INSTITUTO SUPERIOR TÉCNICO

IVP — Image and Video Processing

The goal of this problem is to help you familiarizing with stereo correspondence and reconstruction, by using a concrete example.

Consider a stereo pair characterized by the camera matrices

$$\mathbf{P}_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \qquad \text{and} \qquad \mathbf{P}_2 = \begin{bmatrix} 0 & 1 & 0 & 10 \\ 1 & 0 & 0 & -14 \\ 0 & 0 & 0.5 & 0 \end{bmatrix}.$$

Correspondences: using only the (projective) equality $\mathbf{x} = \mathbf{P}\mathbf{X}$, answer to:

a) A 3D point $\mathbf{X}$ projects onto a point of the line characterized by $y_1 = 2x_1 + 1$ in the image of camera 1 and onto the point $(x_2, y_2) = (20, -10)$ in the image of camera 2. Find the exact location of the projection of $\mathbf{X}$ in the image of camera 1.

b) Is there any 3D point that projects onto $(x_1, y_1) = (0, 0)$ in the image of camera 1 and onto $(x_2, y_2) = (20, -10)$ in the image of camera 2 ? If there is such a point, find its 3D coordinates; otherwise, find the region of the image of camera 1 collecting the projections of all 3D points that project onto $(x_2, y_2) = (20, -10)$ in the image of camera 2.

Correspondences using the fundamental matrix:

c) Compute the fundamental matrix $\mathbf{F}$ for our pair of cameras.

d) Using the result obtained for $\mathbf{F}$, confirm your answers to a) and b) (or, equivalently, answer a) and b) again, now using $\mathbf{F}$).

Reconstruction:

e) Compute the 3D coordinates of $\mathbf{X}$.

f) Notice that you could not solve e) using $\mathbf{F}$ alone, *i.e.*, without knowing $\mathbf{P}_2$ and $\mathbf{P}_2$. Why ? (to make the explanation crystal-clear, provide a different solution for $\mathbf{X}$, also valid according to $\mathbf{F}$).