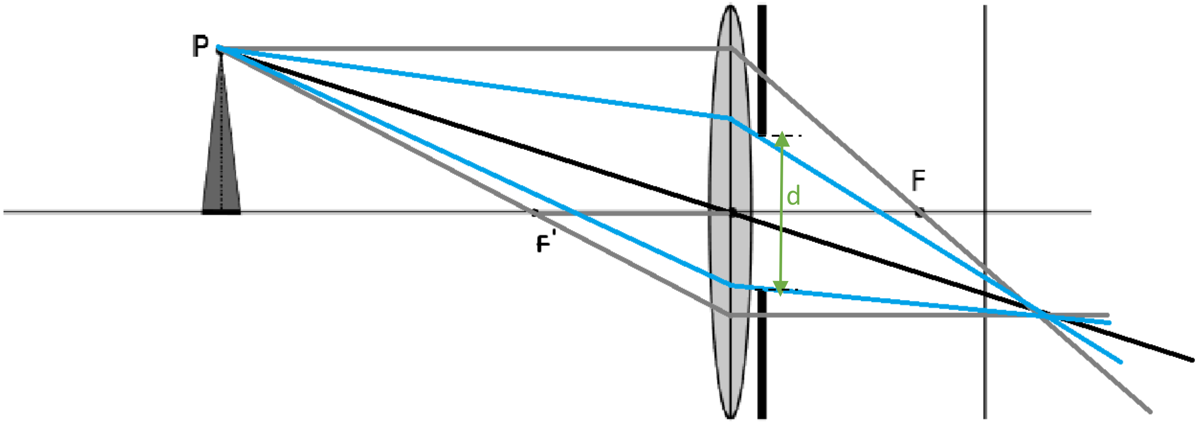
2D-Vision Blatt 3

Nr. 1



Nr. 2

$K = \begin{pmatrix} 2451{,}11 & 0 & 1032{,}52 \\ 0 & 2459{,}52 & 615{,}40 \\ 0 & 0 & 1 \end{pmatrix}$, Resolution $2048 \times 1536\, px$, Image Sensor $5{,}27 \times 3{,}96 mm^2$

$$K = \begin{pmatrix} m_u & 0 & 0 \\ 0 & m_v & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} f & 0 & h_u \\ 0 & f & h_v \\ 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} k_u & 0 & x_u \\ 0 & k_v & x_v \\ 0 & 0 & 1 \end{pmatrix}$$

⇨ $k_u = f * m_u$ $\qquad\qquad$ $k_v = f * m_v$

Focal lengths:

$$f_u = \frac{2451{,}11 * 5{,}27}{2048} = 6{,}31 \qquad\qquad f_v = \frac{2459{,}52 * 3{,}96}{1536} = 6{,}34$$

Nr. 3

Gegeben: $P = \begin{pmatrix} 490 & -390 & -1500 & 1300 \\ -590 & 1400 & -600 & 1300 \\ -0{,}5\sqrt{2} & -0{,}3\sqrt{2} & -0{,}4\sqrt{2} & 5 \end{pmatrix}$

Gesucht: Optical Center, Camera Calibration Matrix, Orientation

$$x_1 = \begin{vmatrix} p_{12} & p_{13} & p_{14} \\ p_{22} & p_{23} & p_{24} \\ p_{32} & p_{33} & p_{34} \end{vmatrix} = \begin{vmatrix} -390 & -1500 & 1300 \\ 1400 & -600 & 1300 \\ -0{,}3\sqrt{2} & -0{,}4\sqrt{2} & 5 \end{vmatrix} = 1{,}085 * 10^7$$

$$x_2 = -\begin{vmatrix} p_{11} & p_{13} & p_{14} \\ p_{21} & p_{23} & p_{24} \\ p_{31} & p_{33} & p_{34} \end{vmatrix} = -\begin{vmatrix} 490 & -1500 & 1300 \\ -590 & -600 & 1300 \\ -0{,}5\sqrt{2} & -0{,}4\sqrt{2} & 5 \end{vmatrix} = 4{,}27346 * 10^6$$

$$x_3 = \begin{vmatrix} p_{11} & p_{12} & p_{14} \\ p_{21} & p_{22} & p_{24} \\ p_{31} & p_{32} & p_{34} \end{vmatrix} = \begin{vmatrix} 490 & -390 & 1300 \\ -590 & 1400 & 1300 \\ -0{,}5\sqrt{2} & -0{,}3\sqrt{2} & 5 \end{vmatrix} = 4{,}5206 * 10^6$$

$$x_4 = -\begin{vmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \\ p_{31} & p_{32} & p_{33} \end{vmatrix} = -\begin{vmatrix} 490 & -390 & -1500 \\ -590 & 1400 & -600 \\ -0{,}5\sqrt{2} & -0{,}3\sqrt{2} & -0{,}4\sqrt{2} \end{vmatrix} = 2{,}40849 * 10^6$$

Optical Center: $\tilde{c} = (x_1, x_2, x_3, x_4)^T$

$$P = [M|p] \qquad M = \begin{pmatrix} 490 & -390 & -1500 \\ -590 & 1400 & -600 \\ -0{,}5\sqrt{2} & -0{,}3\sqrt{2} & -0{,}4\sqrt{2} \end{pmatrix}$$

$$MM^T = KRR^TK^T = KK^T = \begin{pmatrix} 2642200 & 64900 & 667{,}51 \\ 64900 & 2668100 & 162{,}64 \\ 667{,}51 & 162{,}64 & 1 \end{pmatrix}$$

$$x_u = 667{,}51 \qquad x_v = 162{,}64$$

$$k_v = \sqrt{2668100 - x_v^2} = \sqrt{2668100 - 162{,}64^2} = 1625{,}31$$

$$s = \frac{64900 - x_u * x_v}{k_v} = \frac{64900 - 667{,}51 * 162{,}64}{1625{,}31} = -26{,}86$$

$$k_u = \sqrt{2642200 - s^2 - x_u^2} = \sqrt{2642200 - (-26{,}86)^2 - 667{,}51^2} = 1481{,}86$$

Camera Calibration Matrix: $K = \begin{pmatrix} 1481{,}86 & -26{,}86 & 667{,}51 \\ 0 & 1625{,}31 & 162{,}64 \\ 0 & 0 & 1 \end{pmatrix}$

$$R = K^{-1} * M = \begin{pmatrix} \frac{50}{74093} & \frac{134300}{12042409383} & -\frac{10892791885}{24084818766} \\ 0 & \frac{100}{162531} & -\frac{16264}{162531} \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 490 & -390 & -1500 \\ -590 & 1400 & -600 \\ -0{,}5\sqrt{2} & -0{,}3\sqrt{2} & -0{,}4\sqrt{2} \end{pmatrix}$$
$$= \begin{pmatrix} 2{,}93 * 10^{-7} & -1{,}01 * 10^{7} & -0{,}97 \\ -2{,}4 * 10^{-8} & 3{,}41 * 10^{-7} & -0{,}49 \\ -3{,}48 * 10^{-7} & -1{,}29 * 10^{-7} & -0{,}19 \end{pmatrix}$$

Nr. 5

Gegeben: Vektoren $a = \begin{pmatrix} 17 \\ 42 \end{pmatrix}$, $b = \begin{pmatrix} 289 \\ 68 \end{pmatrix}$

Abstand: $\begin{pmatrix} 289 \\ 68 \end{pmatrix} - \begin{pmatrix} 17 \\ 42 \end{pmatrix} = \begin{pmatrix} 272 \\ 26 \end{pmatrix}$

Euklidischer Abstand

$$\sqrt{(289-17)^2 + (68-42)^2} = \sqrt{272^2 + 26^2} = \sqrt{73984 + 676} = \sqrt{74660} = 273{,}24$$

4 Neighborhood

Anzahl der $(x, y+1)$-Schritte $\quad |b_2 - a_2| = |68 - 42| = 26$

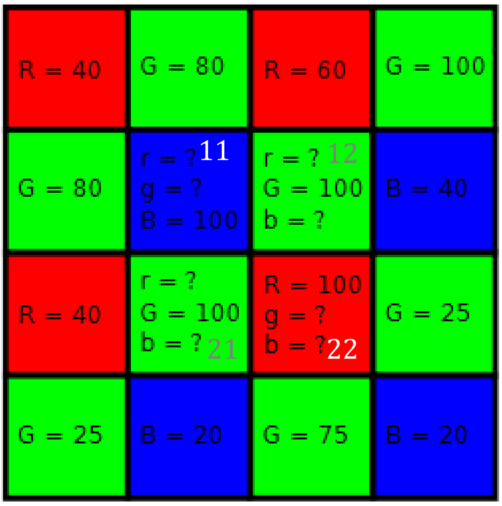
Anzahl der $(x+1, y)$-Schritte $\quad |b_1 - a_1| = |289 - 17| = 272$

Abstand 4-Neighborhood $\quad 26 + 272 = 298$

8-Neighborhood

Anzahl der $(x+1, y+1)$-Schritte	$\min(\lvert b_1 - a_1 \rvert, \lvert b_2 - a_2 \rvert) = \lvert 68 - 42 \rvert = 26$
Restliche Distanz	$b' = \begin{pmatrix} b_1 - a_1 - 26 \\ b_2 - a_2 - 26 \end{pmatrix} = \begin{pmatrix} 246 \\ 0 \end{pmatrix}$
Anzahl der $(x+1, y)$-Schritte	$b_1 - a_1 - 26 = b_1' = 246$
Abstand 8-Neighborhood	$26 + 246 = 272$

Nr. 6



$$r_{11} = \frac{R_{00}+R_{02}+R_{20}+R_{22}}{4} = \frac{240}{4} = 60$$

$$g_{11} = \frac{G_{01}+G_{10}+G_{12}+G_{21}}{4} = \frac{360}{4} = 90$$

$$r_{12} = \frac{R_{02}+R_{22}}{2} = \frac{160}{2} = 80$$

$$b_{12} = \frac{B_{11}+B_{13}}{2} = \frac{140}{2} = 70$$

$$r_{21} = \frac{R_{20}+R_{22}}{2} = \frac{140}{2} = 70$$

$$b_{21} = \frac{B_{11}+B_{31}}{2} = \frac{120}{2} = 60$$

$$g_{22} = \frac{G_{12}+G_{21}+G_{23}+G_{32}}{4} = \frac{300}{4} = 75$$

$$b_{22} = \frac{B_{11}+B_{13}+B_{31}+B_{33}}{4} = \frac{180}{4} = 45$$