D5 - Computer Vision 2018-2019
Assignment 3 – Keypoint Detection
Due Date: Friday, December 21st, 2018, 11.59pm

In this assignment the task is to implement a keypoint detector using the Difference of Gaussians operator and compute the orientation for each keypoint. The recommended steps for the development of the descriptor follow are:

1. You're given a grayscale image.
2. Use 5 octaves and 8 scales in each octave. The values of σ_0 that you will start in each octave are [1, 2, 4, 8, 16]
3. For every octave and scale in each octave compute the respective σ for the current and the upper scale using the formula from the 5th set, slide 41 and using a hsize of 6 sigma compute the 2 Gaussians (**fspecial** function in MATLAB).
4. Once you have computed the difference of the 2 Gaussians compute the output of the convolution using "same" for the border points (**imfilter** function in MATLAB). In total you should compute 5 octaves x (8-1 = 7) scales.
5. Once you have computed the output of the convolution, scan through the image and find the local maxima using a 3x3 window in a) the current b) the upper and c) the lower scales. (You will compare the current value with the rest 27-1 = 26 values. Refer to slide 27, set 5.
6. For every local maximum and the respective σ you have obtained, take a window of size 6 times the respective σ and in that window compute the Matrix M (as in the Harris corner detection) that contains the derivatives in each axis.
7. If trace(M)/det(M) < (r+1)^2/r, r = 10 keep the point coordinates and the value of σ, otherwise discard it.
8. Now we need to compute the orientation for each keypoint. For every keypoint, take a window of size $6*\sigma$ (hsize $=6*\sigma$) and create a Gaussian with $\sigma_g = 1.5*\sigma$. (the scale in which you have detected the keypoint).
9. For every pixel of the window, compute the magnitude and orientation (**imgradient** function in MATLAB).
10. Shift the orientation 180^o to have a range between 0^o and 360^o and compute a weighted histogram with 36 bins (download the **histwc** function from Mathworks)
    a. Compute the convolution of the windowed image with the Gaussian of step 9 using again "same", and convert it to double.
    b. The weights for the histogram are the Magnitude times the output at step 10a.
11. The candidate orientations obtained from the histogram are those that are higher than 80% of the histogram's maximum value.

12. Plot all the keypoints on top of the image, with a circle proportional to the scale that you detected the respective keypoint.
    a. Use the following function which plots a circle with radius r centered at (x,y) along with the command *hold on* to plot the circles on top of the image

```
function [] = plotCircle(r,x,y)
      th = 0:pi/50:2*pi;
      xunit = r * cos(th) + x;
      yunit = r * sin(th) + y;
      h = plot(xunit, yunit);
```

- You should submit your code in a zip file. The code should include a command "KeyPointDescriptorT11(ImageFileName)" providing at its output the image and the keypoints.
- Please send your assignments to cnikou@cse.uoi.gr with the subject: LastName_D5_Assignment_3
- The name of your zip file should be the same with the email subject.