhybrid image. The first one is to limitate the matlab function imfilter. The second is to combine high frequences and low frequence images.
In the myfilter, there are two implement means which has a large difference on the running time.

Explaination

The main part in the my imfilter is the convolution.
The brute force method is multiply the correspondes in the two matrix and then calculate sum of elements. It costs too much time though.
Another method to implement is FFT convolution. Applying matlab function fft2 and ifft2 is easy to calculate the result. FFT and IFFT equation is:

$$F(u,v) = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)e^{-j2\pi(ux/M+vy/N)} \tag{1}$$

$$f(x,y) = \frac{1}{MN}\sum_{u=0} M-1\sum_{v=0} N-1F(u,v)e^{j2\pi(ux/M+vy/N)} \tag{2}$$

Interesting Implementation Detail

My code snippet highlights an interesting point.

```
padsizem=(m2-1)/2;
padsizen=(n2-1)/2;
newout=ifft2(fft2(padimage).*fft2(padfilter));
newout=newout(m2-padsizem:m1+m2-1-padsizem,n2-padsizen:n1
   +n2-1-padsizen);
```

Ensure the size of result is the same as the input. The FFT convolution needs to choose the suitable $m \times n$ block of the result. It should abandon the outer part.

A Result

1. Result 0 fails because I choose the Gaussin kernel as image1's highpass filter while image 2 use a laplacene filter.
2. Result 1 and 2 (Figure 1) is success to implement hybrid.
3. Result 2 and 3 have some little difference. The result 3 is more similar with Dog. It means that σ will decide the weight of two images. The larger σ make the smooth one more blur and the other is more vivid. Then, the weight of the sharped one in hybrid image is larger.
4. Result 4 is my own hybrid image.

My results are summarized in Table 1.

Condition	Time (seconds)
Test FFT method	1.926
Test brude force method	9.754

Table 1: Stunning revelation about the efficiency of my code.

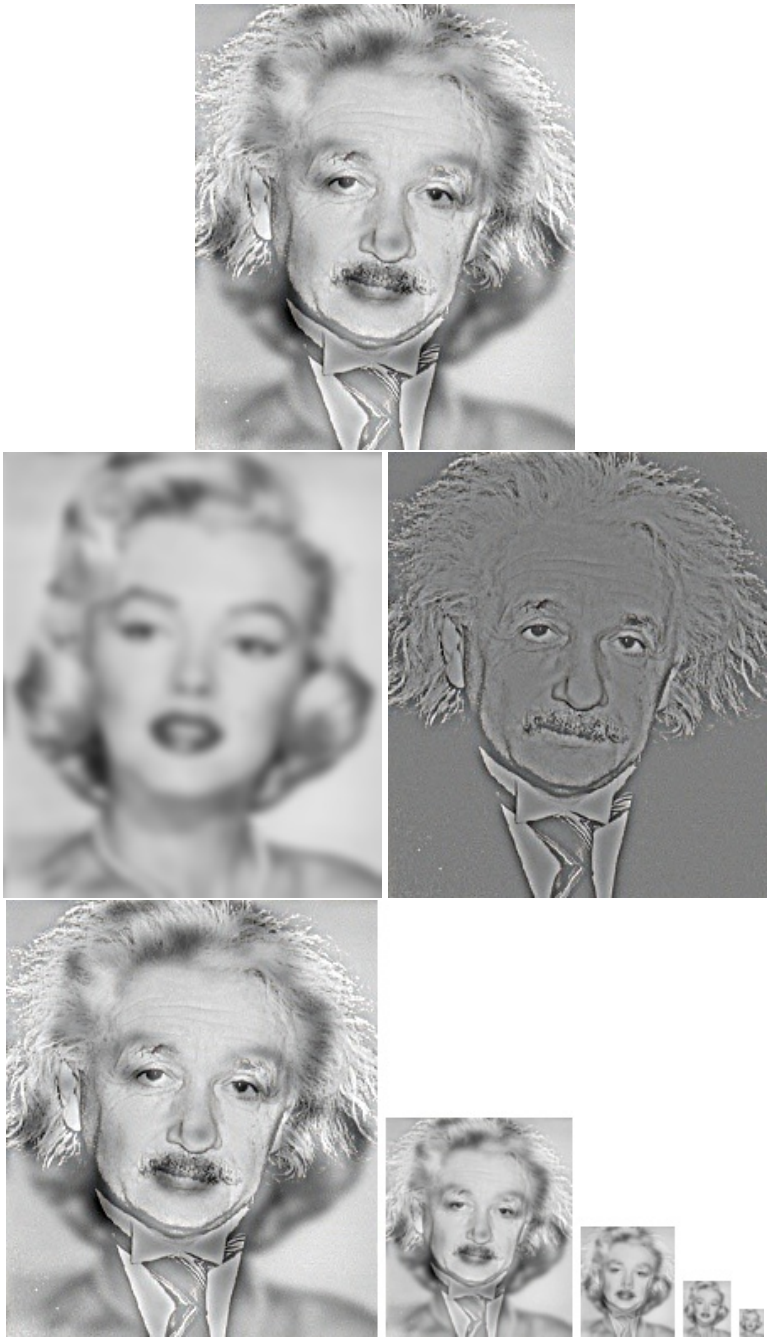

Figure 1: Marilyn and Einstein,$\sigma = 3$

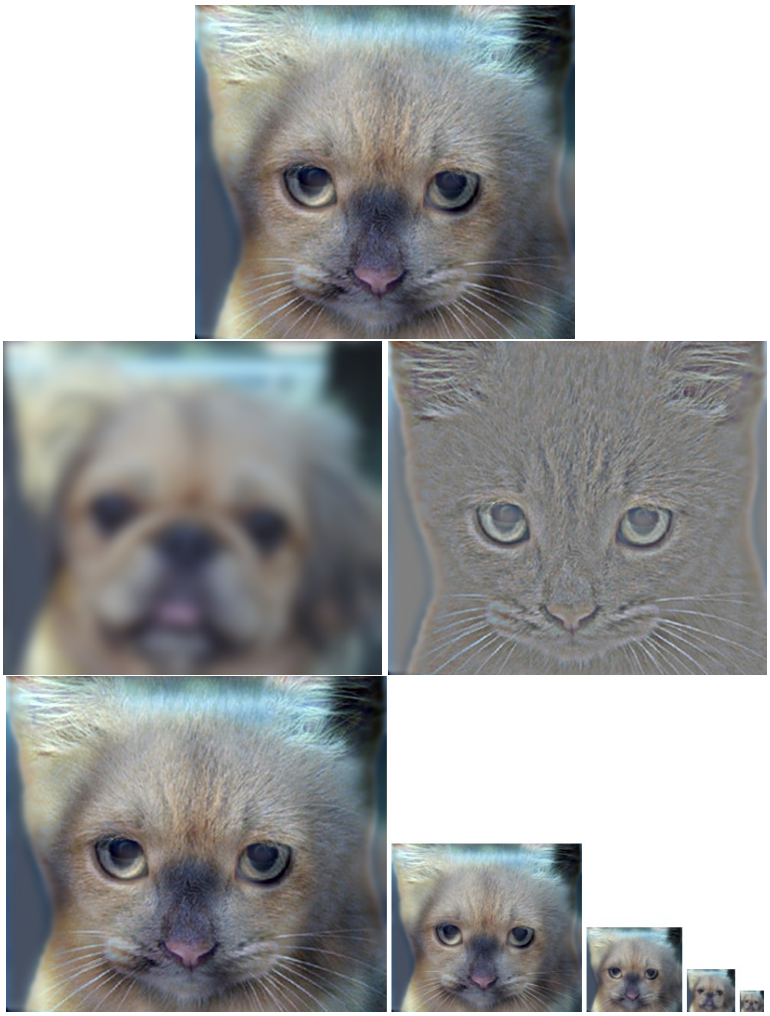

Figure 2: Dog and Cat,$\sigma = 7$

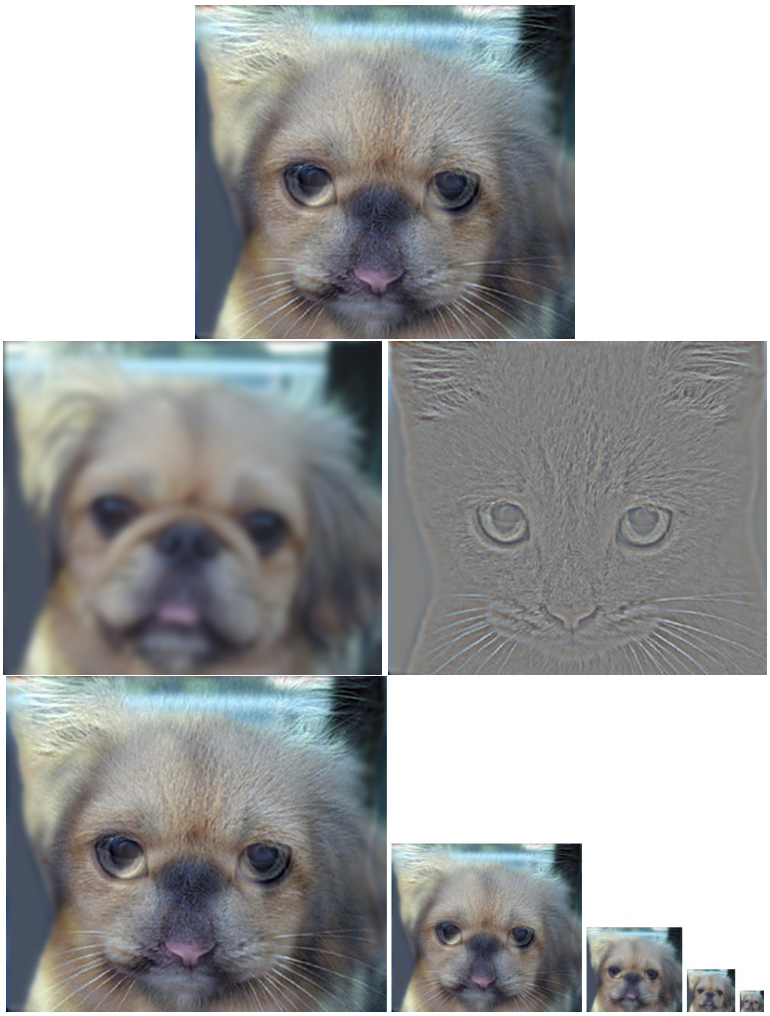

Figure 3: Dog and Cat,$\sigma = 4$

Figure 4: Man and Monster,$\sigma = 6$