Exercise Image Processing

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Sheet 6

In this exercise we cover the chapters *Nonlinear Filters*, *Geometric Transformations*, and *Structure*. The questions are small-part and can be seen as examples of potential exam problems. Also use the formulary for the exam to work through the problems.

Task 6.1: Nonlinear Filters

6.1a)

Apply non-maximum suppression to the following 3x3 neighborhood without considering orientation:

0	3	9
3	8	3
9	3	0

Draw the direction of the steepest descent. What value results from the non-maximum suppression according to Canny?

6.1b)

What class does the anchor point of the following Canny classification into weak (1) and strong (2) edges receive when a hysteresis filter is applied?

1	2	1
0	1	0
0	0	0

What result do you get if the anchor point was not classified as an edge?

Task 6.2: Geometric Transformations & Interpolation

6.2a)

Which coordinate transformations can be realized with an affine 2D mapping?

- ☐ Translation
- ☐ Point reflection
- ☐ Bilinear mapping
- ☐ Shear
- ☐ Axis mirroring
- ☐ Destilation

6.2b)

given is the following geometric transformation:

$$\begin{aligned} x' &= 1 + 2x \\ y' &= 4 - 2y \end{aligned}$$

Is the inverse mapping existent? if yes, what does the inverse mapping look like?

6.2c)

The table shows different types of interpolation and their properties are given. Decide which properties belong to which interpolation types.

	Nearest-Neighbor Interpolation	Bilinear Interpolation	Bikubic Interpolation
light smoothing, few artifacts			
false high frequencies are created, lots of artefacts			
high frequencies are dampened, strong smoothing			

6.2d)

Perform bilinear interpolation for the gray value at location $G(6.5, 8.5)$ when the gray values $G(6,8)$, $G(6,9)$, $G(7,8)$, $G(7,9)$ are given as follows:
What value would you get from a nearest neighbor interpolation?

	6	7
8	6	8
9	2	4

Task 6.3: Gradient & Structure

6.3a)

Which scalar derived quantity of the Hessian matrix is invariant to rotations?

6.3b)

Show by a short calculation that the magnitude of the 2D gradient is invariant to rotations of the coordinate system.

Hint: A 2D rotation by the angle ϕ is given by the rotation matrix $\mathbf{R} = \begin{bmatrix} cos(\phi) & sin(\phi) \\ -sin(\phi) & cos(\phi) \end{bmatrix}$.