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CIE 552: Computer vision project 1

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1 INTRODUCTION

In this project, we will write an image convolution function (image filtering) and use it to create hybrid images! The technique was invented by Oliva, Torralba, and Schyns in 2006, and published in a paper at SIGGRAPH. High frequency image content tends to dominate perception but, at a distance, only low frequency (smooth) content is perceived. By blending high and low frequency content, we can create a hybrid image that is perceived differently at different distances

2 THEORY

The first goal was to apply a filter on the image. The process of applying a filter on an image could be represented by 2d convolution as in the following equation where h [n1,n2] is a linear filter .

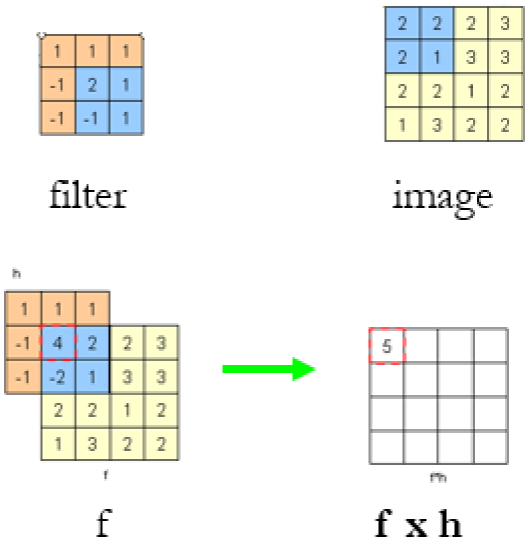
$$f[n_1,n_2] * h[n_1,n_2] = \sum_{m_1=-\infty}^{\infty} \sum_{m_2=-\infty}^{\infty} f[m_1,m_2] h[n_1-m_1,n_2-m_2]$$

3 Algorithm and coding

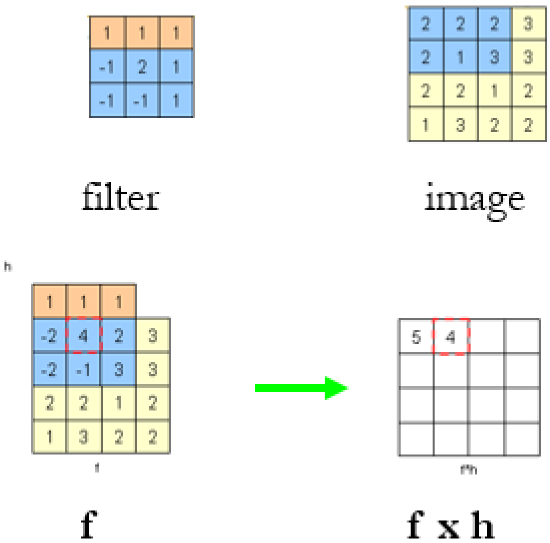
3.1 Algorithm

The filter will slide on every pixel of the image and every element of it will be multiplied with its corresponding one of the image ,and then multination results will be added together and will replace the original value of the pixel , and so . The following images will illustrate the concepts.

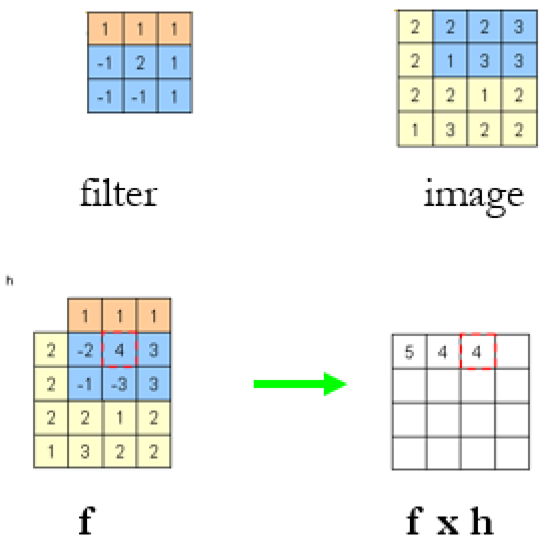
– Step1:



– Step2:



– Step3:



And so on ..

3.2 coding

```
if numel(size (image))<3
[mi,ni]=size (image);%  mi m for rows i for image
[mf , nf]=size(filter ); % mf m for rows ,f for filters
 n_image= zeros(mi,ni);
if ( rem(mf,2)==0)||( rem (nf,2)==0)
    msgbox('Even Filters are not allowed ', 'Error','error');
    return
else
    r=floor(mf/2);c=floor(nf/2);
     p_image =padarray(image,[r c ],0);% padded image

    for i=1:mi
        for j=1:ni
        mul_result = filter.*p_image (i:(i+mf-1), (j:(j+nf-1)));
        s_result=sum (sum(mul_result));
        n_image(i,j)=s_result;

        end
     end
```

The code is designed to work on gray images as well as RGB so it first checks which image it is dealing with through this line :
numel(size (image))<3

Then it checks if the filter has odd dimensions or not, the importance of odd dimensions allows the filter to have a center pixel which will be aligned with the current pixel, so if the dimensions were even it will give an error message

Then we should pad the image with r number of rows and c number of columns such that

```
r=floor(mf/2);c=floor(nf/2);
```

Then we make the filter silde on the image using these lines of coding

```
    for i=1:mi
        for j=1:ni
        mul_result = filter.*p_image (i:(i+mf-1), (j:(j+nf-1)));
        s_result=sum (sum(mul_result));
        n_image(i,j)=s_result;

        end
```

4 Results and discussion

To test the implementation, write this line in any editor window:

```
proj1_test_filtering ()
```

And then run, you will notice that the results matches our expectations as follows

Figure 1 original image

Figure 2 after applying identity filter

Figure 3 after applying small blur by box filter

Figure 4 Large blur

Figure 5 after applying sobel operator

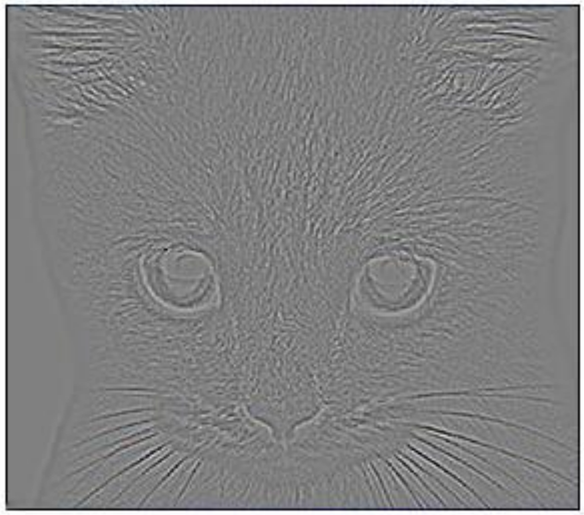


Figure 6 after applying discrete Laplacian filter to get high frequency out of the images.

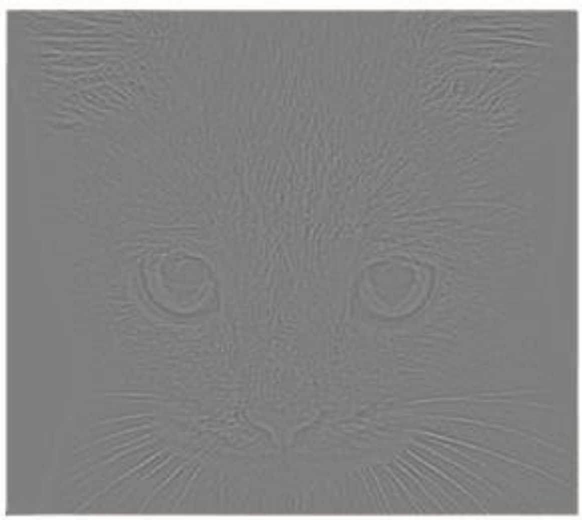


Figure 7 after subtracting low frequency to get high frequency out of the images.

5 second part introduction

Hybrid image is a technique that produces static images with two interpretations, which change as a function of viewing distance. Hybrid images are based on the multiscale processing of images by the human visual system and are motivated by masking studies in visual perception.

6 second part Theory

A hybrid image is the sum of a low-pass filtered version of a first image and a high-pass filtered version of a second image. We must tune a free parameter for each image pair to controls how much high frequency to remove from the first image and how much low frequency to leave in the second image. This is called the "cut-off frequency".

7 second part Algorithm and coding

7.1 Algorithm

We are going to use fspecial (Matlab built in function) to make a low pass filter to get the low frequencies of the first image ,and then use the same filter to get the low frequencies of the second image after that we will subtract the low frequencies from the second image , so the remaining frequencies are the high ones . Finally we will add the low frequencies of the first and the high frequencies of the second image to get the hybrid image.

7.2 coding

```
filter = fspecial('Gaussian', cutoff_frequency*4+1, cutoff_frequency);

low_frequencies=imfilter(image1,filter);

step=my_imfilter(image2,filter);
high_frequencies=image2-step;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Combine the high frequencies and low frequencies
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
hybrid_image = low_frequencies+high_frequencies;
```

8 Results and discussion

Use the vis_hybrid_image to test the functionality, we expect that from near distance one of te image will be prevailing and from far distance the other one will be prevailing instead.

And the result comes to be as expected .

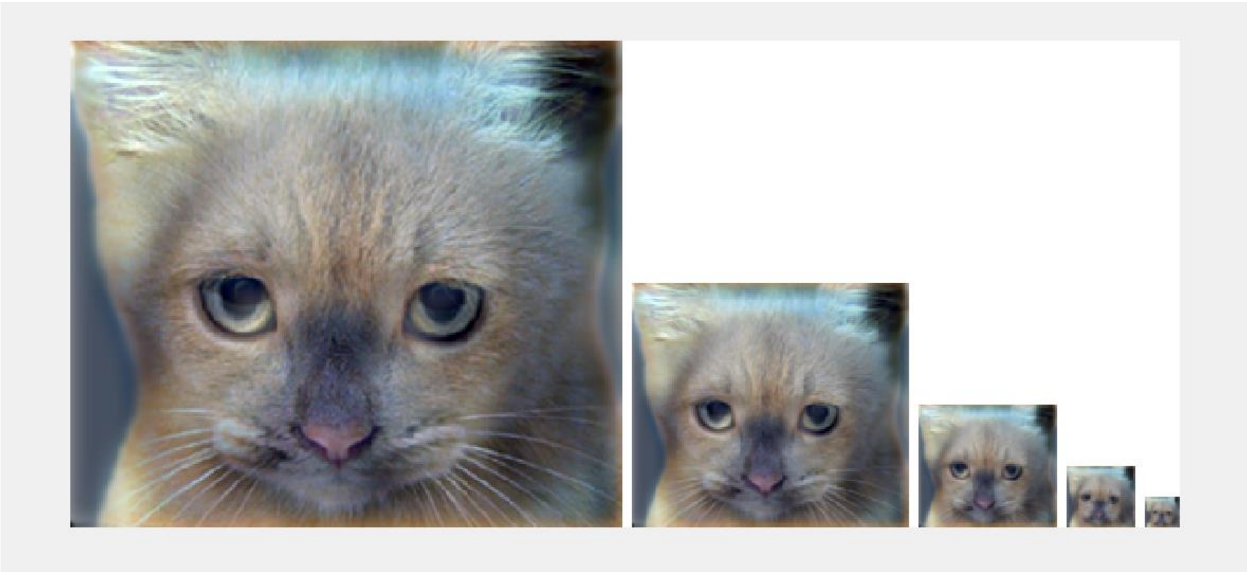


Figure 8 cat from near distance, dog from far distance , cut-off frequency equals 6

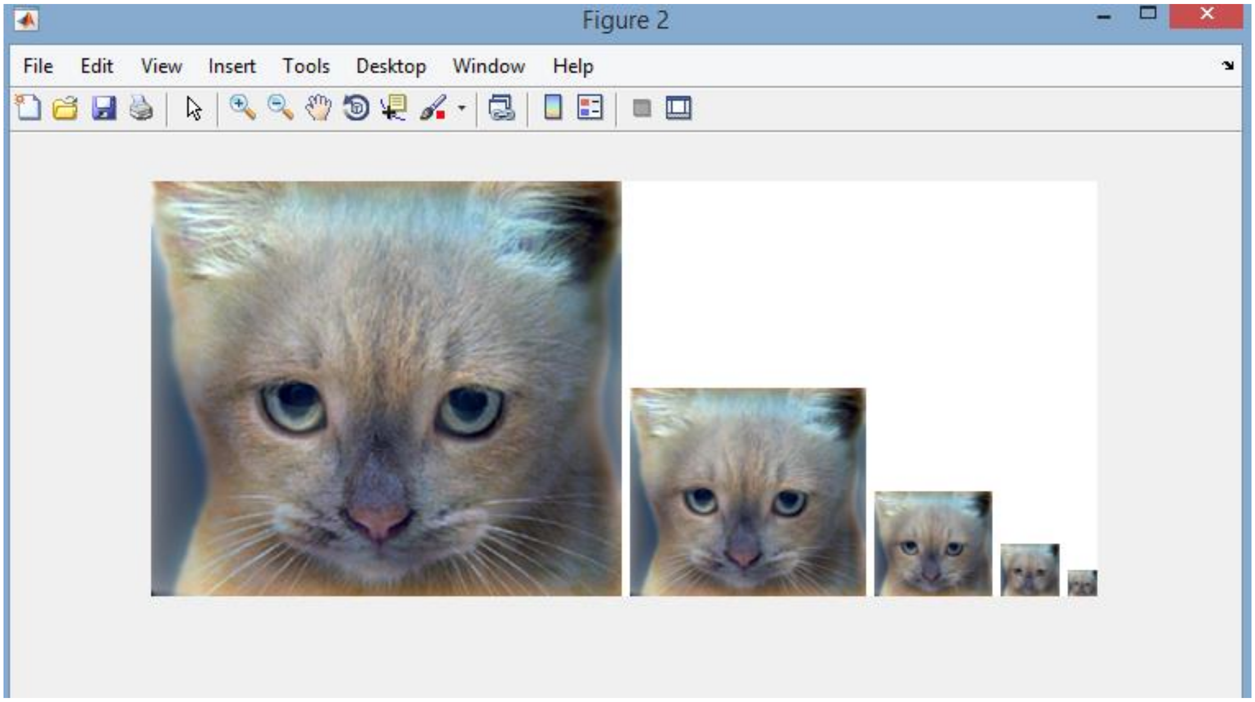


Figure 9 cat from near distance, dog from far distance, cut-off frequency equals 10

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Figure 10 bird from near distance, plane from far distance, cut-off frequency equals 6

Figure 11 motorcycle   from near distance, bike from far distance, cut-off frequency equals 8

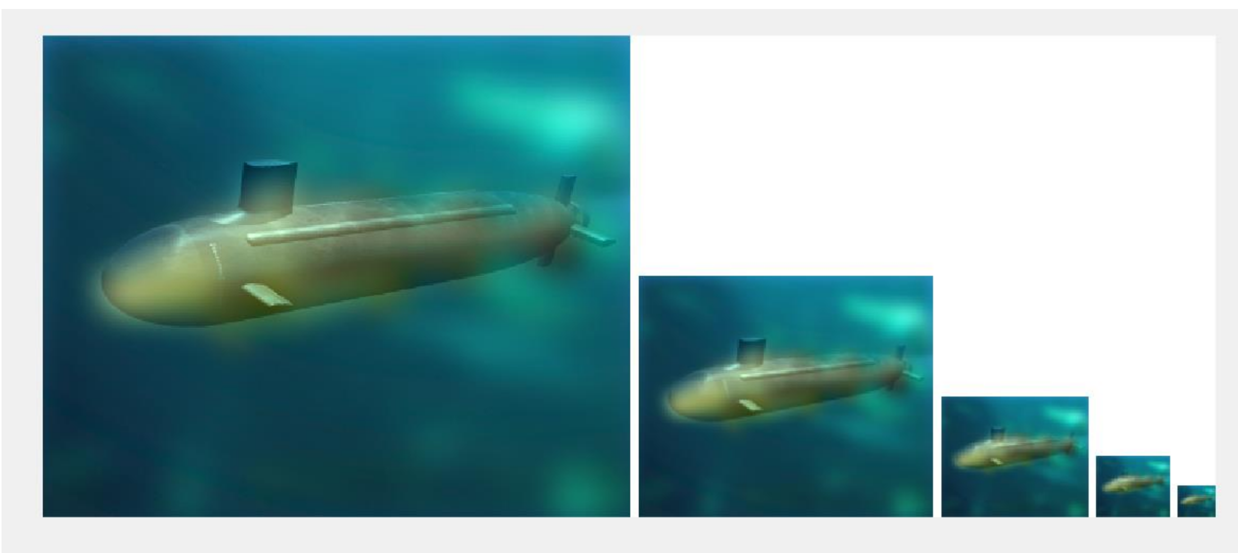

Figure 12 submarine from near distance, fish from far distance, cut-off frequency equals 10

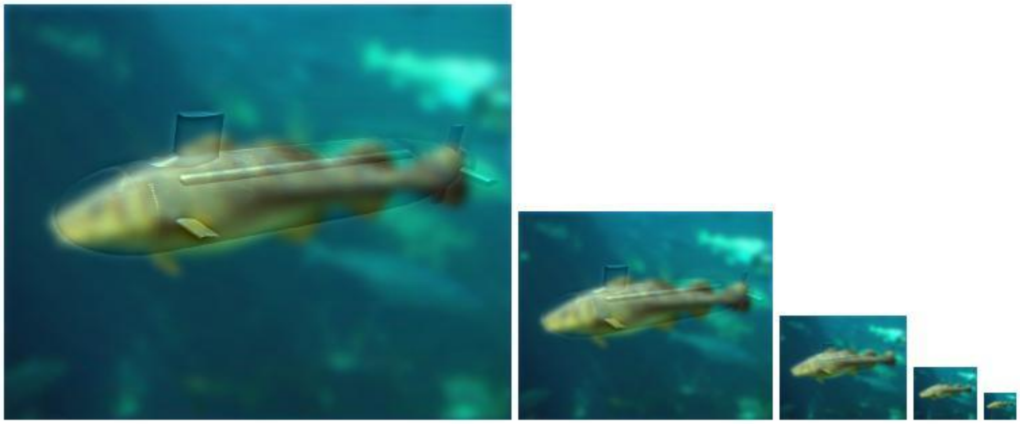

Figure 13 submarine from near distance, fish from far distance, cut-off frequency equals 4

Finally, we could deduce from results the following:

1 – Hybrid images are used to make a certain image has two different looks, one from near distance and the other one from far distance.

2- by changing the cut-off frequency , we can control when an image resemble the look from far distance .For instance if the cut-off frequency is 4 we can see the dog faster than if the cut-off frequency was 10.