Course Title	Computer Vision	Course Code	CCE4238

Sheet2
Image Filtering and Edge Detection

1. Image Filtering

1. Consider the kernel of a linear filter, *H*, given below.

$$H(i,j) = \begin{bmatrix} -1 & -2 & 0 \\ -2 & 0 & 2 \\ 0 & 2 & 1 \end{bmatrix}$$

   a) What type of a linear filter does *H* represent? (i.e. Smoothing Filter or Difference Filter)

   b) Suppose that the filter is applied to an 8-bit grayscale image (i.e. with pixel values in the range 0:255). Determine the possible maximum and minimum pixel values in the resulting image. Assume that no clamping of the results occurs.

   c) Determine the impulse response of the filter.

   d) Is there a difference between convolving an image or filtering an image with this filter? Why?

   e) Is this an isotropic filter?

2. Explain the effect of a separable 2D linear filter, whose 1D components are the filter [1 0 0] and its transpose.

2. Edge Detection

1. Express the Sobel operator in x/y-separable form.

2. For the gray scale image below, compute the gradient vector, the gradient magnitude, and the gradient orientation at pixel (3,3). Use the filter [−1 0 1] to compute gradients.

   If pixel (3,3) lies on an edge in the image, what is the orientation of the edge at this location?

	1	2	3	4	5
1	100	111	97	100	105
2	107	111	107	105	115
3	117	100	117	110	128
4	111	105	111	120	122
5	100	110	100	110	100

3. In an implementation of Canny's algorithm for edge detection, the orientations are approximated to the closest angle in the set {0, 45, 90 ,135}. Consider applying the algorithm on an image patch whose gradient magnitude values are shown below. Suppose that the gradient vector at pixel (3,3) makes a 30 degrees angle with the vertical axis of the image, as shown in the figure. Answer the following questions considering the behaviour of the aforementioned implementation of Canny's algorithm at the pixel (3,3).

	1	2	3	4	5
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.95	0.90	0.67	0.00
3	0.00	0.80	0.98	0.35	0.00
4	0.00	0.10	0.50	0.75	0.00
5	0.00	0.00	0.00	0.00	0.00

(a) What are the other two pixels that the algorithm will consider in the maximum suppression step?

(b) Determine whether the algorithm will suppress the pixel at (3, 3) or keep it for further processing.

(c) Suppose that the high and low thresholds are set to 0.82 and 0.51, respectively. Explain how the pixel at (3, 3) and its neighbours will be handled in the hysteresis thresholding step.

Best Wishes,