Übungsblatt 2

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(2)

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

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

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

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

$F_u = k_u \frac{W}{w}$ „focal length in mm"

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

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

$F_v = k_v \frac{H}{h}$

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

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

=> 2 different focal length's, because pixel's are non squared (see aspectratio of pixel (k_u/k_v))

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(3).2 Determine the related camera matrix

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

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

$MM^T = ($ 490 -390 -1500 $)$ $($ 490 -590 $-0{,}5\sqrt{2}$ $)$

$$MM^T = \begin{pmatrix} 490 & -390 & -1500 \\ -590 & 1400 & -600 \\ -0{,}5\sqrt{2} & -0{,}3\sqrt{2} & -0{,}4\sqrt{2} \end{pmatrix} \begin{pmatrix} 490 & -590 & -0{,}5\sqrt{2} \\ -390 & 1400 & -0{,}3\sqrt{2} \\ -1500 & -600 & -0{,}4\sqrt{2} \end{pmatrix}$$

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

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

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

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

(✓)

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

$$K^{-1} = \left(\begin{array}{ccc|ccc} 1625{,}19 & 64833{,}54 & 472\sqrt{2} & 1 & 0 & 0 \\ 0 & 1633{,}36 & 115\sqrt{2} & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{array}\right) \begin{array}{l} \cdot \frac{100}{162519} \\ \cdot \frac{25}{40834} \\ \end{array}$$

$\vdots$

$$K^{-1} = \begin{pmatrix} \dfrac{100}{162519} & \dfrac{-27013975}{1106050141} & \dfrac{8356138975\sqrt{2}}{3318150423} \\ 0 & \dfrac{25}{40834} & \dfrac{-2875\sqrt{2}}{40834} \\ 0 & 0 & 1 \end{pmatrix}$$

$R = K^{-1} M$

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

ff

/2,5