HW 4 due Mar 4th

Midterm Mar 8th

Tue Feb 23
5:30p

HW 5 larger HW with coding

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until now

- picture of plane $\Rightarrow$ H
- VP $\Rightarrow$ K
- $H, K \Rightarrow R, T$
- P3P $\Rightarrow$ distances to the points $\xRightarrow{\text{Procrustes}}$ R, T
- cross-ratios $\Rightarrow$ measurements

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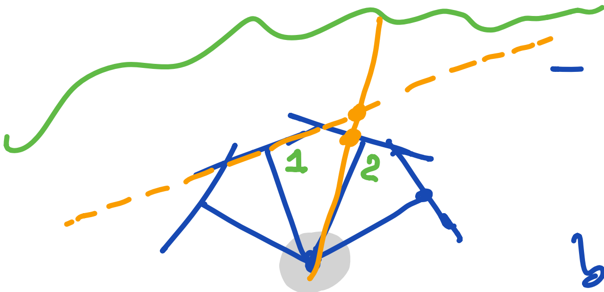
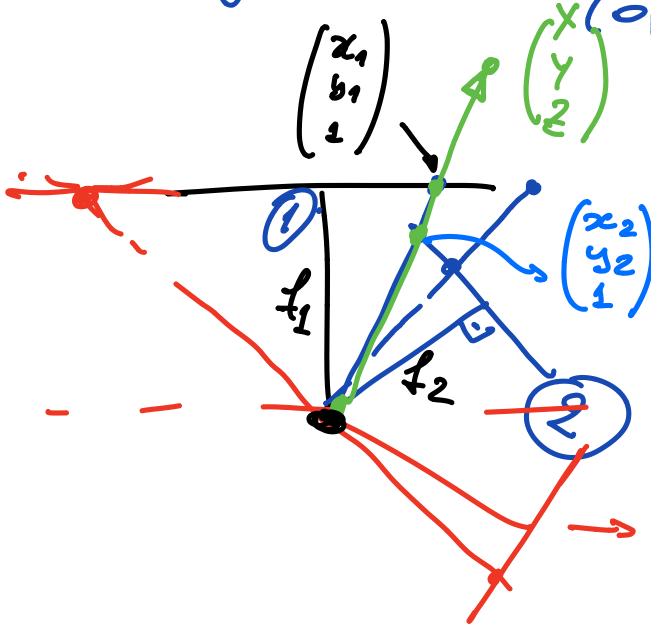
today: if we have two views and no information about measurements in the plane what can we say about the scene?

Panorama



- theoretically a panorama can be taken only if you rotate around an axis through your projection center. (optical)



$$\begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix} \sim K_1 R_1 \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

$$\begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix} \sim K_2 R_2 \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

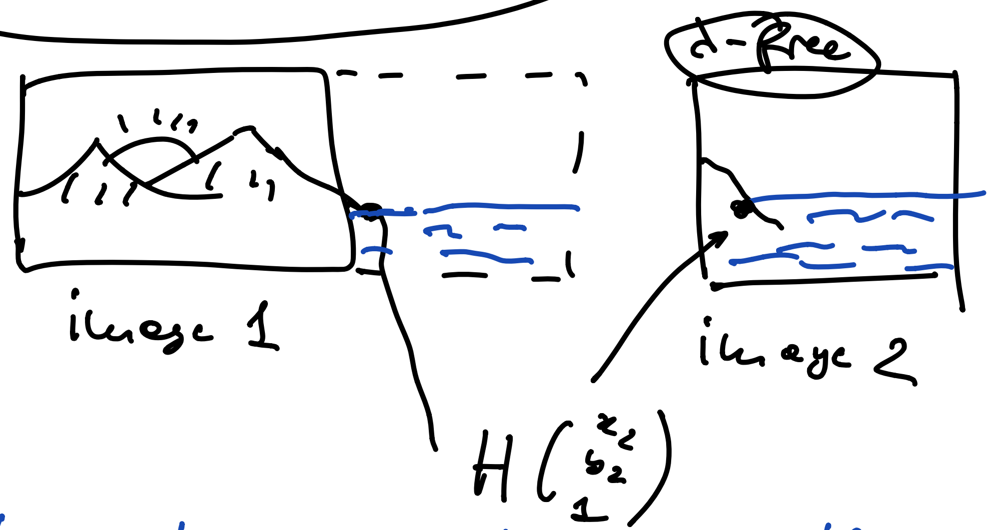
→ cylindrial panorama

$$\underbrace{\begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix}}_{\text{pixel}} \sim \underbrace{\underset{3\times3}{K_1} \, \underset{3\times3}{R_1} \, \underset{3\times3}{R_2^{-1}} \, \underset{3\times3}{K_2^{-1}}}_{\text{proj. transf.}} \underbrace{\begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix}}_{\text{pixel}}$$

$$\begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix} \sim H \begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix}$$

$x_1 =$ ______

$y_1 =$ ______

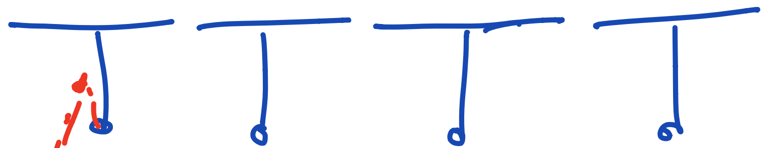


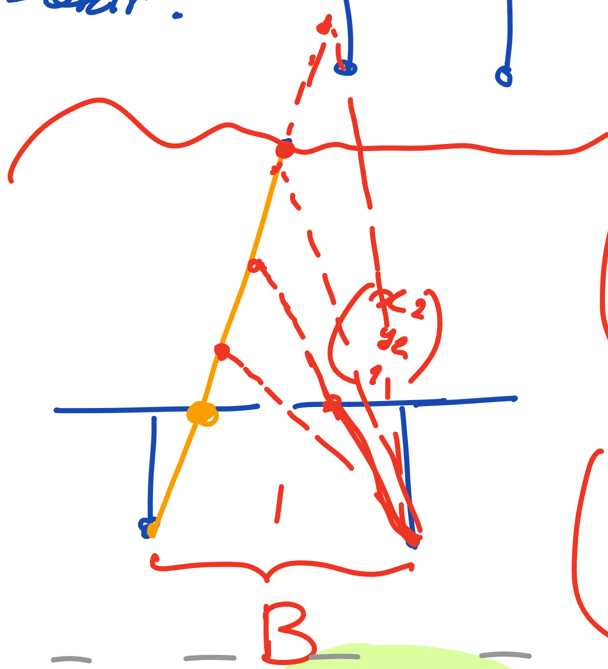
1. do not need to know the rotation (angle) as long as I can find correspondences to compute H

2. do not need to know what is in the scene !! (depth)

explain (2) counter example:

Can I build a panorama by shifting the camera along the x-axis.





no rotation

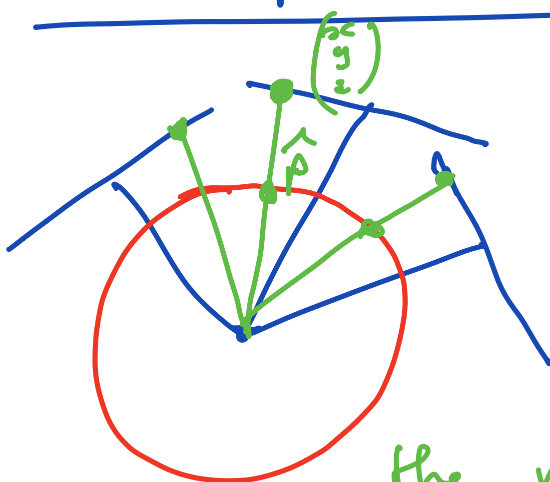
$$\begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix} \sim K_2 \begin{pmatrix} X-B \\ Y \\ Z \end{pmatrix}$$

$$\begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix} \sim K_1 \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

$$\lambda_2 \begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix} = K_2 \left(\underbrace{K_1^{-1} d_1 \begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix}}_{\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}} - \begin{pmatrix} B \\ 0 \\ 0 \end{pmatrix} \right)$$

$$\begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix} \xrightarrow[\text{know } d_1/d_2 \text{ depth}]{\text{you have to}} \begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix}$$

360° panorama

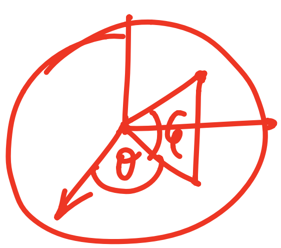


to project on the sphere we need the 3D vector from the projection center to the pixel point

$$p = K^{-1}\begin{pmatrix}x\\y\\1\end{pmatrix} \longrightarrow \hat{p} = \frac{p}{\|p\|}$$

we need to know K (focal length & image center)

Sphere has a coordinate system



1) align sphere with reference image

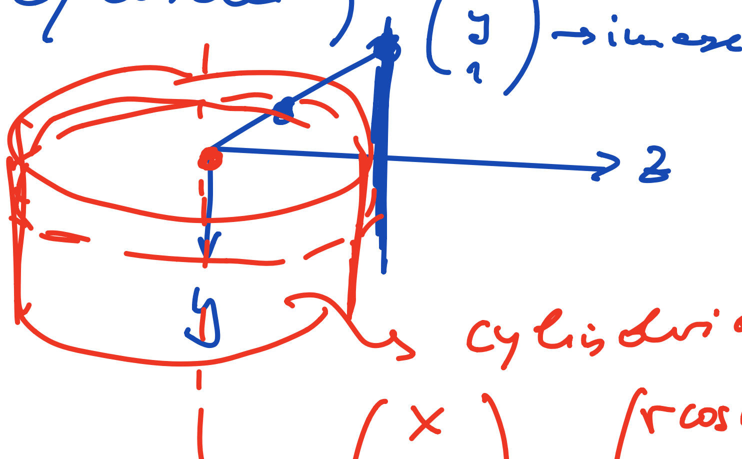
2) $H \sim K_1 R_1 R_2^{-1} K_2^{-1} \Rightarrow R$

unknown

car. f. sphere

360° panorama ⇒ cylindrical projection

cylinder is aligned with the reference image (y-axis of the 1st camera pose is the axis of the cylinder)



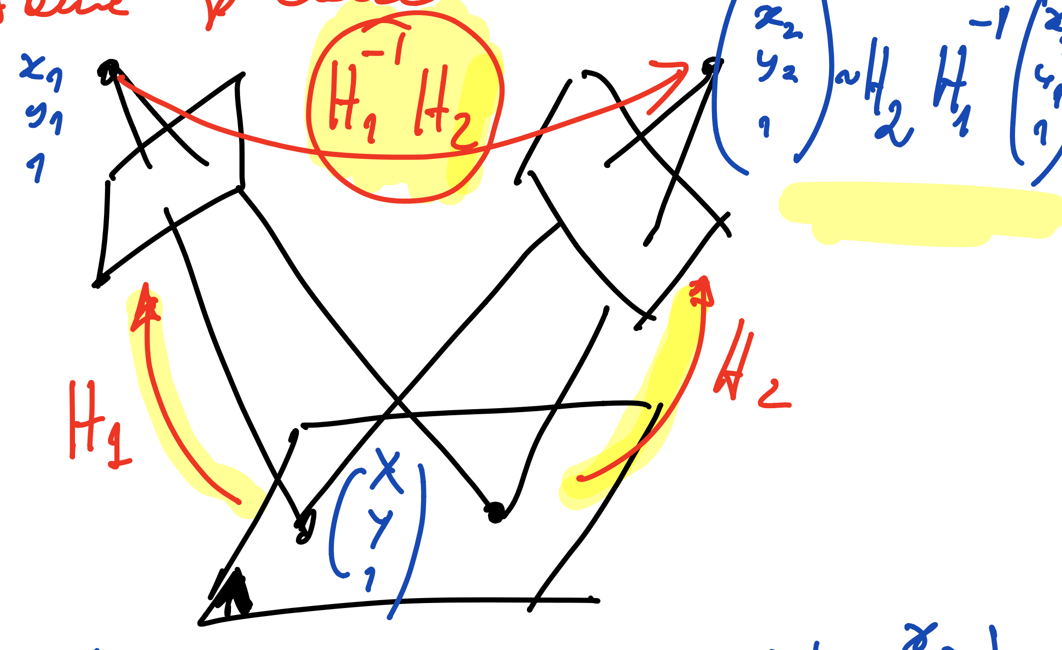
cylindrical coordinate

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} r\cos\varphi \\ r\sin\varphi \\ h \end{pmatrix}$$

<u>Question</u>: If H_{ij} between i-th and j-th image can I find both f and R (u_0, v_0 known)

Which other case can we have a collineation between two images?

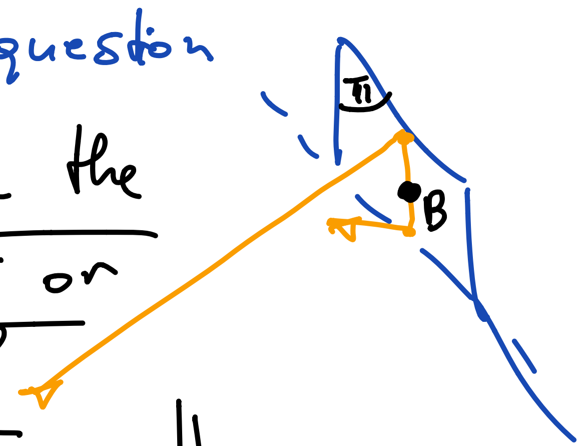
two picture from the same plane!



$$\begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix} \sim H_1 \begin{pmatrix} X \\ Y \\ 1 \end{pmatrix} \sim H_1 H_2^{-1} \begin{pmatrix} x_2 \\ y_2 \\ 1 \end{pmatrix}$$

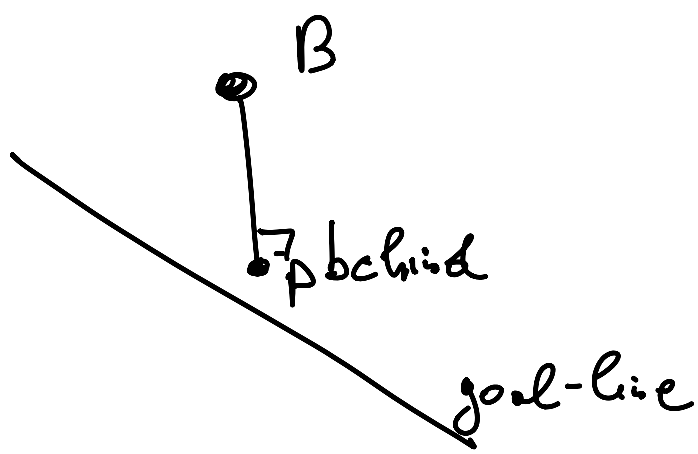
soccer question

B behind the plane π or in front?



$\Downarrow$

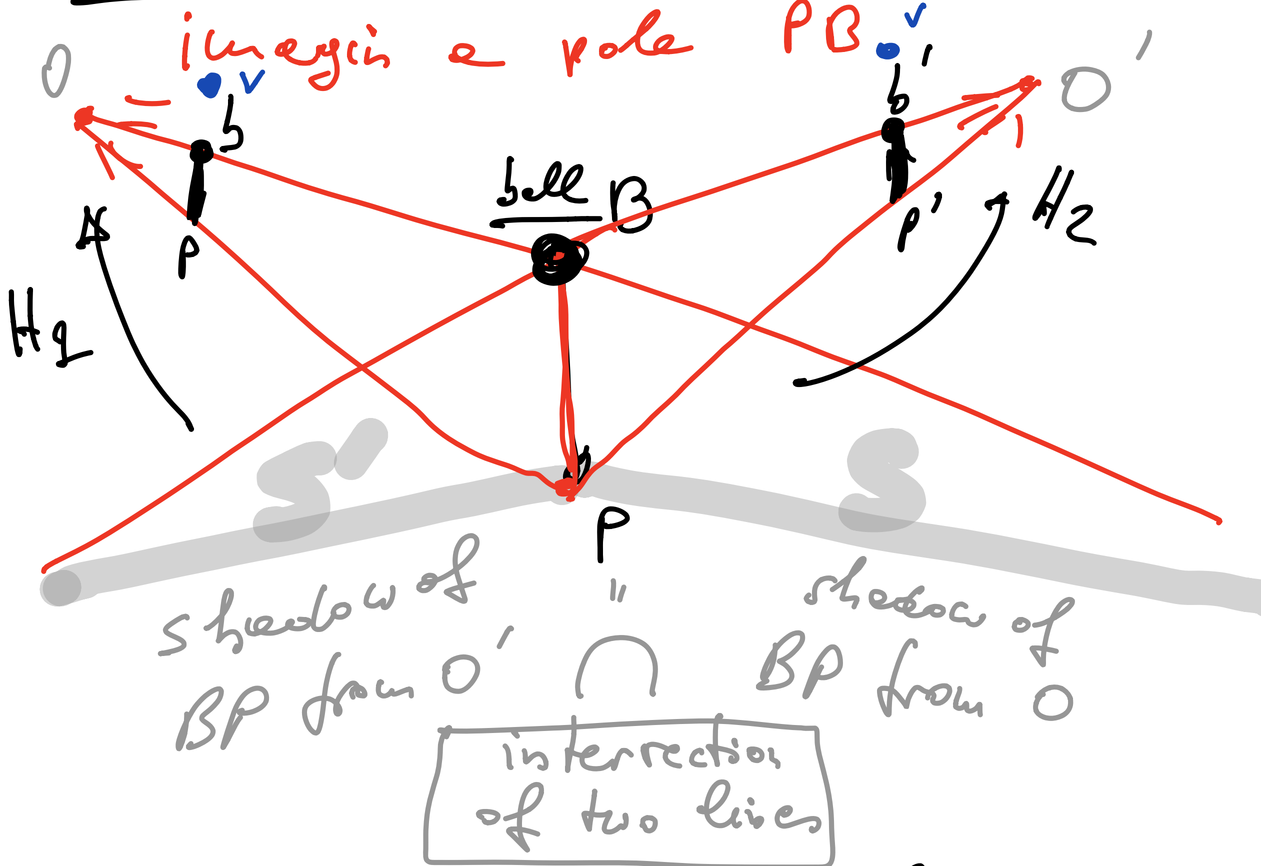
equivalent to finding the vertical projection of B on the plane!



Given: - plane (H between two pictures of planes)

- vertical vanishing point (intersecting projection of vertical lines)

Find: point P given B.



How can we find image lines bp and $b'p'$?

v, v' are the vertical vanishing points

$$\left.\begin{array}{l} bp \sim b \times v \\ b'p' \sim b' \times v' \end{array}\right\} \text{two images}$$

$s \sim \text{backproj}(bp)$

$s' \sim \text{backproj}(b'p')$

$s \sim H^{-1} b \times H^{-1} v$

$s' \sim H'^{-1} b' \times H'^{-1} v'$

$$\boxed{P \sim s \times s'}$$