CSE 455

HW 1 Notes

Overview

- Assignment 1 is a big set of exercises to code functions that are basic and many of which are needed for future assignments.
- Sample functions are provided at the beginning of the code, so you get an idea how to work with the images in Qt.
- The required functions come from the lectures on filtering, edge finding, and segmentation.

QImage Class
in the QT package

- The Qimage class provides a hardware-independent image representation
- Some of the useful methods
  – QImage() (and other forms with parameters)
  – copy(int x, int y, int width, int height) const
  – setPixel(int x, int y, uint index_or_rgb) can use function qRgb(int r, int g, int b)
  – width() const, height() const
- The QRgb class holds a color pixel.
- from http://doc.qt.io/qt-4.8/qimage.html

1. Convolution

- The first task is to code a general convolution function.
- void Convolution(QImage *image, double *kernel, int kernelWidth, int kernelHeight, bool add)
- image is a 2D image of class QImage
- kernel is a 2D mask array
- kernelWidth is the width of the mask
- kernelHeight is the height of the mask
- if add is true, then 128 is added to each pixel for the result to get rid of negatives.

Reminder: 2D Gaussian function with standard deviation σ

In 2-D, an isotropic (*i.e.* circularly symmetric) Gaussian has the form:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

This distribution is shown in Figure 2.

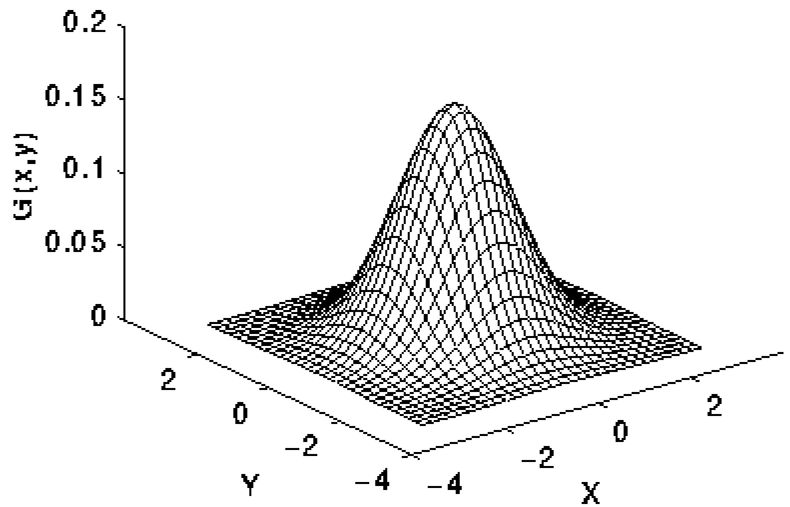


Figure 2 2-D Gaussian distribution with mean (0,0) and σ=1

2. Gaussian Blur

- The second task is to code a Gaussian blur which can be done by calling the Convolution method with the appropriate kernel.
- void GaussianBlurImage(QImage *image, double sigma)
- Let the radius of the kernel be 3 times σ
- The kernel size is then 2 * (radius + 1)

3. Separable Gaussian Blur

- Now implement a separable Gaussian blur using separate filters for the horizontal blur and then the vertical blur. If your Convolution is general enough, you can just call it twice.
- void SeparableGaussianBlurImage(Qimage *image, double sigma)
- The results should be identical to the 2D Gaussian Blur.

4. First and Second Derivatives of the Gaussian

- void FirstDerivative_x(QImage *image, double sigma) takes the derivative in the x direction using a 1*3 kernel of { -1.0, 0.0, 1.0 } and then does a standard Gaussian blur.
- void FirstDerivative_y(Qimage *image, double sigma) takes the derivative in the y direction and then does a standard Gaussian blur
- void SecondDerivImage(Qimage *image, double sigma) computes the Laplacian function and then does a standard Gaussian. For the Laplacian, rather than taking the derivative twice, you may use the 2D kernel:

  0.0, 1.0, 0.0
  1.0, -4.0, 1.0
  0.0, 1.0, 0.0

- All of these add 128 to final pixel values in order to see negatives. That can be done in the call to the Gaussian which calls Convolution.

5. Sharpen Image

- Sharpen an image by subtracting the second derivative image from the original. Will need to subtract back off the 128 that second derivative added on.
- void SharpenImage(Qimage *image, double sigma, double alpha)
- Sigma as usual and alpha is the constant to multiply the sharpened image by as on the slide.

6. Sobel Edge Detector

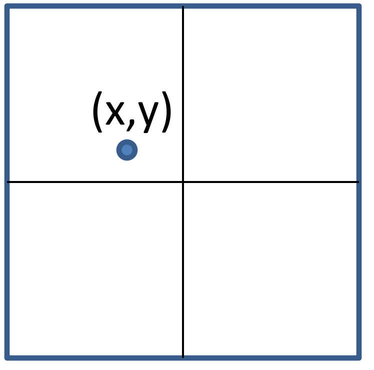
- Implement the Sobel operator, produce both the magnitude and orientation of the edges, and display them.
- void SobelImage(QImage *image)
- Use the standard Sobel masks:

```
-1,  0,  1,
-2,  0,  2,
-1,  0,  1

 1,  2,  1,
 0,  0,  0
-1, -2, -1
```

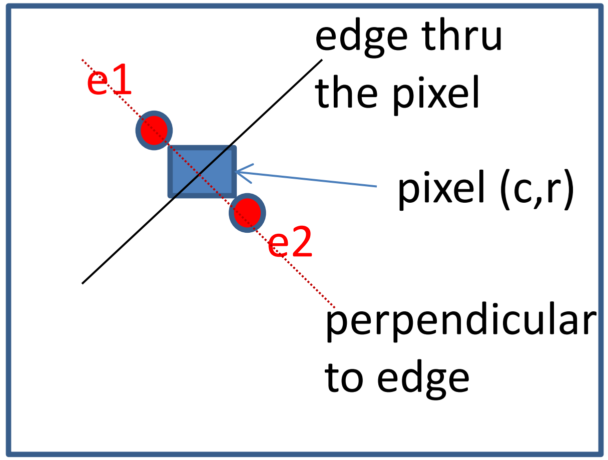
7. Bilinear Interpolation

- Given an image and a real-valued point (x,y), compute the RGB values for that point through bilinear interpolation.
- void BilinearInterpolation(QImage *image, double x, double y, double rgb[3])
- Put the red, green, and blue interpolated results in the vector rgb.



8. Find Peaks of Edge Responses

- This function finds the peaks of the edge responses perpendicular to the edges.
- void FindPeaksImage(Qimage *image, double thres)
- It first uses Sobel to find the magnitude and orientation at each pixel.
- Then for each pixel, it compares its edge magnitude to two samples perpendicular to the edge at a distance of one pixel, which requires BilinearInterpolation.
- If the pixel edge magnitude is e and these two are e1 and e2, a peak e must be larger than “thres” and larger than e1 and e2.
- See next slide.



$$e1x = c + 1 * \cos(\theta);$$
$$e1y = r + 1 * \sin(\theta);$$
$$e2x = c - 1 * \cos(\theta);$$
$$e2y = r - 1 * \sin(\theta);$$

Example: $r=5$, $c=3$, $\theta=135$ degrees
$\sin\theta = .7071$, $\cos\theta = -.7071$
e1 =(2.2929,5.7071)
e2 = (3.7071, 4.2929)

9. Color Clustering

- Perform K-means clustering on a color image first with random seeds and then by selecting seeds from the image itself.
- void RandomSeedImage(QImage *image, int numb_clusters)
- void PixelSeedImage(QImage *image, int numb_clusters)
- Use the RGB color space, and the distance between two pixels with colors (R1,G1,B1) and (R2,G2,B2) is |R1-R2|+|G1-G2|+|B1-B2|.
- Use max iteration# = 100