Exercise in Feature Extraction

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This is the exercise in feature extraction for course 02501. This exercise covers/illustrates the material of Chapter three of my lecture notes. In this exercise you are expected to write the code for the Harris corner detector, as well as try the Canny edge detector.

The images you are expected to work with are:

```
TestIm1.bmp
TestIm2.bmp
House1.bmp
House2.bmp
```

Which should be located together with this text.

1 Harris Corner Detector

You should implement Harris corner detector and apply it to the image `TestIm1.bmp`. To do this you should start off by calculating the derivatives of the gaussian smoothed image. The following MatLab code is a way of doing this

```
t=sigma*sigma;
x=-3*ceil(sigma):3*ceil(sigma);
g=exp(-x.*x./(2*t))/sqrt(2*pi*t);
gx=(-x/t).*exp(-x.*x./(2*t))/sqrt(2*pi*t);

Ix= filter2(gx,im,'same');
Ix= filter2(g',Ix,'same');
Iy= filter2(g,im,'same');
Iy= filter2(gx',Iy,'same');
```

NB: It is assumed that `sigma` and `im` are specified before running this code.

1. **Question:** Why is the rang of `x` set as it is?
2. **Question:** Based on the above code, how would you perform *only* gaussian smoothing, i.e. *without* differentiation? NB: This is not a step in the Harris corner detector.
3. **Task:** Calculate the 3 components of the $\mathbf{C}(x,y)$ matrix

$$\mathbf{C}(x,y) = \begin{bmatrix} g_\sigma * I_x(x,y)^2 & g_\sigma * I_x(x,y)I_y(x,y) \\ g_\sigma * I_x(x,y)I_y(x,y) & g_\sigma * I_y(x,y)^2 \end{bmatrix} .$$

   Display the images.

4. **Task:** Implement the Harris score

$$r(x, y) = ab - c^2 - k(a + b)^2 \ ,$$

and display it.

5. **Task:** What is the maximum $r(x, y)$ value?

6. **Task:** Threshold the $r(x, y)$ image with a threshold value set as an appropriate percentage of the above calculated maximum. Display the result for varying thresholds.

7. **Task:** Do non-maximum suppression on the pixel positions which are above your chosen threshold above. The remaining pixels are your corner pixels. Display the result.

8. **Task:** Extract the coordinates of the Harris corners x, y, and display on the original image via

```
imagesc(im)
colormap gray
hold on
plot(x,y,'.')
hold off
```

9. **Task:** Apply your Harris corner detector to the two images `House1.bmp` and `House2.bmp`, and display the results.

2 Canny Edge Detector

As well as many other imaging operations the Canny edge detector is available in MatLab. This functionality is available via the function `edge`, try e.g. typing `helpwin edge`.

1. **Task:** Figure out how to run MatLab's Canny Edge detector and apply it to the four images.

2. **Task:** What is the effect of the two threshold parameters in the Canny Edge detector, specifically on `TestIm2.bmp`.