Digital Image Processing, 2017

Exercise 5

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Problem 16: Morphological Filters

The two basic morphological operations on binary images, erosion and dilation, can be combined in two ways: Erosion followed by dilation is called *opening*, and dilation followed by erosion is called *closing*.

a) What is the effect of closing on lines?

b) What is the effect of opening on lines?

c) How to make a morphological operation (opening or closing) affect only, e.g., vertical lines?

d) What is different if we use a 5×5 structural element (instead of 3×3 as in the lecture) in morphological operations (erosion, dilation, opening, closing)?

Problem 17: Connected components

How can the algorithm to mark and count connected components be extended so that during the second pass through the image also the area of each connected component is determined?

Problem 18: Chain code and curvature code

a) What is the chain code and the curvature (boundary) code of

```
          E
          A
            A
            A
      A A A
E A A
```

Note: The letter "E" just denotes the endpoints of a line, the letter "A" a pixel in the line. Start at both ends and compare the results.

b) How does the curvature code of a triangle look, how the curvature code of a rectangle? Can we use the curvature code to distinguish rectangles from triangles?

c) How about the chain code of triangles and rectangles - is it useful as well?

Problem 19: Co-occurrence matrix

Two images contain black and white pixels. One image is black in the left half and white in the right half, the other one has alternating black and white (pixelwise checkerboard).

For each of the two images, calculate the co-occurrence matrix A for horizontal neighbors (i.e., $\boldsymbol{p} = (1, 0)$). Note that as there are only 2 grey levels (black and white), the co-occurrence matrix is only a 2 by 2 matrix. Normalise the the matrix such that its 4 elements add up to 1.0.

Which is the most frequent grey-level combination for each image? Explain the difference.

For both matrices, calculate

a) the "inertia":

$$I = \sum_{i=0}^{1} \sum_{j=0}^{1} (i - j)^2 A_{ij}$$

b) the "energy":

$$E = \sum_{i=0}^{1} \sum_{j=0}^{1} A_{ij}^2$$

c) the "entropy":

$$H = -\sum_{i=0}^{1} \sum_{j=0}^{1} A_{ij} \log A_{ij}$$

Comment on the result.