2812ICT Perceptual Computing
Midterm Test
Duration: 60 minutes
Date: 7/9/2021

Name: Sebastian Perry Student ID: S5132483

This exam consists of 3 questions worth a total of 15 marks.

Question 1 (6 marks):

An 8-bit grayscale image consists of a rectangular array of integer values, called pixels, within the range [0-255]. Bob wanted to create an indexing scheme to his photo album. He proposed to describe each of the image in his album using the histogram distribution computed from the pixel values within the image.

(a) (2 marks) What is one main problem with this scheme?

The main problem that could come about from indexing images in such a fashion would be the potential for collisions, for example in the week 3 lecture alone we shuffled the positions of the pixels around and it produced an unarguably different image that had the same histogram. Apart from that example while it may be unlikely it would still be possible for completely different and unrelated images to have the same histogram.

(b) (2 marks) While still using histogram of pixel value, could you suggest one straightforward way to overcome the problem you identify in part (a)?

In order to remedy this issue, I would suggest continuing to use the histogram method with the addition of generating a hash as well in order to prevent collisions in the event of 2 images falling upon the same histogram index.

(c) (2 marks) Sketch how you would implement such a photo indexing system using pseudo-code or diagram like a flowchart. Make sure that it is logical and implementable.

In answering the questions above, illustrate your answer with diagram if necessary.

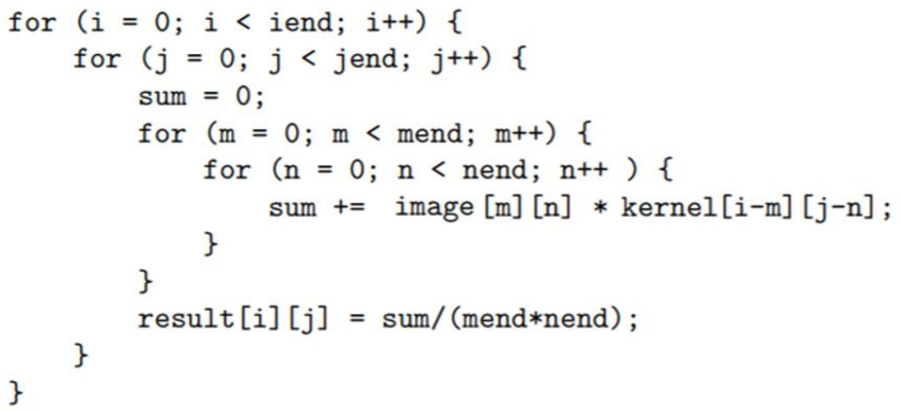
```
#Indexing

Histo = Generate the histogram(image)

Hash = Generate the hash(image)

Scheme[Histo][Hash] = image
```

Question 2 (3 marks):
What is the following block of code doing over the image array image[i][j] as it computes the resulting new image array result[i][j]?
(a) (1 marks) Give the mathematical name for this operation

Convolution / Moving Average in 2D

(b) (2 marks) Give a computer vision task that might use this block of code

A filtering / smoothing task may use this code in order to reduce the impact of errors, outliers, and noise in the image, with this being said it will have the effect of blurring the image



```
for (i = 0; i < iend; i++) {
    for (j = 0; j < jend; j++) {
        sum = 0;
        for (m = 0; m < mend; m++) {
            for (n = 0; n < nend; n++ ) {
                sum +=  image [m] [n] * kernel[i-m] [j-n];
            }
        }
        result[i] [j] = sum/(mend*nend);
    }
}
```

Question 3 (6 marks):

In many computer vision systems, edge detection is a fundamental step. One well-known approach, Canny edge detection, involves the following operations:

1. Filter the image with x and y derivatives of Gaussian to obtain the gradient images
2. Find the magnitude and orientation of the gradient images
3. Perform non-maximum suppression
4. Perform hysteresis thresholding

(a) (2 marks) Describe how you can compute the magnitude and orientation of the edges in the image

In order to calculate the magnitude and orientation of edges found within the image you first need to calculate the calculate the first derivative in the Gx and Gy dimensions, with these the edge magnitude and orientation can be calculated for each pixel using the formulas below

$$(G) = \sqrt{G_x^2 + G_y^2}$$

$$\theta) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

Source
https://medium.com/swlh/computer-vision-lane-finding-through-image-processing-516797e59714

(b) (2 marks) Describe and explain the purpose of non-maximum suppression

Non-Maximum Suppression is the last stage in detecting the desired object within an image, it’s when the computer will process down a list of proposed object boundary boxes in an attempt to try and create a boundary box which best fits and encapsulates the object in question.

(c) (2 marks) Describe and explain the purpose of Hysteresis thresholding
Illustrate/explain your answer with diagram if necessary.

The purpose of Hysteresis thresholding is to attempt to reduce the amount of noise in the image that may have been falsely identified in addition to the desired detection of the actual edges