CS485/685 Computer Vision

Spring 2010 – Dr. George Bebis

Homework 2

Due Date: 2/23/2010

1. Consider the subimage shown below. Find the gradient magnitude and gradient direction at the center entry using **(i)** the Prewitt operator, **(ii)** the Sobel operator.

4	1	6	1	3
3	2	7	7	2
2	5	7	3	7
1	4	7	1	3
0	1	6	4	4

2. Separable kernels. Create a 3-by-3 Gaussian kernel using rows [(1/16, 2/16, 1/16), (2/16, 4/16, 2/16), (1/16, 2/16, 1/16)] and with anchor point in the middle.
   a. Run this kernel on an image and display the results.
   b. Now create two one-dimensional kernels with anchors in the center: one going "across" (1/4, 2/4, 1/4), and one going down (1/4, 2/4, 1/4). Load the same original image and use `cvFilter2D()` to convolve the image twice, once with the first 1D kernel and once with the second 1D kernel. Describe the results.
   c. Describe the order of complexity (number of operations) for the kernel in part a and for the kernels in part b. The difference is the advantage of being able to use separable kernels and the entire Gaussian class of filters—or any linearly decomposable filter that is separable, since convolution is a linear operation.

3.

In this exercise we learn to experiment with parameters by setting good `lowThresh` and `highThresh` values in `cvCanny()`. Load an image with suitably interesting line structures. We'll use three different high:low threshold settings of 1.5:1, 2.75:1, and 4:1.

a. Report what you see with a high setting of less than 50.
b. Report what you see with high settings between 50 and 100.
c. Report what you see with high settings between 100 and 150.
d. Report what you see with high settings between 150 and 200.
e. Report what you see with high settings between 200 and 250.
f. Summarize your results and explain what happens as best you can.

4. Generate the mask for $255 \times \nabla^2 G(x, y)$, for σ=1. Truncate all the mask values to the nearest integer.

Graduate Students Only:

Prove the following properties of the Gaussian function $G(x) = e^{\frac{\cdot}{2\sigma^2}}$:

(a) Symmetry: $G(x) = G(-x)$
(b) Scaling: $G^{\sigma}(x) * G^{\sigma}(x) = G^{\sqrt{2}\sigma}(x)$

Using property (b), propose a more efficient way to compute $(f(x) * G^{\sigma}(x)) * G^{\sigma}(x)$. Justify your answer by comparing the number of calculations (i.e., multiplications/additions) required.