

## Exam - Computer Vision

Date: 19/01/2022

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Duration: 2 hours

### Part I - Fundamental Topics (10 points)

1. **Digital Image.** Consider an image where the only component of the color present is the *intensity* of each pixel, represented in Figure 1. The image is in digital format, has a 5x5 resolution and an 8-bit quantization.

|     |     |     |     |     |
|-----|-----|-----|-----|-----|
| 0   | 100 | 100 | 100 | 100 |
| 150 | 150 | 150 | 150 | 150 |
| 150 | 150 | 150 | 150 | 150 |
| 150 | 150 | 200 | 200 | 200 |
| 200 | 200 | 200 | 200 | 255 |

I Component

**Figure 1**

- a) Calculate the histogram of the image *intensity*. Present the calculations made and the final result in chart form. (2 points)
  - b) Apply a *contrast stretching* operation to the image represented in Figure 1. Present the calculations made and the final result in matrix form (1 point).
  - c) Discuss and apply a strategy that makes it more effective to apply a *contrast stretching* operation to the image in Figure 1. Present the calculations made and the final result in matrix form (3 points)
2. **Digital Filters** Consider the image represented in Figure 2, where each value corresponds to the *intensity* of the color at that point. The image is in digital format, has 4x4 dimension and has a 4-bit quantization.

|    |    |   |   |
|----|----|---|---|
| 10 | 10 | 5 | 5 |
| 10 | 10 | 5 | 5 |
| 0  | 0  | 5 | 5 |
| 0  | 0  | 0 | 0 |

Figure 2

- a) Apply one of *Sobel's* filters to the image depicted in Figure 2, with size 3x3, over the gray area of image. Present the calculations you find relevant and the final result in matrix form. (2 points)
- b) Explain what quantity is being calculated with this filter, and how it can be used to build an edge detector algorithm. (2 points)

**Part II - Advanced Topics (10 points)**

**3. Segmentation**

- a) Identify and explain the 3 fundamental steps present in most region-based segmentation algorithms. Describe the implementation of these 3 steps for a *region merging* algorithm (2 points)
- b) Explain the concept of semantic segmentation by comparing it with conventional segmentation (1 point)

**4. Neuronal Networks**

- a) Describe the McCulloch-Pitts neuron model, and how these neurons can be combined to form an artificial neural network. (2 points)
- b) Briefly describe the architecture and operation of a convolutional neuronal network. (2 points)
- c) What are the advantages of a *convolutional neural network* compared with a network with only *fully connected layers*? (2 points)
- d) Explain the operation of an artificial neuronal network of the *autoencoder* type. (1 point)