Report: Panorama

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Nicolás Violante

nviolante96@gmail.com

Equation deduction

We want to compute the parameters of the homography given by

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

Where $(x', y', y')^T \in I_2$ and $(x, y, y)^T \in I_1$ are points in homogeneous coordinates.

Let (x_1, y_1) be a point of the image I_1 and (x_2, y_2) the corresponding point in image I_2. Note that these points are in inhomogeneous coordinates. If we apply the homography matrix to the point $(x_1, y_1, 1)^T$ we obtain

$$x_2 = \frac{x'}{z'} = \frac{h_{11}x_1 + h_{12}y_1 + h_{13}}{h_{31}x_1 + h_{31}y_1 + h_{33}}$$

$$y_2 = \frac{x'}{z'} = \frac{h_{21}x_1 + h_{22}y_1 + h_{23}}{h_{31}x_1 + h_{31}y_1 + h_{33}}$$

Let the vector $h = (h_{11}, h_{12}, h_{13}, h_{21}, h_{22}, h_{23}, h_{31}, h_{32})^T$ and fix $h_{33} = 1$. Then we can write the system as

$$\begin{bmatrix} x_1 & y_1 & 1 & 0 & 0 & 0 & -x_1x_2 & -y_1x_2 \\ 0 & 0 & 0 & x_1 & y_1 & 1 & -x_1y_2 & -y_1y_2 \end{bmatrix} h = \begin{bmatrix} x_2 \\ y_2 \end{bmatrix}$$

Since we need to determine eight parameters, we need at least four pairs of corresponding points $(x_1, y_1) \in I_1$ and $(x_2, y_2) \in I_2$. Each pair adds two equations to the linear system.

Results