Laboratory Session 4

Computer Vision - Università Degli Studi di Genova

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***Abstract*—Image segmentation based on splitting of the image channels is performed in order to detect two different cars in an image. Additionally the Laplacian of Gaussian is used for blob detection of two sunflowers.**

***Index Terms*—Image segmentation, image channels, RGB, HSV, Laplacian of Gaussian, Blob Detection, characteristic scale**

I. Introduction

The purpose of this lab [2] is to implement colour segmentation and blob detection algorithms. Six different versions of Fig 1 were given, which were all very similar to each other. The images were split into RGB and HSV components. The hue component was taken and analyzed in order to detect the black and red car in the images. For Fig. 2, a Laplacian of Gaussian Filter of multiple scales was applied to the filter in order to detect the blobs in the image.

Fig. 1: Test image of cars for segmentation. Source: [2]

II. Procedure

A. Task 1

The 6 images are first split into the three RGB-channels and to the three HSV channels. The dark car is segmented by finding out the mean hue value of the blue car and the standard deviation of the hue value in that region. Then, the relevant hue-range is defined as the mean hue $\pm\sigma$. Consequently, a mask can be created, which sets all the pixels within that hue range to one, and the other ones to zero. Using the matlab

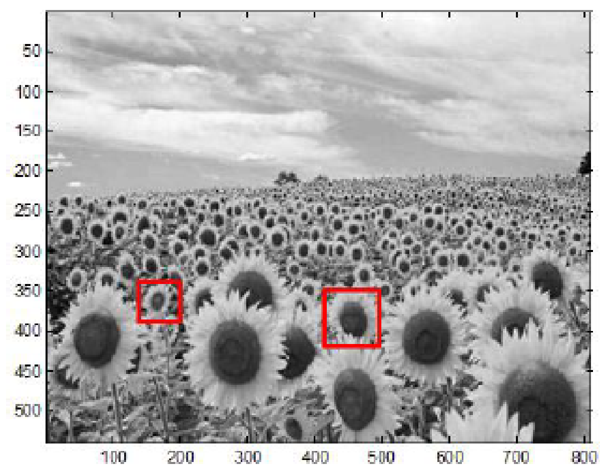


Fig. 2: Test image of Sunflowers. Source: [2]

function `regionprops`, a centrode and a bounding box are found of the area with the highest density of pixels within the hue range. In the second step, this bounding box can be applied to the color image to display the detected blob in the original image. The entire procedure is done to detect the dark car and the red car.

B. Task 2

The scales of the Laplacian of Gaussian Filters were created from the parameters given in [2]. These are then applied to the image, and a matrix that saves the Laplacian response of each pixel in the image with the filters. Non maxima suppression is used in order to find the max value of each blob, which will be its center. For the specific sunflowers that were requested, the max laplacian response of each filter was saved and a chart was created that plotted the max response with the scale of the filter (sigma) to determine its characteristic scale.

III. Results and Analysis

A total of 68 images were obtained after running the Lab4.m script in the MATLAB workspace as follows:

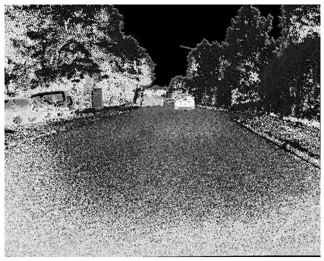
Lab4();

The following images and analysis shown are the most useful ones for understanding the effect of each task from the procedure. However, the reader can access the full set of images in the folder called ”plots”, automatically generated when the script is executed.

A. Task 1

Fig. 3 shows the decomposition of the image ur_c_s_03a_01_L_0376.png into the HSV-channels and Fig. 4 shows the greyscale image as well as the decomposition of the image into its RGB-channels.

a) Color image



b) H-channel

c) S-channel

d) V-channel

Fig. 3: Decomposition of color image into HSV-Channels. Source: Own Elaboration

a) Greyscale image

b) R-channel

c) G-channel

d) B-channel

Fig. 4: Decomposition of color image into RGB-Channels. Source: Own Elaboration

It can be noted, that the car is getting darker, when turning to the left. The consequence is, that the r-value, g-value and b-value are changing. They all increase in value when the image gets darker. The hue value, on the other hand, does not change, when the image gets darker or brighter. This is why it makes most sense to use the hue value to segment the image and find the cars.

To segment the dark car, the mean hue-value of 0.7741 and the standard deviation of 0.0521 was used to define the hue range of the car. Using the function `regionprops`, the bounding box and centroid shown in Fig. 5 were determined.

Fig. 5: Segmentation of dark car in thresholded hue image (binary). Source: Own Elaboration

Applying the bounding box of that car onto the color image results in the image shown in Fig. 6

Fig. 6: Application of centroid and bounding box of dark car on color image. Source: Own Elaboration

All the previous steps are repeated to identify the red car, as shown in Fig. 8 and Fig. 9. The most obvious idea would be to take the mean of the hue value around the red car again, but then, an interesting effect would arise: Red is on the sides of the hue colormap, as shown in Figure 7. Consequently, some values of the red car are close to zero and other values are close to one. The mean value would then be something in the middle of the colormap, maybe cyan, which is as far from red as possible. That is why the hue range to mask the image is simply chosen manually as 0.97 to 1.00.

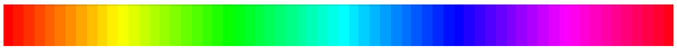


Fig. 7: Hue-Colormap. Source: [3]

Fig. 8: Segmentation of red car in thresholded hue image (binary). Source: Own Elaboration

Fig. 9: Application of centroid and bounding box of red car on color image. Source: Own Elaboration

B. Task 2

The characteristic scale and its corresponding laplacian response for each flower are displayed in Table I.

	Left Flower	Right Flower
Characteristic Scale	7.0	14.0
Laplacian Response	58.0	79.0

TABLE I: Characteristic Scale Results

In Fig. 10 and Fig. 11 the laplacian response as a function of the scales of the filters is shown. It can clearly be seen that there is a maximum value to each of the plots. This maximum value corresponds to the characteristic scale of each flower, which is how it was determined. It is important to notice that these graphs were produced by using different parameters from the ones provided in the instructions of the lab. With these parameters, it is better to see the evolution of the curve for the characteristic scale for both blobs in question, since it is like sampling the curve with a higher frequency. Otherwise, the curve would not have enough data points to visualize what is really happening around its maxima. This was done only for a better understanding; however, the reader when running the scripts can choose between the two sets of parameters to decide how the graphs are computed.

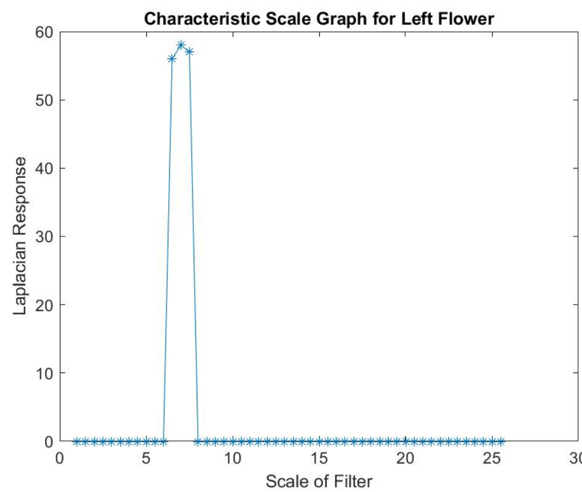


Fig. 10: Laplacian response of left flower as function of scales. Source: Own Elaboration

IV. Conclusions

- The hue value is most appropriate to perform color-segmentation, because it neglects differences in brightness.
- Red hue values need special attention because they are on both ends of the hue colormap.
- The characteristic scale of a blob has the maximum laplacian response when a LoG filter is applied to it, which is useful for blob detection.

References

[1] Solari, F. Part 4 - pyramid, blobs and color, 2020. Retrieved from: https://2019.aulaweb.unige.it/pluginfile.php/209261/mod_resource/content/3/lecture4_pyramid_color.pdf

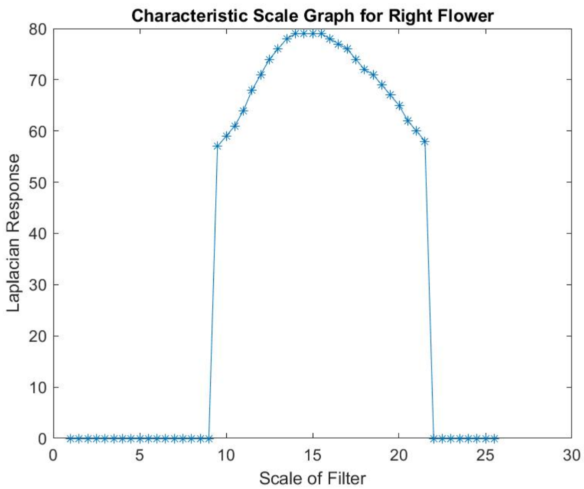


Fig. 11: Laplacian response of right flower as function of scales. Source: Own Elaboration

[2] Solari, F. Lab Session n.4, 2020. Retrieved from: https://2019.aulaweb.unige.it/pluginfile.php/209263/mod_resource/content/3/Lab4.pdf

[3] Matlab-documantation on the hsv colormap array. Retrieved from: https://it.mathworks.com/help/matlab/ref/colormap_hsv.png