18CSE390T
Computer Vision

S2-SLO1-Projective Reconstruction

Camera Calibration

- A camera projects 3D world points onto the 2D image plane
- Calibration: Finding the quantities internal to the camera that affect this imaging process , Image center ,Focal length ,Lens distortion parameters
- **Camera calibration** is the process of estimating intrinsic and/or extrinsic parameters.
- Intrinsic parameters deal with the **camera's** internal characteristics, such as, its focal length, skew, distortion, and image center.
- Extrinsic parameters describe its position and orientation in the world.

Projective Reconstruction

- When we try to build 3D model from the photos taken by unknown cameras, we do not know ahead of time the intrinsic calibration parameters associated with input images.
- Still, we can estimate a two-frame reconstruction, although the true metric structure may not be available.
- $\hat{x}_1^T E \hat{x}_0 = 0,$: the basic epipoler constraint.

Projective Reconstruction (cont.)

- In the unreliable case, we do not know the calibration matrices $\hat{x}_j = K_j^{-1} x_j.$ K_j, so we cannot use the normalized ray directions.
- We have access to the image coordinate x_j, so *essential matrix* becomes:

$$\hat{x}_1^T E \hat{x}_1 = x_1^T K_1^{-T} E K_0^{-1} x_0 = x_1^T F x_0 = 0,$$

- *fundamental m*

$$F = K_1^{-T} E K_0^{-1} = [e]_\times \hat{H}$$

Projective Reconstruction (cont.)

$$F = [e]_\times \tilde{H} = U\Sigma V^T = \begin{bmatrix} u_0 & u_1 & e_1 \end{bmatrix} \begin{bmatrix} \sigma_0 & & \\ & \sigma_1 & \\ & & 0 \end{bmatrix} \begin{bmatrix} v_0^T \\ v_1^T \\ e_0^T \end{bmatrix}.$$

- Its smallest left singular vector indicates the epipole e_1 in the image 1.
- Its smallest right singular vector is $e_{0.}$

Projective Reconstruction (cont.)

- To create a projective reconstruction of a scene, we pick up any valid homography $\tilde{H}$ that satisfies

$$F = K_1^{-T} E K_0^{-1} = [e]_\times \tilde{H}$$

and hence $$F = [e]_\times \tilde{H} = S Z R_{90^\circ} S^T \tilde{H} = U \Sigma V^T$$

$$\tilde{H} = U R_{90^\circ}^T \hat{\Sigma} V^T,$$

$\hat{\Sigma}$: singular value matrix with the smallest value replaced by the middle value.