Hybrid images

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Abstract

1. Introduction

Hybrid images can be seen as visual illusions where static images change in interpretation as a function of the viewing distance. To do so, one image must pass through a low pass filter and the other through a high pass filter. This due to the fact that a high-pass filter makes the image look sharper and emphasize fine details, therefore high frequencies tend to dominate at close distances. On the other hand, a low pass filter averages out rapid changes in intensity so the image loooks blurred at close distances but it looks better at a distance.
Oliva et al. suggest using a 2D Gaussian filter to create the low pass filter and they suggest for the high pass filter to subtract the Gaussian-filtered image from the original. Likewise, the cutoff-frequency must be determined experimentally. Finally, the hybrid image is obtained when adding the high frequency portion of one image and the low frequency portion of the other.

A Gaussian pyramid is a technique in image processing in which an image is filtered with a low-pass gaussian filter and then is subsampled repeatedly. In the same way, a Laplacin pyramid is a technique in which the difference between successive levels of the gaussian pyramid are saved. These two pyramids can be used, for example, when blending two images so it looks more uniform.

In this project, an hybrid image was created, then it was calculated and displayed a Gaussian pyramid of 5 scales in order to approximate how the image would look from different distances.

2. Materials and methods

For this lab, the software implemented was MATLAB R2016b. The inside functions implemented were the following:

- impyramid: This function was used to construct the gauss pyramid reduction and expansion.
- imgaussfilt: his function filters the image with a 2-D Gaussian smoothing kernel with standard deviation determined experimentally in each case.
- fspecial: This function created the gauss kernel with a σ specified by the user.
- conv2: Convolutes the image with the kernel made in fspecial.
- imsubtract: function used to succesfully subtract two images.

2.1. Hybrid image

For this section, 6 images were selected:

- In the first place, were used one family picture of one of the authors during a trip to Atlanta, US. and a picture of the famous Cinderella Castle in World Disney World during the same trip. These pictures were cropped so that they will be aligned and then the resize function was used so that they were of the same size. Also, the image taken in Atlanta was modified so that the background was only white.
- In the second place, were used the pictures of both authors, Francisco and Johanna. These photos were taken with a white background to avoid noise and care was taken that, when taking the photo, the distances were preserved.
- In the third place, it was taken a picture of a matrioska (a souvenir from Bariloche of one of the authors) and a picture of the same author when he was 4 years old. Likewise, atese photos were taken with a white background to avoid noise and care was taken that, when taking the photo, the distances were preserved.

  All the images can be seen in the Annexes section.

Once the images were set, a folder was created that saved them. Then, a ”for” was made to run through this folder in pairs and proceeds to calculate each hybrid image. So, first, image 1 is filtered with a Gaussian kernel (using the imgaussfilter function) with sigma found experimentally.

Then, image 2 is filtered with another Gaussian kernel but a different sigma (also calculated experimentally) and this image is subtracted from the original, to obtain the image with the high frequencies. Finally, both images are added and this is the hybrid image. The process is repeated for the 3 pairs of images.

2.2. Visualization

In this section, it was calculated a gaussian pyramid, using the function impyramid and using as the first input, the image, and as the second input, the parameter 'reduce' in order to approximate how the image looks from different distances. Then, it was created a "cell array" to save the hybrid images and then it was used a code found in [**?**] to display them.

2.3. Blended image

In this section, the portraits of the authors from this paper were used. At first, the resolution of the images was reduced by a factor of 8. then, the left half of one portrait was concatenated with the right half of the other (see figure). Once concatenated the images, the function *pyr*, which is simmilar to the impyramid function, but takes as an input the σ associated to the gauss filter, was implemented to calculate the pyramid expansion. Finally, the corresponded laplacian pyramid was added to the previous result. The last two processes were implemented three times, so the images would had a better blending.

3. Results

3.1. Hybrid image and visualization

Three hybrid images were obtained and are shown in the Annexes section. Also, there can be found the gaussian pyramid sthat were calculated and those hybrid images from different distances.

3.2. Blended image

Even though after the blending, the concatenated images looked a little blurred (see figure). Nevertheless, after zooming in the authors' faces, the division between the two portraits disappear and the blending looks natural (see figure).

4. Conclusions

5. Anex

5.1. Images

All the codes created and used are attached.

References

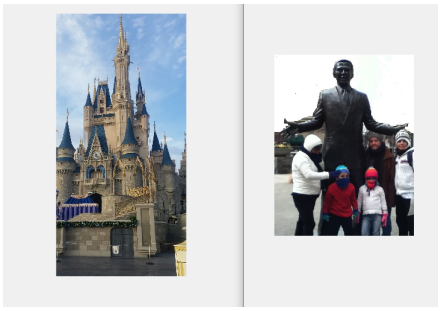

Figure 1. First pair of images.

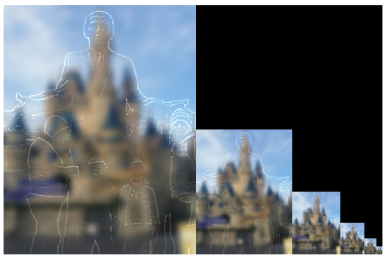

Figure 2. First hybrid image.

Figure 3. Second pair of images.

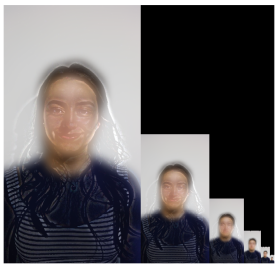

Figure 4. Second hybrid image.

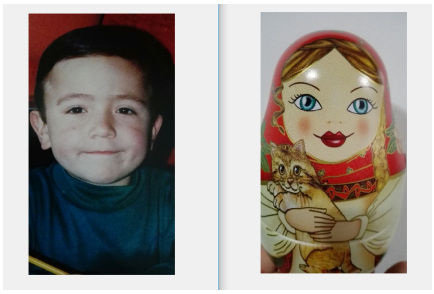

Figure 5. Third pair of images.

Figure 6. Third hybrid image.

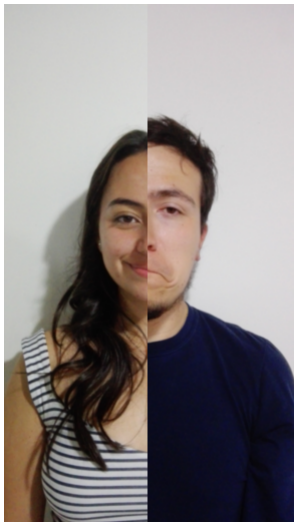

Figure 7. Zoom on blended images

Figure 8. Zoom on blended images

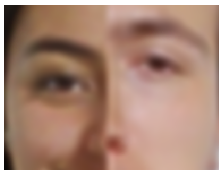

Figure 9. Zoom on blended images