Exame – Visão Computacional

Data: 18/01/2019
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Duração: 2 horas

Part I (10 points)

1. **Digital Filters.** Consider the image represented in Figure 1, where each value corresponds to the *intensity* of the color of this pixel. The image is in digital format, its resolution is 4x4, and has an 8-bit quantization.

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

Figure 1

   a) Apply a *Gaussian* filter of size 3x3 to the area marked in grey of the image represented in Figure 1. Present all relevant calculations and the final result in the form of a matrix. (2 points)
   b) Apply a *contrast stretching* operation to the image represented in Figure 1. Use the original image, and not the one processed in the previous exercise. Present all relevant calculations. (2 points)
   c) What algorithm would you choose to segment the image represented in Figure 1? Justify your choice, explain the chosen algorithm, and present the final result of this segmentation. (2 points)

2. **Morphological Filters.**
   a) Apply an *opening* operation to all points of the image represented in Figure 2. Use the 3x3 mask represented in Figure 3. Present the final result in the form of a matrix, as well as all relevant calculations and explanations you consider relevant. (2 points)
   b) Which algorithm should you use to count the number of connected components resulting from this operation? Describe using your own words how this algorithm works. (2 points)

0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1
0	0	0	1	1	1	1	1
0	0	0	0	1	0	0	0

Figure 2

0	1	0
1	1	1
0	1	0

Figure 3

Part II (10 points)

3. **Advanced Segmentation**
    a) Identify the fundamental difference between *segmentation by clustering* algorithms and *segmentation by fitting* algorithms. Explain in which situations it is more adequate to use each strategy. Give an example of an algorithm of each type. (3 points)
    b) How can we model the *external energy* of an *active contours* algorithm? Support your explanation using the diagrams or formulas that you consider adequate. (2 points)
    c) The more recent statistical learning algorithms of the *deep learning* type enable a type of advanced segmentation in which most of the computational effort is on the individual classification of each pixel. Generically describe how this type of algorithms works and identify one type of neural network architecture that is adequate for this purpose. (1 point)

4. **Local Invariant Descriptors.** SIFT (Scale Invariant Feature Transform) is one of the most popular algorithms for extracting local invariant descriptors of an image.
    a) Describe how SIFT identifies the salient points of an image. Be rigorous in your description or use adequate mathematical equations for support. (2 points)
    b) Explain how SIFT searches for salient points across multiple scales, and selects the most adequate one. (2 points)