

Symbol	Name	Formula	Description / Example
Homography			
\tilde{X}_i^c	Image coordinates	$\tilde{X}_i^c \sim \tilde{H}_b^c \cdot \tilde{p}_i^b$	
K_c	Calibration matrix, Camera matrix	$K_c = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix}$	If $c_x = c_y = 0$ the camera produces centered images
\tilde{x}	homogenous transformation	$\tilde{x} = K_c * \begin{bmatrix} x \\ y \\ z \end{bmatrix}$	for direction of light rays f.e.
\tilde{p}_i^b	Object point		Coordinates on the planar object
E_b^c	Camera extrinsic matrix	$E_b^c = \begin{bmatrix} R_b^c & t_{cb}^c \\ 0 & 0 & 0 & 1 \end{bmatrix}$	Relative pose between object and camera
E_c^g	Inverse rigid motion matrix	$E_c^g = (E_g^c)^{-1} = \begin{bmatrix} R_g^c & t_{cg}^c \\ \vec{0} & 1 \end{bmatrix} = \begin{bmatrix} R_c^g & -R_c^g t_{cg}^c \\ \vec{0} & 1 \end{bmatrix}$	
R_b^c	Rotation matrix	$R_b^c = \begin{bmatrix} r_x & r_y & r_z \end{bmatrix}$	
t_{cb}^c	Translation vector	$t_c^b = p^c - R_b^c * p^b$	
\vec{E}_g	Coordinate frame basis	$\vec{E}_g = \begin{bmatrix} \vec{e}_{g, x} & \vec{e}_{g, y} & \vec{e}_{g, z} \end{bmatrix}$	A coordinate frame consists of a basis and an origin
\vec{o}_g	Origin of the coordinate frame	\vec{o}	
\vec{p}	Point in the coordinate frame	$\vec{p} = \vec{e}_{g, x} \cdot p_x^g + \vec{e}_{g, y} \cdot p_y^g + \vec{e}_{g, z} \cdot p_z^g + \vec{o}_g$	
\vec{p}	Point in the coordinate frame	$\vec{p} = \vec{E}_g \cdot p^g + \vec{o}_g$	
H_b^c	Homography matrix	$H_b^c \sim K_c \cdot \begin{bmatrix} r_{b, x}^c & r_{b, y}^c & t_{cb}^c \end{bmatrix}$	
$r_{b, x}^c$	Rotation vector x	$r_{b, x}^c = \begin{bmatrix} 0 & -t_{cb, z}^c & t_{cb, y}^c \end{bmatrix}$	

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	Object point to image point	$\begin{bmatrix} x_{s,i} \\ y_{s,i} \\ 1 \end{bmatrix} = H_b^c \cdot \tilde{p}_i^b$	
Hough transform			
x_i, y_i	Image space coordinates	$y_i = m \cdot x_i + c \Leftrightarrow c = -m \cdot x_i + y_i$	Converted to parameter space, lines
θ	Angle of point	θ	angle between x and line in parameter space
ρ	Proper Line Parametrization	$\rho = x \cos(\theta) + y \sin(\theta)$	length of line
ρ		$\rho = \begin{bmatrix} x \\ y \end{bmatrix}^t \cdot n$	Test if a point is on a line
n	normal vector	$n = \begin{bmatrix} \cos(\theta) \\ \sin(\theta) \end{bmatrix}$	Defined by the θ angle
RANSAC probabilities			
ϵ	Probability of picking an outlier	$\epsilon = \frac{N_{outliers}}{N_{inliers} + N_{outliers}}$	with N = no of, s = points, n = no. of trials
	probability of picking individual inlier	$p = 1 - \epsilon$	
	probability of picking s inliers in sequence	$p = (1 - \epsilon)^s$	
	probability of not picking s inliers in sequence	$p = 1 - (1 - \epsilon)^s$	
	probability of not picking s inliers in sequence of n trials	$p = (1 - (1 - \epsilon)^s)^n$	

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	probability of picking at least in one of n trials s inliers in sequence	$p_{success} = 1 - (1 - (1 - \epsilon)^s)^n$	for lines 2 , for circles 3 points are needed
	expected number of trials needed	$n = \frac{\log(1 - p_{success})}{\log(1 - (1 - \epsilon)^s)}$	
Geometric transformation			
\tilde{x}	Intersection of two lines	$\tilde{x} = \tilde{I}_1 \times \tilde{I}_2$	cross product of two lines defines their intersection
\tilde{I}	two points lie on the line	$\tilde{I} = \tilde{x}_1 \times \tilde{x}_2$	cross product of two points define their collective line
Matrix basics			
E	unit matrix	$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$	
R^{-1}	Inverse rotational matrix	$R^{-1} = R^T$	
R_x	Rotational matrix around x	$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos & -\sin \\ 0 & \sin & \cos \end{bmatrix}$	
R_y	Rotational matrix around x	$R_y = \begin{bmatrix} \cos & 0 & \sin \\ 0 & 1 & 0 \\ -\sin & 0 & \cos \end{bmatrix}$	
R_z	Rotational matrix around x	$R_z = \begin{bmatrix} \cos & -\sin & 0 \\ \sin & \cos & 0 \\ 0 & 0 & 1 \end{bmatrix}$	

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Camera calculations			
F	Focal length in [mm]	$F = \frac{L * x_{chip}}{2 * W}$	$L =$ Length from sensor to object, $W =$ Width from sensor to object, all in [mm]
f_x	Focal length in [$\frac{pixel}{mm}$]	$f_x = \frac{F * x_{pixel}}{x_{chip}}$	$x_{pixel} =$ pixel in x-direction $x_{chip} =$ length of sensor chip in x-direction, analog for f_y with y_{pixel} and y_{chip}
f_x, f_y	Focal length (Assumption)	$f_x = f_y = f$	In some calculations just assume: focal length is the same in both directions
c_x, c_y	image center coordinates	$c_x = \frac{x_{pixel}}{2}$	optical axis pointing perpendicularly through sensor chip center, analog for f_y with y_{pixel} and y_{chip}