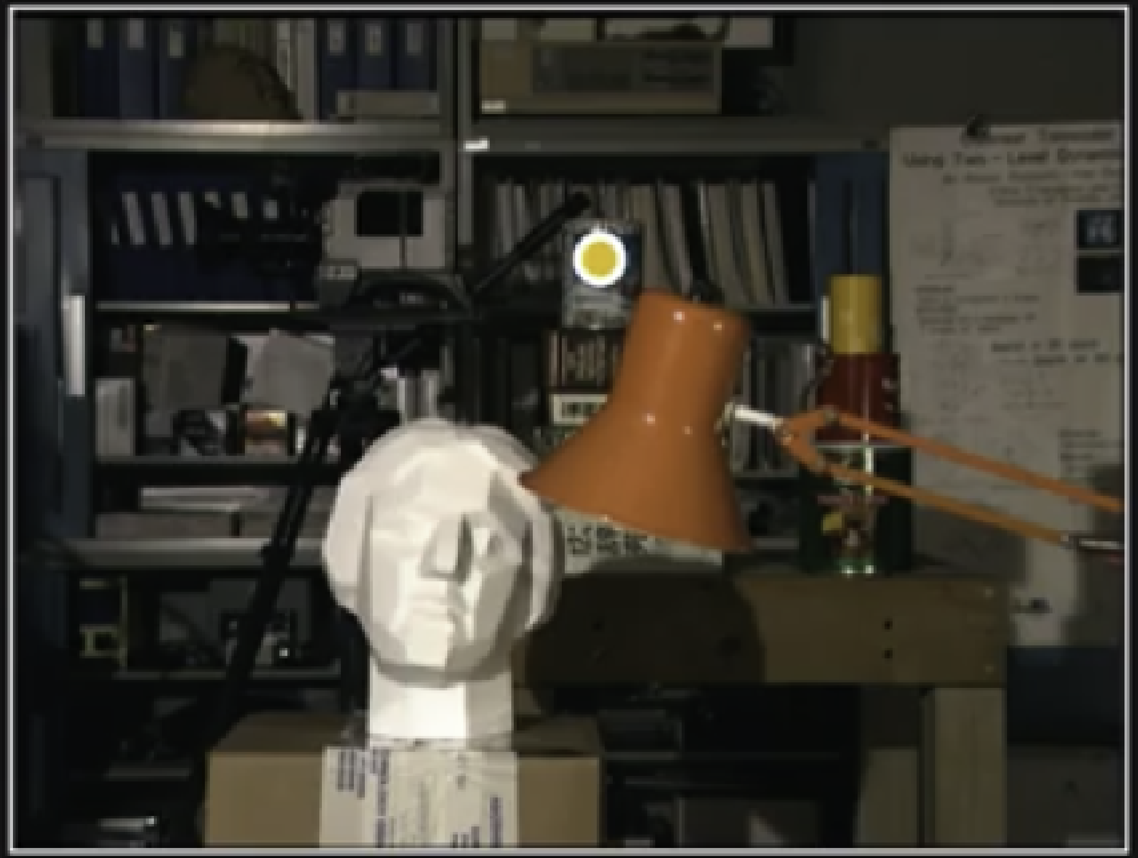
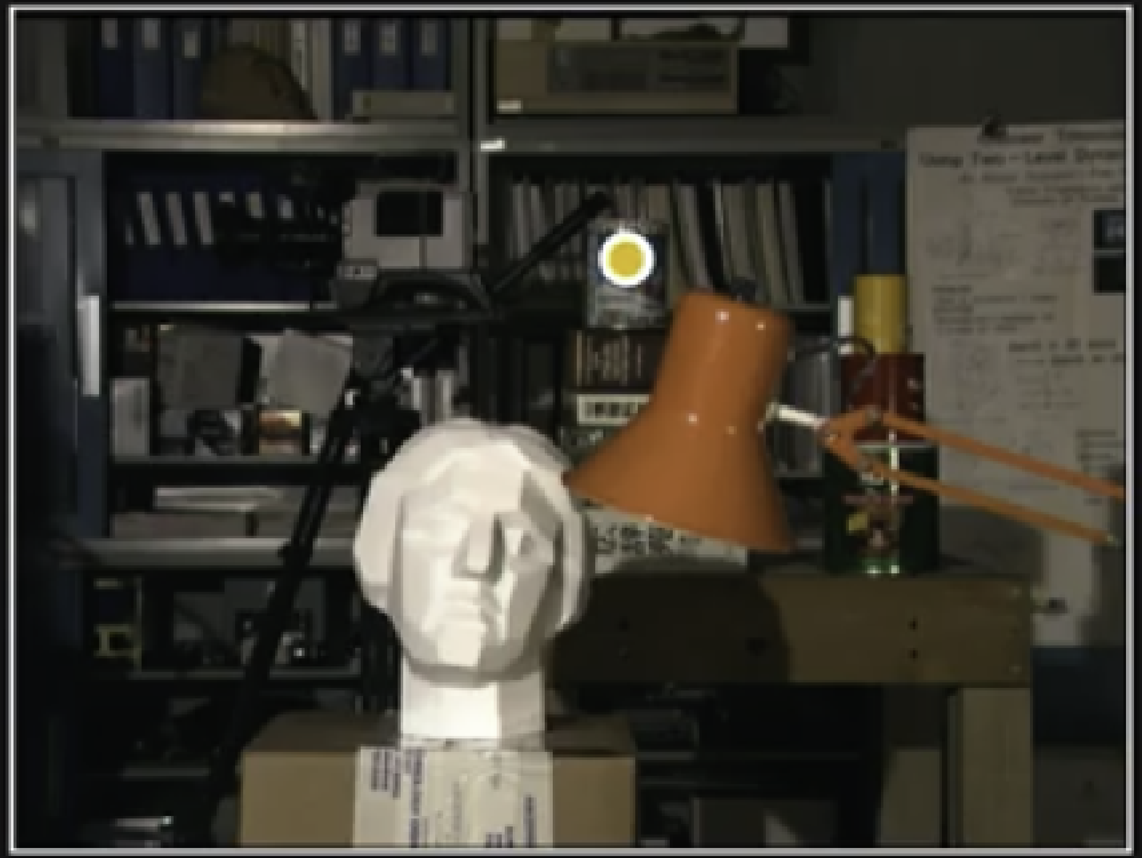
Computing Depth

Simple Stereo: Finding Correspondences

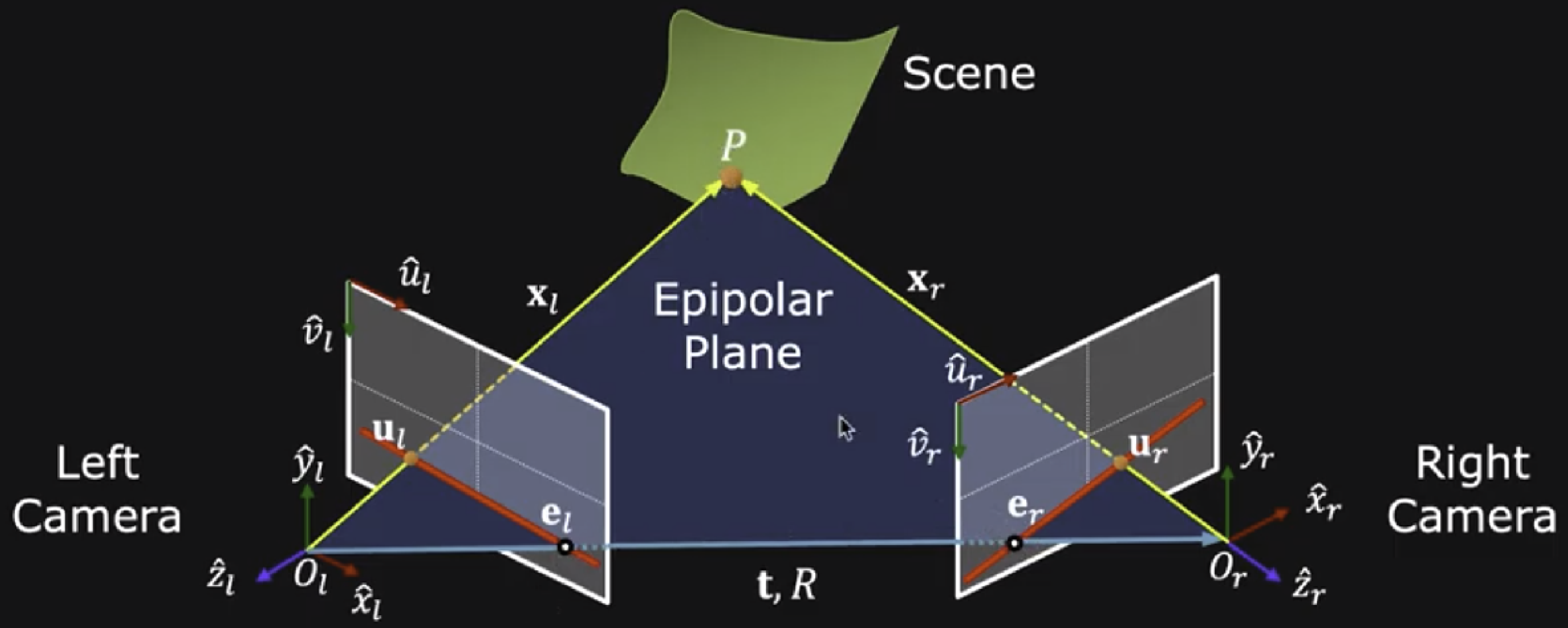


Left Camera Image



Right Camera Image

Epipolar Geometry: Epipolar Line



Epipolar Line: Intersection of image plane and epipolar plane.

Finding Epipolar line

$$\begin{bmatrix} u_l & v_l & 1 \end{bmatrix} \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{bmatrix} \begin{bmatrix} u_r \\ v_r \\ 1 \end{bmatrix} = 0$$

$$\Rightarrow (f_{11} u_l + f_{21} v_l + f_{31}) u_r + (f_{12} u_l + f_{22} v_l + f_{32}) v_r + (f_{13} u_l + f_{23} v_l + f_{33}) = 0$$

$$\Rightarrow \boxed{a_l u_r + b_l v_r + c_l = 0}$$

Finding Epipolar Lines: Example

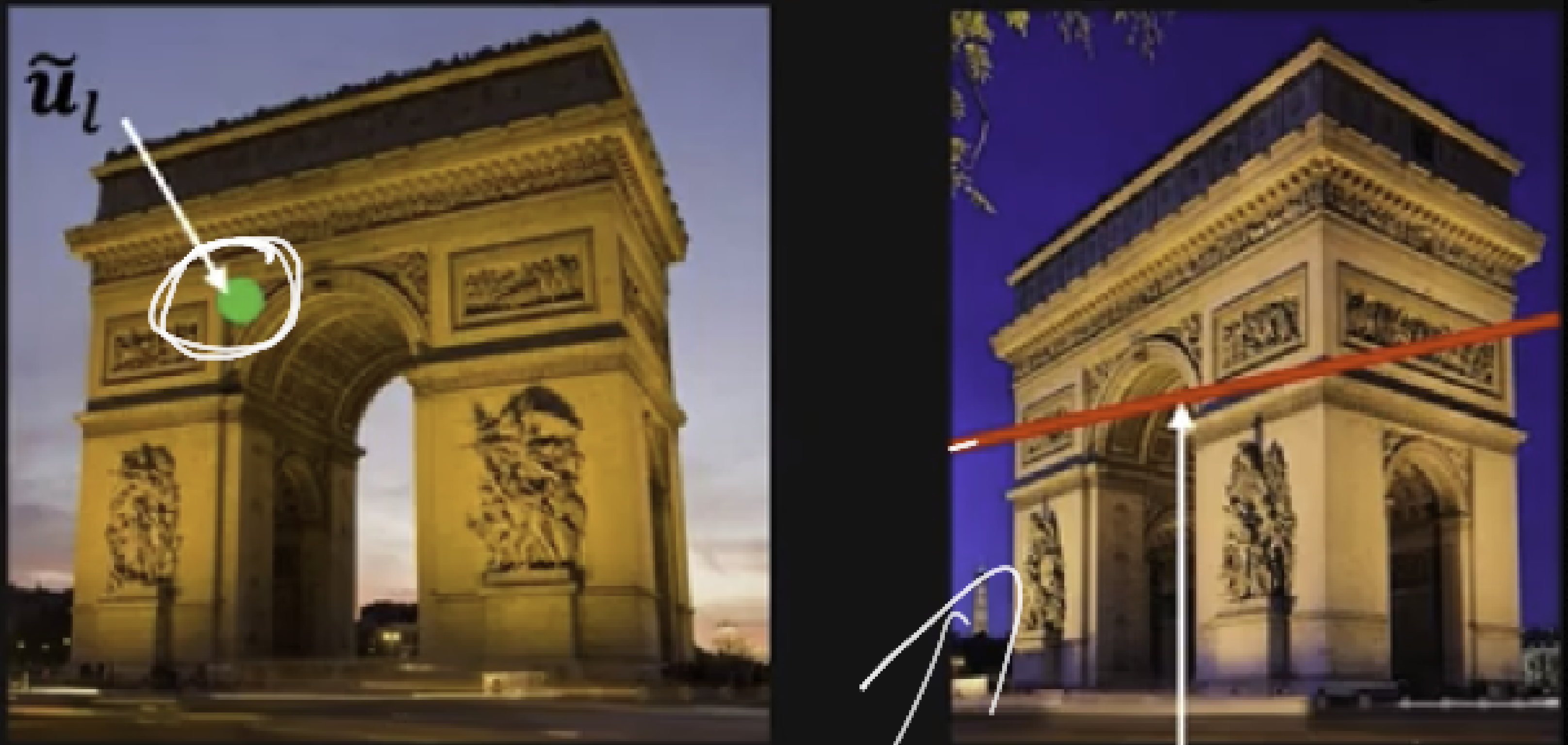
Given the Fundamental matrix,

$$F = \begin{bmatrix} -.003 & -.028 & 13.19 \\ -.003 & -.008 & -29.2 \\ 2.97 & 56.38 & -9999 \end{bmatrix}$$

and the left image point

$$\tilde{\boldsymbol{u}}_l = \begin{bmatrix} 343 \\ 221 \\ 1 \end{bmatrix}$$

Left Image Right Image



Epipolar Line

The equation for the epipolar line in the right image is

$$\boxed{.03u_r + .99v_r - 265 = 0}$$

Computing Depth :-

$$\begin{bmatrix} u_l \\ v_l \\ 1 \end{bmatrix} = \begin{bmatrix} f_x^l & 0 & O_{x_l}^l & 0 \\ 0 & f_y^l & O_{xy} & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_l \\ y_l \\ z_l \\ 1 \end{bmatrix} \quad \text{(1)}$$

$$\begin{bmatrix} u_r \\ v_r \\ 1 \end{bmatrix} = \begin{bmatrix} f_x^r & 0 & O_x^r & 0 \\ 0 & f_y^r & O_y^r & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_r \\ y_r \\ z_r \\ 1 \end{bmatrix} \quad \text{(2)}$$

→ left camera Imagin eq.

$$
\begin{bmatrix} x_l \\ y_l \\ z_l \\ 1 \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_x \\ r_{21} & r_{22} & r_{23} & t_y \\ r_{31} & r_{32} & r_{33} & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_r \\ y_r \\ z_r \\ 1 \end{bmatrix}
$$

3

$$
\begin{bmatrix} u_l \\ v_l \\ 1 \end{bmatrix} = \underbrace{\begin{bmatrix} f_x^l & 0 & o_x^l & 0 \\ 0 & f_y^l & o_y^l & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}}_{3\times 4} \underbrace{\begin{bmatrix} r_{11} & - & - \\ - & - & \cdot \\ - & - & - \end{bmatrix}}_{4\times 4} \begin{bmatrix} x_r \\ y_r \\ z_r \\ 1 \end{bmatrix}
$$

$$\begin{bmatrix} u_l \\ v_l \\ 1 \end{bmatrix} = P_l \begin{bmatrix} x_r \\ y_r \\ z_r \\ 1 \end{bmatrix} \Rightarrow \boxed{\hat{U}_l = \underset{3\times 4}{P_l} \hat{X}_r}$$

$$\boxed{\hat{U}_r = \underset{3\times 4}{M_{int}} \hat{X}_r}$$

know

Can

$$\begin{bmatrix} \; & \; & \; \\ \; & \; & \; \\ \; & \; & \; \\ \; & \; & \; \end{bmatrix}_{4\times 3} \begin{bmatrix} x_r \\ y_r \\ z_r \end{bmatrix}_{3\times 1} = \begin{bmatrix} \; \\ \; \\ \; \\ \; \end{bmatrix}_{4\times 1}$$

$$\boxed{A \hat{X}_r = b}$$

$$A^T \cdot A \hat{x}_r = A^T b$$

$$\boxed{\hat{x}_r = (A^T A)^{-1} A^T b}$$