Practical Course: Vision-based Navigation (IN2106)

Exercise 3

Feature Detectors, Descriptors, Epipolar Geometry, RANSAC

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17.11.2018

Exercise 2: Epipolar Constraint

1. Derive the computation of the essential Matrix from the transformation between two cameras?

   Answer:

x_1 = Projection of 3D point X into camera 1

x_2 = " " " " X " " 2

λ_1 = Depth of " " X " " 1

λ_2 = " " " " X " " 2

Let $K = 1$ and for the first camera there is no rotation (R) and translation (T).

$\therefore$ The equations are:

$$\lambda_1 x_1 = X \qquad (1)$$

$$\lambda_2 x_2 = RX + T \qquad (2)$$

Inserting equation (1) into (2)

$$\lambda_2 x_2 = R(\lambda_1 x_1) + T$$

$$\Rightarrow \lambda_2 x_2 = \lambda_1 R x_1 + T$$

$$\Rightarrow \lambda_2 \hat{T} x_2 = \lambda_1 \hat{T} R x_1 + \hat{T} T$$

$$\Rightarrow \lambda_2 \hat{T} x_2 = \lambda_1 \hat{T} R x_1 \qquad [\because \hat{T} T = T \times T = 0]$$

$$\Rightarrow \frac{\lambda_2}{\lambda_1} x_2^T \hat{T} x_2 = x_2^T \hat{T} R x_1$$

$$\Rightarrow x_2^T \hat{T} R x_1 = 0 \qquad [\because \langle x_2, \hat{T} x_2 \rangle = \langle x_2, (T \times x_2) \rangle = 0]$$

The matrix $E = \hat{T} R$ is called essential matrix.