Computer Vision
Exercise 1: Image Filtering

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Due date: Friday January 25th at noon

1 Programming exercises

This week we will look into filtering for the programming exercises. With your exercise answers provide the matlab code for the require functions as well as a script to recreaete each exercise. If the script is not provided, the exercise would be consider invalid.

Correlation and Convolution: The first task consist in generating your own correlation and convolution functions in matlab. Each one of these functions take as input an image as well as a mask, and outputs the results of the corresponding processing as follows

```
image_conv = convolution(image_in,mask);
image_corr = correlation(image_in,mask);
```

Mask: Implement a function in matlab that computes a Gaussian mask, with parameters σ and the size of the mask as follows

```
mask_gauss = mask_gauss(sigma,size);
```

Filtering: Create an image I of size 100×100 which contains a single non-zero value located in the middle of the image. Create a mask g using the mask_gauss function. What is the results of $g * I$? And of $g \otimes I$? What about $I * g$? and $I \otimes g$. Verify your answers with the matlab functions you previously created.

Gaussian pyramid: Take your favorite image and construct a Gaussian Pyramid. Display the results. What is the minimum size necessary to store it?

Fourier: Compare the result of convolving with a Gaussian using your convolution function and by employing matlab's Fourier transform (i.e., fft function). Is the result the same? How did you obtain it? What about for the correlation? How can you create a high pass filter using only the mask_gauss function? and a band-pass filter? Verify this empirically using your functions.

Steerable Filters: We will now see that the Gaussian derivatives is a steerable filter. How many basis do you need? Why? How would you verify that is steerable? Verify that it is the case by constructing a function

```
[residual, filter, basis] = steerable(image,theta);
```

This function returns the basis, the steerable filter of angle θ, as well as the residual that shows that this is a steerable filter. Use the functions that you have previously done.

2 Critic reading exercise

Read [1] and provide a one page summary of the paper. Utilize another page to summarize the good and bad points of the paper, and to brainstorm on how you think the paper could be improved?

3 Problem Sets

Steerable Filters: Show that the second order derivatives of a Gaussian are steerable and that only 3 basis are possible. Provide a formal proof. How many would you need for the third order derivatives? Don't proof it, but say how many you think and why.

References

[1] J. Kopf and D. Lischinski. Depixelizing pixel art. In *SIGGRAPH*, 2011.