Hybrid images

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Abstract

In this practice we explored frequency characteristics in computer images, creating hybrid and blended images through Gaussian filtering and Laplacian pyramids.

1. Introduction

It is possible to produce static images with two different interpretations according to the viewing distance. For this, the hybrid image technique, which is based on visual perception and multi-scale image analysis, is used. The scale to be considered depends on each specific computer vision problem. That is, it is necessary to have the scale in which the visual characteristics of interest in the image are significantly appreciable [1].

2. Materials and methods

For the creation of hybrid images, we used the following image and numerical processing software:

- Adobe Photoshop (Optional)
- MATLAB

Any two images are useful for this practice. In our case, the first image used was a Corgi in a lawyer suit leaning on a book in his office (Fig. 1a); the second image was another Corgi, really excited, showing its teeth while playing on the grass (Fig.1b).
Image processing in Photoshop was minimal, it consisted only on the rotation and resizing of the second image and cropping for both (Fig. 2).

From the aligned images, a hybrid image was generated, which was visualized by a Gaussian pyramid. Finally, an image was formed from the halves of each image and combined by applying a Laplacian pyramid and its subsequent reconstruction.

(a)

(b)

Figure 1: Original images

3. Results

3.1. Hybrid Images

Given two images, the process to create hybrid images is pretty much straightforward using the method described by Oliva et. al [1]: For one of the images, high frequency characteristics are kept (Fig. 2a), subtracting low frequency characteristics of the same image; then, only low frequency

characteristics are extracted from the other image (Fig.2b), using Gaussian blurring. Finally, the high frequency characteristics of the first image are added to the low frequency characteristics of the second, producing a hybrid image as the one seen in Fig.3.

(a) High Frequency Image

(b) Low Frequency Image

Figure 2: Processed images

Figure 3: Final Hybrid Image

```
function img = createhybrid(im1, im2,
    sigma, ksize)

  nim1 = imgaussfilt(im1,sigma(1),'
    FilterSize',ksize);
  nim2 = imgaussfilt(im2,sigma(2),'
    FilterSize',ksize);
  img = im1-nim1+nim2;
```

3.2. Image pyramid

In order to visualize the low frequencies of the hybrid image, as it would be observed when increasing the distance of vision, it is possible to decrease the scale of the same by means of a Gaussian pyramid as shown in the Figure 4. For this, a Gaussian filter with sigma equal to 1 and a down sampling factor of 2 was used.

```
%% Gaussian pyramid
pyramid_down{1} = imread('hybrid.png');
sigma = 1;
for i = 2:6
        % Gaussian filter
    down = imgaussfilt(pyramid_down{i
    -1}, sigma);
    % Down sampling
    pyramid_down{i} = down(1:2:end,
    1:2:end, :);
    subplot(2, 3, i)
    imshow(pyramid_down{i})
end
```

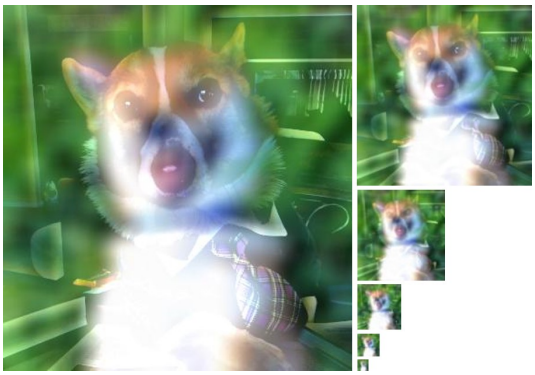

Figure 4: Gaussian pyramid for the hybrid image.

From a Laplacian pyramid and its subsequent reconstruction, it is possible to create blended images. On the one hand, the Figure 5 shows the result of the union of two images as the concatenation of the matrices by which they are represented. On the other hand, in Figure 6 the image given by the reconstruction of a Laplacian pyramid with sigma equal to 3 is shown.

```
%% Pyramid blendin
pyramid_laplacian{1} = blended;
sigma = 3;
for i = 2:6
    [r, c, w] = size(pyramid_down{i-1})
    ;
    % Up sampling and subtraction of
    filter image.
     pyramid_laplacian{i} = imsubtract(
    pyramid_down{i-1}, imresize(
    pyramid_down{i}, [r c]));
end
pyramid_up{6} = pyramid_down{end};
for i = 6:-1:2
    [r, c, w] = size(pyramid_laplacian{
    i});
    % Up sampling and addition of
    Laplacian image
     pyramid_up{i-1} = imadd(imresize(
    pyramid_up{i}, [r c]),
    pyramid_laplacian{i});
end
```

4. Conclusions

Hybrid images give a clear grasp of what are the frequency characteristics of an image: high frequency characteristics consist of fine details that can only be seen from up close; low frequency characteristics, however, are those that can be seen from afar, such as the background or rough shape of an object.

Figure 5: Blended image.

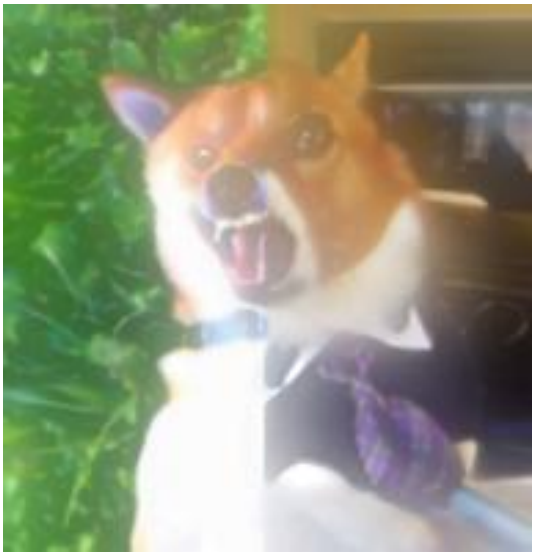

Figure 6: Pyramid blending.

Finally, the analysis of multi-scale images, specifically through the use of image pyramids, allows us to visualize only the low frequencies of an image. In addition, with these tools two images can be combined in a smoother way.

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.