Handout Computer Vision

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1 Image Represantation

We can understand a greyscale Image as a function :

$I : \mathbb{R}^2 \longrightarrow [0, 255] : (x, y) \mapsto I(x, y)$

2 2D-Transformations

2.1 Homogenous Coordinates

Let $K \subset \mathbb{R}^2$ be a 2D. We construct a homogenous coordinate system by choosing a fixed $h \in \mathbb{R}$ and transforming for each $(x, y) \in K$:
$(x, y) \Rightarrow (x_h, y_h, h)$
$x_h = x * h$
$y_h = y * h$

2.2 Translation

2D-Coordinates

$\mathrm{x}' = x + t_x$
$\mathrm{y}' = y + t_y$

Homogenous Coordinates

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \end{bmatrix} \begin{bmatrix} x_h \\ y_h \\ h \end{bmatrix}$$

2.3 Rotation

2D-Coordinates

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Homogenous Coordinates

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \end{bmatrix} \begin{bmatrix} x_h \\ y_h \\ h \end{bmatrix}$$

2.4 Scalling

2D-Coordinates

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Homogenous Coordinates

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \end{bmatrix} \begin{bmatrix} x_h \\ y_h \\ h \end{bmatrix}$$

3 Filtring

3.1 Kernels

Blurring

Mean

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Gaussian

$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Sharpening

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

Laplace

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Sobbel

$$G_x = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$$

$$G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

$$G = \sqrt{G_x^2 + G_y^2}$$

4 Edge Detection

4.1 Image gradient

We did understand $I(x, y)$ as a function. Thus $\lambda I(x, y)$ points in the direction where I increases the strongest.

With $t_x = t_y = 1$