

Übungsblatt 2

Donnerstag, 12. November 2020 12:46

$$\textcircled{2} \quad K = \begin{pmatrix} 2451,11 & 0 & 1032,52 \\ 0 & 2459,52 & 615,4 \\ 0 & 0 & 1 \end{pmatrix}$$

$$w = 2048 \text{ px} \quad W = 5,27 \text{ mm}$$

$$h = 1536 \text{ px} \quad H = 3,96 \text{ mm}$$

$$\left. \begin{array}{l} k_u = 2451,11 \text{ px} \\ k_v = 2459,52 \text{ px} \end{array} \right\} \begin{array}{l} \text{focal length} \\ \text{with respect to} \\ \text{pixel size} \end{array}$$

$$\bar{f}_u = k_u \frac{W}{w} \quad \text{"focal length in mm"}$$

$$= 2451,11 \text{ px} \cdot \frac{5,27 \text{ mm}}{2048 \text{ px}}$$

$$\approx 6,31 \text{ mm} \quad \text{Focal length of the camera in u direction}$$

$$\bar{f}_v = k_v \frac{H}{h}$$

$$= 2459,52 \text{ px} \cdot \frac{3,96 \text{ mm}}{1536 \text{ px}}$$

$$\approx 6,34 \text{ mm} \quad \text{Focal length of the camera in v direction}$$

\Rightarrow 2 different focal lengths, because pixels are non squared
(see aspect ratio of pixel (k_u/k_v))

$\textcircled{3}.2$ Determine the related camera matrix

$$MM^T = K \underbrace{RR^T}_I K^T = K K^T = \begin{pmatrix} k_u & s & x_u \\ 0 & k_v & x_v \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} k_u & 0 & 0 \\ s & k_v & 0 \\ x_u & x_v & 1 \end{pmatrix}$$

$$= \begin{pmatrix} k_u^2 + s^2 + x_u^2 & sk_v + x_u x_v & x_u \\ sk_v + x_u x_v & k_v^2 + x_v^2 & x_v \\ x_u & x_v & 1 \end{pmatrix} = \begin{pmatrix} a & b & c \\ b & d & e \\ c & e & 1 \end{pmatrix}$$

$$MM^T = \begin{pmatrix} 490 & -390 & -1500 \\ -390 & -590 & -0,5\sqrt{2} \\ -1500 & -0,5\sqrt{2} & 1 \end{pmatrix}$$

$$MM^T = \begin{pmatrix} 450 & -350 & -1500 \\ -550 & 1400 & -600 \\ -0,5\sqrt{2} & -0,3\sqrt{2} & -0,4\sqrt{2} \end{pmatrix} \begin{pmatrix} 450 & -550 & -0,5\sqrt{2} \\ -350 & 1400 & -0,3\sqrt{2} \\ -1500 & -600 & -0,4\sqrt{2} \end{pmatrix}$$

$$= \begin{pmatrix} 2642200 & 64900 & 472\sqrt{2} \\ 64900 & 2668100 & 115\sqrt{2} \\ 472\sqrt{2} & 115\sqrt{2} & 1 \end{pmatrix}$$

Comparing entries in order $\begin{pmatrix} 5 & 4 & 2 \\ & 3 & 1 \end{pmatrix}$ we get:

$$1) x_v = e = 115\sqrt{2}$$

$$2) x_u = c = 472\sqrt{2}$$

$$3) k_v^2 + x_v^2 = d \Rightarrow k_v = \sqrt{d - x_v^2} \Rightarrow k_v = 1633,36 = \sqrt{2668100 - (115\sqrt{2})^2}$$

$$4) sk_v + x_u x_v = b \Rightarrow s = \frac{b - x_u x_v}{k_v} \Rightarrow s = \frac{b - ce}{\sqrt{d - e^2}} \approx 64833,54$$

$$5) k_u = \sqrt{a - \frac{(b - ce)^2}{d - e^2} - c^2} \approx 1625,19$$

$$\Rightarrow K = \begin{pmatrix} 1625,19 & 64833,54 & 472\sqrt{2} \\ 0 & 1633,36 & 115\sqrt{2} \\ 0 & 0 & 1 \end{pmatrix}$$

$$(3.3) R = K^{-1}M$$

$$K^{-1} = \left(\begin{array}{ccc|ccc} 1625,19 & 64833,54 & 472\sqrt{2} & 1 & 0 & 0 \\ 0 & 1633,36 & 115\sqrt{2} & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{array} \right) \cdot \begin{array}{l} \frac{100}{1625,19} \\ \frac{25}{40834} \\ \end{array}$$

$$K^{-1} = \left(\begin{array}{ccc|ccc} \frac{100}{1625,19} & -\frac{27013975}{1106050141} & \frac{8356138975\sqrt{2}}{3318150423} & 1 & 0 & 0 \\ 0 & \frac{25}{40834} & -\frac{2875\sqrt{2}}{40834} & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{array} \right)$$

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$$R = \begin{pmatrix} 12,19 & -35,94 & 11,72 \\ -0,29 & 0,899 & -0,31 \\ -0,7 & -0,42 & -0,57 \end{pmatrix}$$