Exam – Visão Computacional

Data: 18/01/2020
Docente: Miguel Tavares Coimbra
Duração: 2 horas

Part I – Core (10 points)

1. **Digital Image.** Consider the image represented in Figure 1, in analog format, with 3x3 resolution. Each value represents the *intensity* of the colour of that pixel, and varies continuously between 0 and 20.

11.1	11.3	18.1
8.4	5.4	4.9
0.3	4.2	3.3

Figure 1

   a) Consider that you have to design a computer vision system, with an internal memory of 2MBits, and that you need to record at least an hour of video, with a sampling rate of 10 Hz, and with the format described for Figure 1. What is the quantization that you would choose for the digitalization of your image? Justify your answer. (2 points)
   b) What is the result of the application of a 2-bit quantization operation to the image represented in Figure 1? Present your calculations and the final result in the form of a matrix. (2 points)
   c) What is the maximum quantization error that you can obtain for each value, if you use a 2-bit quantization for images with the format described in Figure 1? (2 points)

2. **Digital Filters.** Consider the image represented in Figure 2, where each value corresponds to the *intensity* of the colour of that pixel. The image is represented in digital format, has 4x4 resolution and an 8 bit quantization.

100	100	50	50
100	100	50	50
0	0	50	50
0	0	0	0

Figure 2

   a) Apply a *Laplacian* filter to the image represented in Figure 2, of size 3x3, over the area marked in grey. Present the calculations you consider relevant and the final result in the form of a matrix. (2 points)
   b) Apply the same filter to the pixel located in the top right corner of the image (value 50). Present your calculations and justify your answer. (2 points)

Part II – Advanced (10 points)

3. **Advanced Segmentation.** Accurately describe the various elements of an *active contours* algorithm. Use formulas whenever you feel adequate, or alternatively describe the specific details using your own words.
   - **a)** Data structure (1 point)
   - **b)** Internal energy (2 points)
   - **c)** External energy (2 points)

4. **Neural Networks**
   a) Describe a McCulloch-Pitts artificial neuron model, and how these neurons can be combined to form the structure of a neural network. (2 points)
   b) Briefly describe the architecture and operation of a convolutional neural network. (2 points)
   c) Explain how you would use a convolutional neural network to create an algorithm capable of detecting skin cancer lesions on dermoscopy images. (1 point)