PCV Exercise 4

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1 Points on second camera plane

Projection points of two observed points on second view

Two points are marked on a 3D scene. Those points are projected to the coordinate $x_1 = (1, 0, 1)^T$ and $x_2 = (2, 1, 1)^T$ on the first camera plane. Given that Fundamental matrix F of this system as follow:

$$F = \begin{pmatrix} 0 & 1 & 0 \\ 1 & -1 & 0 \\ 1 & -1 & 0 \end{pmatrix}$$

With the Fundamental matrix F two epipolar lines can be computed as follow:

$$l'_1 = F \cdot x_1 = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$$

$$l'_2 = F \cdot x_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

We know that x'_1 and x'_2 *i.e.* the two points correspondent of x_1 and x_2 on the second image plane will lie on l'_1 and l'_2 respectively:

$$l'_1 : y + 1 = 0$$

$$l'_2 : x + y + 1 = 0$$

Epipole e_2

We know that at the epipole point e_2, the two epipolar lines intersect. With that we can compute epipole point e_2 as the cross product of the two lines l'_1 and l'_2:

$$e_2 = l'_1 \times l'_2 = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} \times \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix}$$

Now we can scale the epipole e_2 by multiplying it with -1 to obtain a homogenous coordinate:

$$e_2 = -1 \cdot \begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \\ 1 \end{bmatrix}$$

Epipole position change from convergent to stereo-normal view

In the stereo-normal view the epipolar lines are in parallel, since the two cameras will have the same orientation and position, except a translation in the x-axis. This means that the optical axis is parallel between the two cameras. Given that the epipolar lines are parallel, which means they intersect at infinity. We can derive that the epipole, where the epipole lines intersect, would be at infinity along the x-axis. Hence the new position of the epipole would be at $(1, 0, 0,)^T$