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Homework 5: 3D Reconstruction

1) With the 8-point algorithm, point correspondences between a left and right camera viewpoints directed at the same figure are used to estimate the fundamental matrix. With this algorithm, no camera parameters are utilized, neither extrinsic nor intrinsic. For each point correspondence, a homogenous equation exists:

$$\bar{p}_r^T F \bar{p}_l = 0$$

which can also be written as

$$x_l x_r f_{11} + x_l y_r f_{21} + x_l f_{31} + y_l x_r f_{12} + y_l y_r f_{22} + y_l f_{32} + x_r f_{13} + y_r f_{23} + f_{33} = 0$$

Solving the equation for every component $f$ yields the whole fundamental matrix F. To determine F, at least eight point correspondences are required, hence its name. A matrix A of size $n$, number of points, by 9 is created and SVD of A is computed $A = UDV^T$. F can be extracted by taking the final column of V. A has a rank 8.

The 8-point algorithm differs from the built-in function as it does not provide the best results in practice, hence it isn't very accurate. The function find FundamentalMat implements a more optimal algorithm as there are various ways to compute F, such as using camera parameters.

6) Reconstruction with only the essential matrix requires an estimate of the fundamental matrix, which then allows one to derive the camera matrix before using it for triangulation. Reconstruction when H is known requires QR decomposition to extract intrinsic and extrinsic matrices to be used for triangulation as Euclidian reconstruction.