Hybrid and Blended Images

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1. Introduction

Hybrid images are produced with the frequency content of a low-pass and a high-pass filtered images. The low-pass filtered image contains the low-spacial scale of that preprocessed image whereas the high-pass filtered image contains the high-spacial scale of that image [1]. The addition of these two processed images give us a hybrid image.

When seeing the hybrid image close to it, a human sees the high-pass filtered image and from far away he can recognize the low-pass filtered image. Then, hybrid images change as a function of viewing distance or their perception is dependence of distance [1], [2].

For creating an hybrid images, we must filtrate one image with a Gaussian filter and substract the Gaussian filtered image obtained with the second one to the second image. Then, we add the two images processed. Another way to do this, it is to work with the frequency spectra of the images and apply to them a low-pass filter and a high-pass filter.

A blended image is a combination of the left half of an image with the right half of another image so that the resulting images seems like only one image. A blended image is obtained with Gaussian and Laplacian pyramids. The algorithm downsizes the image into different levels with Gaussian and then, it expands the Gaussian from the lower lever and subtracts it from the image in the immediately above level to acquire the Laplacian image [3]. The Laplacian pyramid of both images are combined in half. Finally, each level of the combined Laplacian pyramid is expanded and added with the same level of the resulting expanded image until it reaches the size of the original images.

2. Materials and Methods

In this laboratory, we used two images of faces. The first one, Figure 1, is an adult's face that was taken for the Colombian resident visa, in 2018. The person's name is Javier. Javier's photo was taken indoor in front of a white background, with a Samsung cell phone and at night, so it was illuminated by artificial light. Javier was smiling, and he was wearing a sweater and glasses.

The second image, Figure 2, is a photo of Esteban, Javier's little brother, when he was six months old, in 2016. The baby's image was taken outdoor, in the yard of their house. The baby was loaded high by a sister of these brothers and in the photo her hands are seen. Esteban was surprised seen the camera, a GoPro, hence he appears with his mouth open. The baby was wearing a blue t-shirt with a needlework of three balls. Behind Esteban, we can see the facade of the house. The sky seems white, probably because of the clouds or it is an artifact of the camera.

Figure 1. Javier's original photo.

Figure 2. Esteban's original photo.

Javier's image was portrait while Esteban's was landscape. Because Esteban's face is rounder than Javier's face, Javier's image was resizing to reduce in 5% the length of the vertical axis. The first image processing step was to crop squarely both images with Microsoft Photo Editor for Windows 10. The most important restriction was to make the size and position of the head, eyes and mouse to match in both images. After that, we obtained two square aligned images but the sizes of them were different. The next step was resizing the images with Paint to 512x512. Then, both images were the same size and they were aligned as shown in Figure 3 and Figure 4.

For generating the hybrid image, we created two Gaussian kernel (GK). The first GK had dimensions 35x35 and the standard deviation was 21. The second GK had dimensions 25x25 and the standard deviation was 25. The first GK was used as a filter for Esteban's image to get the low-frequencies of it. The second one was used as a filter for Javier's image to get also the low-frequencies of it, but then we subtract the original from this smoothed image to get the high-frequencies of Javier's image. After that, we added the two resulting images and we obtained the hybrid image as shown in Figure 5.

With Figures 3 and 4, we also generated a blending image. We down-sampled each image 7 times by a factor of 2 each time so we got the Gaussian pyramid of both images. After that, we obtained the Laplacian pyramid of the images. We expand, by a factor of 2, a Gaussian pyramid image, and we subtract the Gaussian pyramid image from the previous level with the expanded one to get the Laplacian pyramid image of that previous level. Then, for each level of Laplacian pyramid, we combined the halves of the images. Finally, we reconstructed the blended image expanding the combined image at the lower level and adding it to the combined image of the next level, and we repeated this process until we reached the top level.

Figure 3. Javier's final processed photo.

Figure 4. Esteban's final processed photo.

3. Results

In Figure 5, we show the hybrid image obtained with Figures 3 and 4. Figure 6 is the same hybrid image but smaller than in Figure 5. Figure 7 corresponds to the direct blending images. Figure 8 is the blended image obtained with the Gaussian and Laplacian pyramids.

Figure 5. Hybrid image obtained with both faces.

Figure 6. Small Hybrid image obtained with both faces.

Figure 7. Direct blending with both faces.

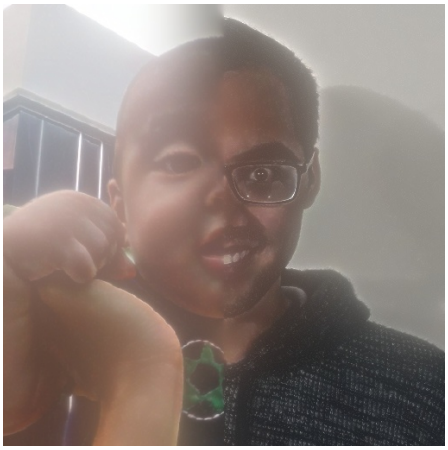

Figure 8. Pyramid blending with both faces.

Figure 9. Hybrid image with small windows size of the HP filter.

4. Conclusions

We obtain a hybrid image from two images of faces because of the Gaussian blurring. The Gaussian filtering serves as an frequency filter that keeps the low and high frequency of two images. The result will be analogous to apply the Fourier transform to the images in order to obtain the same frequency spectra.

The size of the filters matters. For the low pass filter, if the size is smaller the contours are not well blurred so in the hybrid image they are seen. For the high pass filter, if the size is smaller, we get only the fine contours, so the resulting hybrid image seen like a cartoon, as seen in Figure 9.

The blended image can enhance the equivalent result of direct blending smoothing the border between the two images. Gaussian and Laplacian pyramids help us to obtain different frequencies (components) of the images that gives the desire result.

References

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5. Code

The hybrid image was done in Matlab. The blended image was done in Python. In Matlab, we use fspecial for the Gaussian filter and imfilter for filtering the images with the Gaussian kernel. In Python, we got the Gaussian pyramid with cv2.pyrDown and the Laplacian pyramid with cv2.subtract and cv2.pyrUp as we explained in Materials and Methods. For adding the halves we used np.hstack.