COMPUTER VISION PROJECT
ON
HYBRID IMAGE WITH IMAGE FILTERING

This article is about a specific optical illusion constructed by combining two images

SUBMITTED By

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1 INTRODUCTION

Hybrid images are static images that change in interpretation as a function of the viewing distance. The basic idea is that high frequency tends to dominate perception when it is available, but, at a distance, only the low frequency (smooth) part of the signal can be seen. By blending the high frequency portion of one image with the low-frequency portion of another, we can get a hybrid image that leads to different interpretations at different distances.
This technique for creating hybrid images exhibiting this optical illusion was developed by Aude Oliva of MIT and Philippe G. Schyns of University of Glasgow, a method originally proposed by Schyns and Oliva in 1994.
In this project we will make a hybrid image from a dog image and a cat image shown below and then we will explore few more pictures

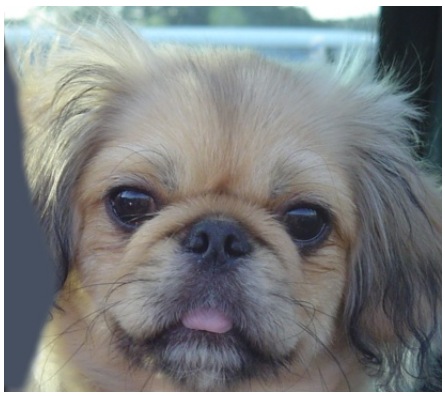



Figure 1: Cat and Dog image for making the hybrid image

2 IMPLEMENTATION OF FILTERING FUNCTION

I applied convolution to each layer in the image if color, or only once if grayscale. For each pixel, I identified the neighborhood of the image that is the same size as the applied filter. For corner pixels, I padded the boundary regions of the image with reflect method, resulting in reflection of the edges of the image but still producing the desired effect for the majority of the image with the applied filter. So the procedure I performed for convolution and as a result, image filtering, was as follows:
1)Identify image size and filter size
2)Pad image with reflection method to make filter compatible
3)Initialize new filtered image
4)For each pixel in each layer, get the pixel neighborhood and compute

5)inner product with filter of same dimensions.
6)Assign new pixel value to new filtered image.

3 TESTING OF THE FILTERING FUNCTION AND PROCEDURE

The procedure for creating a hybrid images work by applying a low pass filter such as a blurring Gaussian filter on one image and applying a high pass filter such as by removing the low frequencies on the other image, and then blending or summing each images' pixel values into a final image. The first step in order to create a hybrid image is first finding a way to blur an image. One way this step is done by applying a Gaussian filter to each pixel in the image. This is called convolution. I applied convolution to a sample cat image provided with different filters (identity filter, blur filter, large blur filter, sobel filter, laplacian filter, sharpen filter). The results are shown below.

Figure 2: **Identity filter** - This filter should do nothing regardless of the padding method we use

Figure 3: **Small blur with a box filter** - This filter removes some high frequencies.

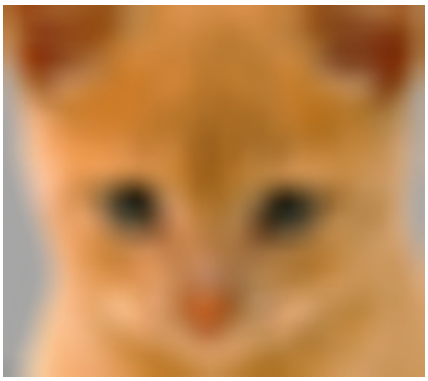


Figure 4: **Large blur with a Gaussian filter** - This filter completely blurs out the image.

Figure 5: **Oriented filter (Sobel operator)** - this filter will respond to horizontal gradients.

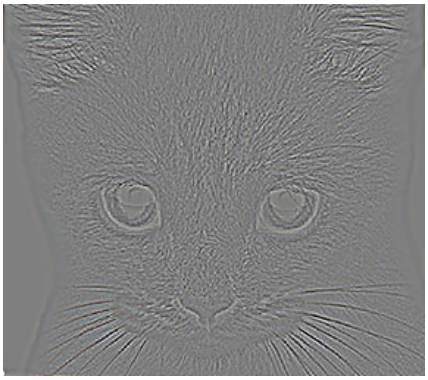
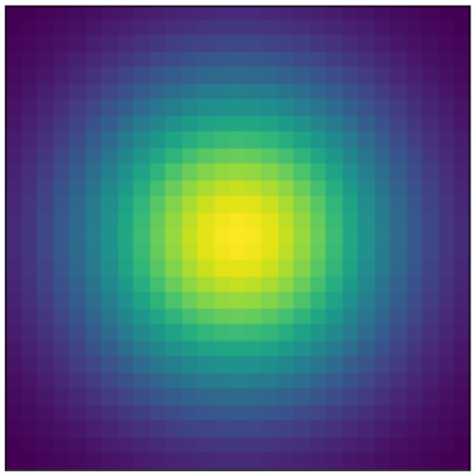


Figure 6: **High pass filter (discrete Laplacian)** - This filter detects edges.

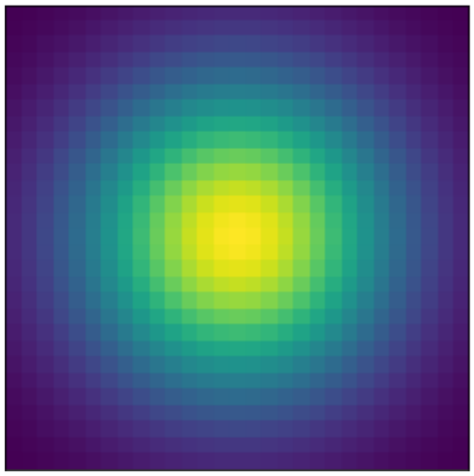
4 MAIN PART

4.1 Creating own filter

I made a filter to apply in my blurring function.We compare it with gaussian filter.



(a) my own filter



(b) gaussian filter

4.2 Creating low and high frequency images

Once I had a procedure for image filtering, I now went about creating hybrid images. The filter I used for creating hybrid images was the Gaussian filter, which is a low-pass filter. To sharpen an image, I would take the original image and subtract out the low frequencies of the image by applying the Gaussian filter to the image (original - blurred image = sharper image). For the Gaussian filter, the standard deviation of the Gaussian can be applied as the cutoff frequency. The same Gaussian filter was applied to both blurred image1 and sharpened image2.

(a) low frequency image

(b) high frequency image

4.3 Creating the hybrid image

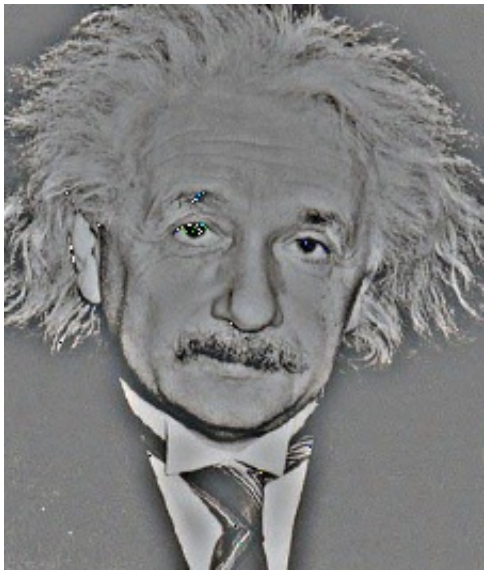
For each image pair below, the hybrid image was created by selecting qualitatively the best cutoff frequency. Below is a detailed example for the default hybrid image of two aligned images - the dog image with a low frequency band pass filter, the cat image with a high frequency band pass filter, with the subjective, qualitatively optimal cutoff frequency being 7. This is the hybrid image in pyramid style. Here we can clearly notice the difference the nearby images and the far ones.The hybrid image is perceived in one of two different ways, depending on viewing distance, based on the way humans process visual input.

Figure 9: **Hybrid Image**

5 FEW MORE HYBRID IMAGES

5.1 Marilyn-Einstein

(a) low frequency image



(b) high frequency image

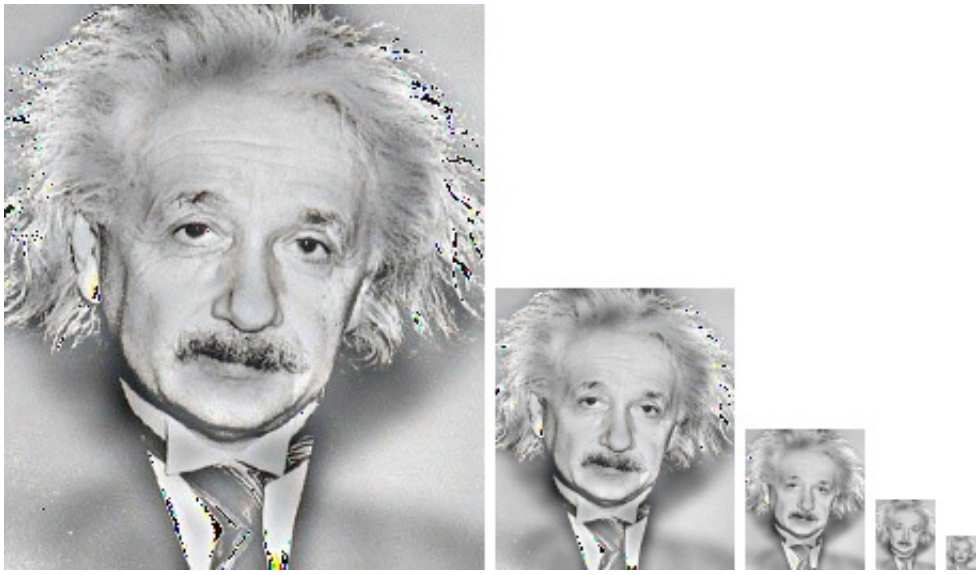


Figure 11: **Hybrid Image**

5.2 Bicycle-Motorcycle

(a) low frequency image

(b) high frequency image

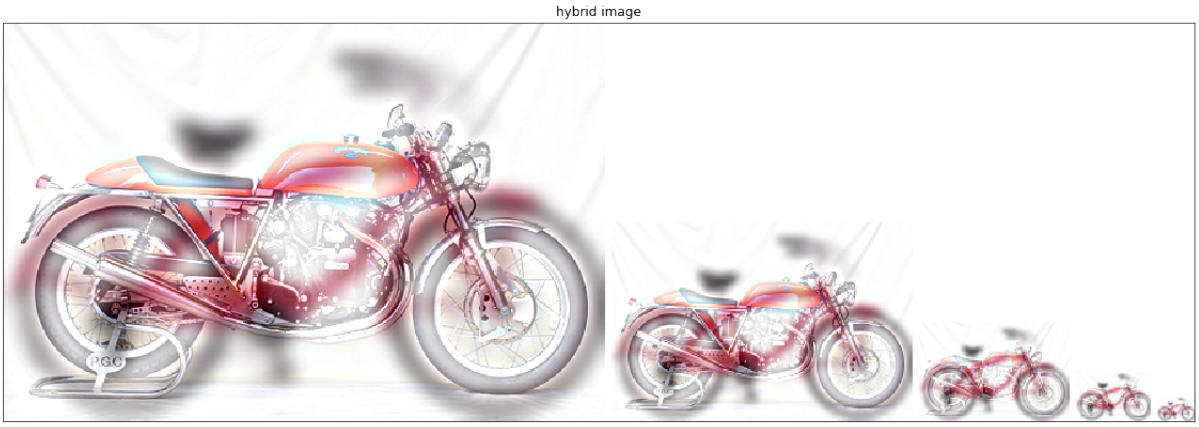
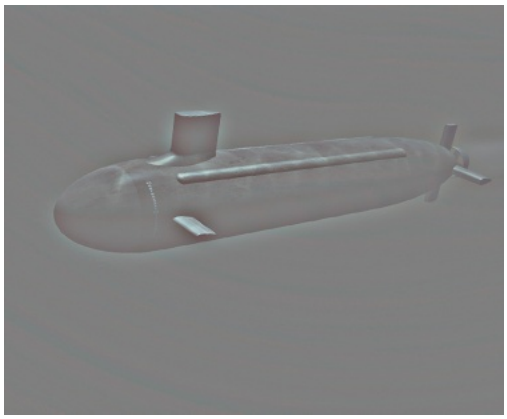


Figure 13: **Hybrid Image**

5.3 Submarine-Fish

(a) low frequency image



(b) high frequency image

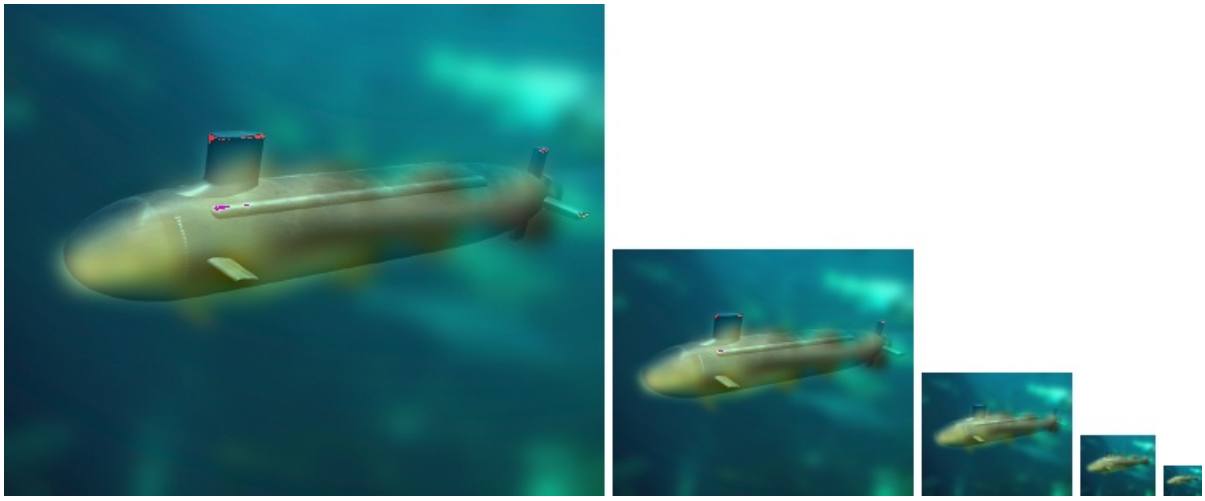


Figure 15: **Hybrid Image**

6 CONCLUSION

The project deals with studying the effects of different filters on the image and formation of hybrid images. By setting an appropriate cut-off frequency we can obtain a good hybrid image.

7 PARTICIPATION

Both of us did this project under the guidence of Tamal Maharaj with great enjoyment.At first we wrote the functions for filtering,sharpening and creating our own filter without using openCV library separately and then we merged our codes. We wrote this project in LaTeX overleaf together.