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Lappeenranta University of Technology

LUT Mathematics and Physics

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BM40A1200 Digital Imaging and Image Preprocessing

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Exercise 10: Imaging and geometry

1. Basic geometric transformations (1 point): Derive the necessary transformation matrices for the 2-D cases below.

(a) Translation of a point according to Fig. 1.

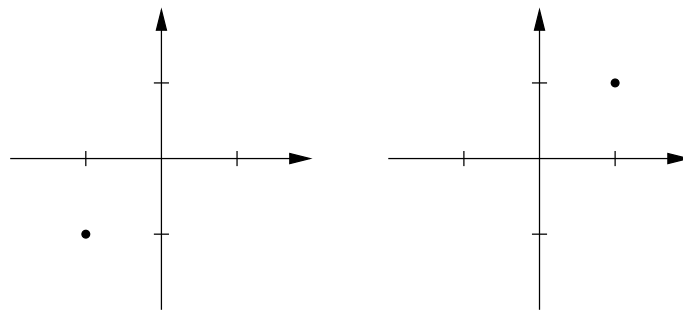


Figure 1: A point.

(b) Translation and scaling of a circle according to Fig. 2.

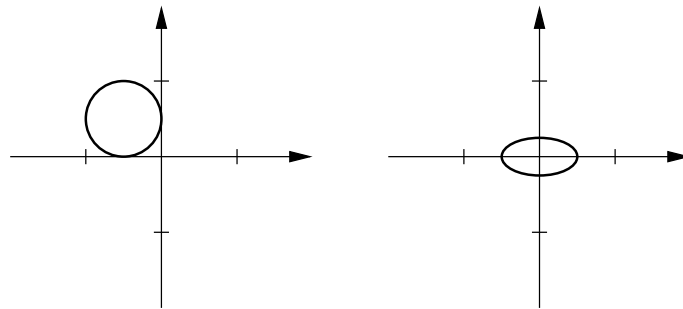


Figure 2: A circle.

(c) Rotation of a rectangle according to Fig. 3.

2. Radial distortion (2 points): A typical geometric distortion, usually due to wide-angle optics, is the radial distortion. An elementary distortion of this type can be modelled as follows:

$$r_d = r(1 + kr^2) \quad (1)$$

where r is the Euclidean distance of a point from the image centre, r_d is the distance of that point after distortion, and k is the degree of distortion (radial distortion coefficient).

Select a suitable image and perform varying degrees of radial distortions on the image.

If wanted, what would be needed to correct a radially distorted image?

Additional resources: `cart2pol`, `pol2cart`, `imwarp`.

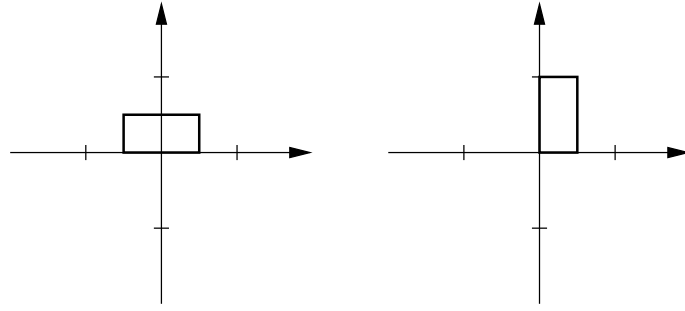


Figure 3: A rectangle.

3. Basic camera model (1 point): Let us assume a distortionless perspective camera with the optical axis along the (positive) z axis and the parameters given in Table 1. Determine the locations of the following point sets projected onto the virtual image plane.

Table 1: Camera parameters.

Parameter	Value
Focal length f	1
Principal point O	$(0, 0, 0)$

- (a) The point set is as follows:

$$P = \left\{ \begin{pmatrix} 0, 0, 3 \\ 1, 0, 3 \\ 1, 1, 3 \\ 0, 0, 3 \end{pmatrix} \right\}.$$

- (b) The point set is as follows:

$$P = \left\{ \begin{pmatrix} 0, 1, 3 \\ 1, 1, 3 \\ 1, 1, 4 \\ 0, 1, 4 \end{pmatrix} \right\}.$$