Exercise Sheet Computer Vision 7

Submission: 30.06   (30 Points)

Exercise 1   Convolution   (6 Points)

a) What is a convolution? What operations can be represented in this format?
(2 Points)

b) What is a kernel? Make an example of a squared one   (1 Points)

c) Can you think of operations that cannot be represented as a convolution? Why?   (3 Points)

Exercise 2   Edge Detection   (14 Points)

a) Explain, considering the given code sample, each step of the Sobel-Algorithm. What is it used for? What are the two mathematical concepts behind this algorithm? Individuate their implementation in the code.

```
function sobel(Image image) {
    int[][] Sx = { {-1,0,1},  {-2,0,2}, {-1,0,1} };
    int[][] Sy = { {-1,-2,-1}, {0,0,0}, {1,2,1} };
    for (int x=1;x<image.getWidth()-1;x++)  {
       for (int y=1;y<image.getHeight()-1;y++)  {
       int intensity_sum_x=0, intensity_sum_y=0;
      for (int i=-1;i<=1;i++) {
            for (int j=-1;j<=1;j++) {
int intensity = image.getintensity(x+i, y+j);
intensity_sum_x+=(intensity*Sx[1-j][1-i]);
intensity_sum_y+=(intensity*Sy[1-j][1-i]);
            }
       }
int new_intensity = sqrt((intensity_sum_x)*(intensity_sum_x)
+(intensity_sum_y)*(intensity_sum_y));
edges_image.setIntensityPixel(x, y, new_intensity);
      }
      }
    return edges_image;
}
```

b) Compute the LoG matrix given the (1) Laplacian

$$L = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

and (2) the Gaussian

$$G = \begin{bmatrix} 0.0625 & 0.125 & 0.0625 \\ 0.125 & 0.25 & 0.125 \\ 0.0625 & 0.125 & 0.0625 \end{bmatrix}$$

and (3)the discrete convolution defined as follows:

$$y(m, n) = x(m, n) \otimes h(m, n) = \sum_{i=-1}^{1} \sum_{j=-1}^{1} x(i, j) h(m - i, n - j); \quad (1)$$

Keep the axis as follows: m and i increasing moving to the right and n and j increasing moving downward in the image.
(8 Points)

Exercise 3 Harris Corners and SIFT (10 Points)

a) What is a point of interest in an image? How is it defined? Which image properties can be used to find such points?   (3 Points)

b) Explain the Harris-Corner pseudo code   (4 Points)

c) What are the differences between Harris Corners and SWIFT features? (3 Points)