CSci 4270 and 6270
Computational Vision,
Spring Semester, 2021
Lecture 05 Exercise
Due: Wednesday, February 2, 2022 at 5 pm EST

Problem

The gradient magnitude at pixel location (x, y) of an image, I, is defined as

$$g(x,y) = \left[\left(\frac{\partial I}{\partial x}(x,y) \right)^2 + \left(\frac{\partial I}{\partial y}(x,y) \right)^2 \right]^{1/2}.$$

When we model the image as a continuous function this is clear and unambiguous. When we turn to a discrete implementation, things are a bit more complex. In particular, the Jupyter notebook distributed for class shows two different implementations of the partial derivative, one using just two values and one using six values in each "Sobel kernel". One immediate consequence of this is that the gradient magnitude values for the Sobel derivatives will be larger than for the first. This can be partially corrected by scaling down the Sobel results by a factor of 8 (think about why this is). But there will still be differences.

Write a short script that reads an image (as grayscale), computes the gradient magnitude using the two-valued kernel (the -1/2, 0, 1/2 kernel) and using (and rescaling) the Sobel kernels. It should then compare the gradients to determine

1. The image-wide average of the gradient magnitudes computed using the two-valued kernel (accurate to one decimal place).
2. The image-wide average of the gradient magnitudes computed using the rescaled Sobel kernels (accurate to one decimal place).
3. The maximum of the absolute value of the difference between the gradients.
4. The percentage of pixels (accurate to the nearest integer) where the two-valued gradient magnitude is larger than the Sobel gradient magnitude. (This requires the use of `np.where` — see Lecture 2.)

Start from the code provided, including the Jupyter notebook. Notes:

1. The second argument to both `cv2.Sobel` and `cv2.filter2D` should be `cv2.CV_32F`.
2. In order to obtain consistent output, use:

   ```
   grad_mag = np.sqrt(im_dx**2 + im_dy**2)
   ```

   to compute the gradient magnitude from two partial derivative images.