Practice 4: Hybrid images

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Abstract

The creation of visual illusions are very common in everyday life, these illusions depend on the perspective of the person with respect to the image received. One of these optical illusions are the hybrid images, which are the union of two images and depending on the distance at which you can observe some of the images. A common process for obtaining hybrid images is the use of Gaussian filters, which can also be used for the creation of Gaussian pyramids.

1. Introduction

The perception is the way the brain to interpret the environment using the light in the visible spectrum. All the physiological components involved in vision are called as visual system. The visual system allows individual to incorporate the information that surround, however this perception can be altered by illusion that differ from normal reality. One of this visual illusion is a hybrid image, that is an image that is perceived in one of two different ways, depending on viewing distance. The first technique for creating hybrid images was created by Aude Olive of MIT and Philippe G. Schyns of University of Glasgow, this method originally proposed in 1994. This kind of image, combine the low spatial frequencies of one picture with the high spatial frequencies of another picture, create an image that changes the perspective interpretation with viewing distance. [1] The purpose of this laboratory is to create a hybrid images using spatial frequencies filter, and create a Gaussian pyramid.

2. Methodology

For this laboratory, were used two images of the friends and family photographs folder. The figure 1, its a friend's cat, it is a very nice animal; it is in front, which facilitated the alignment with the second image selected and its face was small. This was a good accommodation with the child's face in the second image. In figure 2, is the cousin of Oscar, this image was selected, because, he was a small face and he was in front, which helped with the alignment; in addition, was a baby, which is also tender. Finally, both were with serious expressions, which facilitated a best hybrid image.

Figure 1. Original Image Cat

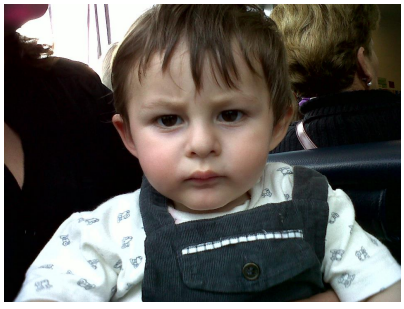

Figure 2. Original Image Baby

For both images, the faces are cut before were used in the code to hybridize them, within the program written in python, the color and size were changed, both were in 500 x 500 and in scale of grays as shown in figure 3 and 4.

On the other hand, to obtain the hybrid images, two methods were developed in python. The first consists of the application of Gaussian filters, for the image of the cat, a low-pass Gaussian filter was applied with deviation of 45 in each axis, then the resulting image is subtracted from the

Figure 3. Modified Image of Cat

Figure 4. Modified of Image Baby

original image, with this the high frequencies of the image are obtained. After, Gaussian filter was applied in the image of baby with a deviation of 35 for each axis, which allowed to leave the low frequencies; finally, both results are added to obtain the hybrid image. Next, the most relevant part in the code used.

```
BabyBlur = cv2.GaussianBlur(Baby, (35,35), 0)
CatBlur = cv2.GaussianBlur(Cat, (45,45), 0)

High = Cat - CatBlur

Hybrid = High + BabyBlur
```

The other method used is the double Fourier transform that allows us to obtain the spectrum of frequencies present in the image. In this way, the transform was applied to each image and in the image of the cat the low frequencies were eliminated eliminating the center of the frequency spectrum, with the minimum ones in the center. For the image of the baby, the high frequencies were eliminated, the center of the frequency spectrum was maintained and the rest was set to zero. Next, the most relevant part in the code used.

```
s,z = 500, 500

Cat = cv2.imread(image1,0)
Cat = cv2.resize(Cat, (s,z))
fcat = np.fft.fft2(Cat)
fscat = np.fft.fftshift(fcat)

Baby = cv2.imread(image2,0)
Baby = cv2.resize(Baby, (s,z))
fbaby = np.fft.fft2(Baby)
fsbaby = np.fft.fftshift(fbaby)

a = 2
x,y = Cat.shape
crow,ccol = x/2 , y/2
fscat[crow-a:crow+a, ccol-a:ccol+a] = 0

b = 15
m = np.zeros((x,y))
m[crow-b:crow+b, ccol-b:ccol+b] = 1

fsbaby = fsbaby*m

f_iscat = np.fft.ifftshift(fscat)
img_cat = np.fft.ifft2(f_iscat)
img_cat = np.abs(img_cat)

f_isbaby = np.fft.ifftshift(fsbaby)
img_baby = np.fft.ifft2(f_isbaby)
img_baby = np.abs(img_baby)

Hybrid = img_baby + img_cat
```

3. Results

Using the algorithm described above, the figure 3 was processed with low pass filter, the filter used was a Gaussian filter with a kernel of a derivation of 35 for each axis. This process have a result to create a image with only high frequency, which means that the information of the cat image can only see in short distance viewing. In additionally, with the figure 4 was processed with high pass filter, the filter used was a Gaussian filter with the same kernel used previously, the different with the previously filter is that after process the image with the kernel, is subtracted from the original image the image result with Gaussian filter. Finally both images will be additional to form the hybrid image. The result of this process is the figure 5.

The other method to created the hybrid image is filter using the spectrum of frequencies present in the image. For the figure 3 was processes to only remain the high frequency of the image, it was use fft2 and fftshift functions to obtain the spectrum of frequencies in the image. Using a threshold in the spectrum of frequencies. Likewise, for the figure 4 was processes with the same previous procedure, with the only different in the threshold so that remain the lower frequency of the image. The result can be observed in the figure 6.

In the figure 7, we present the Gaussian pyramid

In the figure 8, we present the pyramid blending

Figure 5. Hybrid image with Gaussian filter

Figure 6. Hybrid image with fft2

Figure 7. Pyramid Hybrid image

Figure 8. Pyramid Hybrid image

The code used to make the pyramid blending was taking of $https : //docs.opencv.org/3.0 - beta/doc/py_tutorials/py_imgproc/py_pyramids/py_pyramids.html$ and modify for this case.

4. Discussion

With the results obtained by the two methods, to create a hybrid image, you can observe noticeable differences in the results. For figure 5, in which Gaussian filters are used to obtain the hybrid image, it can observe the change of perspective in different viewing distance, however it can been seen in the figure loss of information or saturation in the image, which is due to the filtering process and to the construction of the final image. As opposed in the figure 6, you can better observe the optical illusion without a damage in the final image obtained. In this way, it can be concluded that the most optimal way to perform image hybridization is by filtering the frequency spectrum of each image, making sure that both images are aligned.

References

[1] A. Oliva, A. Torralba, and P. G. Schyns. Hybrid images. In *ACM Transactions on Graphics (TOG)*, volume 25, pages 527–532. ACM, 2006.