Intro to Image Understanding (CSC420)

Assignment 1

Posted: Jan 18, 2019 **Submission Deadline : Jan 26, 11.59pm, 2019**

Instructions for submission: Please write a document (pdf or doc) with your solutions (include pictures where needed). Include your code inside the document. Please submit through MarkUs. You are expected to work on the assignment **individually**.

Max points: 15

1. (a) **[2 points]** Write your own code for computing convolution of the 2D (grayscale) image and a 2D filter. Make the output matrix be the same size as the input image. Be careful to correctly deal with the border of the image – the easiest way to do this is to "zero-pad" the image prior to correlation.
   (b) **[1 point]** Extend this code to handle RGB images and 3D filters (having the third dimension equal to 3).

2. (a) **[2 points]** You convolve an image I with a filter $f_1 = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, then take the output and convolve it with another filter $f_2 = \begin{pmatrix} e & f \\ g & h \end{pmatrix}$. Is it possible to get the same final result by just performing one convolution? If so, what is the filter to do this?
   (b) **[1 point]** Write your own function that creates an isotropic Gaussian filter with σ as an input parameter.
   (c) **[1 point]** Convolve the attached waldo.png with a (2D) Gaussian filter with $\sigma = 1$ and visualize the result (display the result of the convolution). You can use built-in functions for convolution.
   (d) **[2 points]** Is a vertical derivative, $\frac{\partial G(x,y)}{\partial y}$, of a Gaussian filter G a separable filter? Analyze both the isotropic and anisotropic case. Explain your answer.
   (e) **[1 point]** What is the number of operations required for performing 2D convolution? What is the number of operations for performing convolution with a separable filter?

3. (a) **[1 point]** Compute magnitude of gradients for the attached images waldo.png and template.png.
   (b) **[1 point]** Write a function that localizes the template (template.png) in the image waldo.png based on the magnitude of gradients.

4. (a) **[3 points]** Implement Canny edge detector yourself. You do not need to do hysteresis thresholding. However, do perform non-maxima suppression. Please visualize your results on waldo.png.