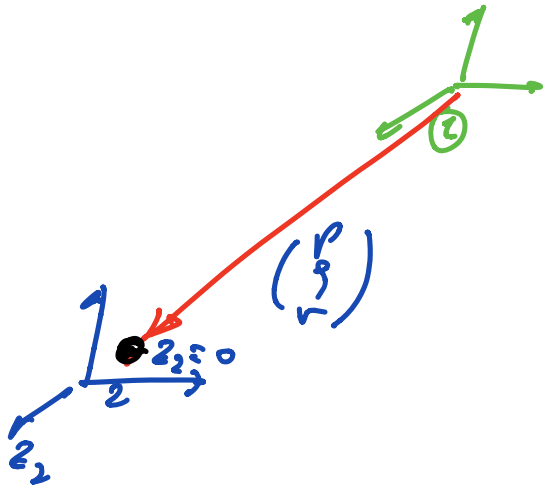
Parenthesis:

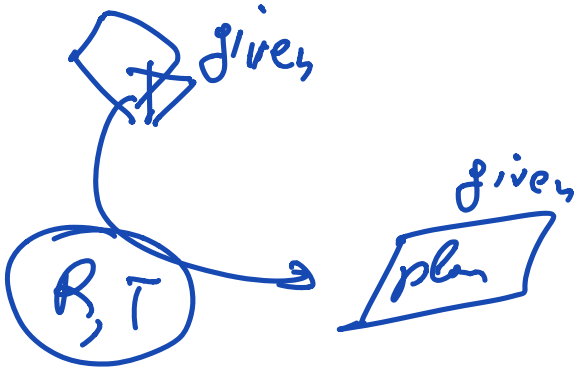


$$P_1 = P_2 + T$$

$$\begin{pmatrix} p \\ q \\ r \end{pmatrix} = \begin{pmatrix} \cdot \\ \cdot \\ 0 \end{pmatrix} + T$$

$$T = \begin{pmatrix} a \\ b \\ r \end{pmatrix} \qquad a \neq p \quad b \neq q$$

TODAY:



PnP : 2D - 3D $\Rightarrow$ R, T

Rocnsac : 3D - 3D $\Rightarrow$ R, T

Pose from Proj: 2D – 2D ⇒ R, T

Two view Proj. Trans: 2D–2D ⇒ R, T

Two views from a 3D structure

Structure from Motion (SfM)

n-view: visual SLAM

visual odometry

1 AR project furniture

option 1: on known pattern (R, T) w.r.t pattern

option 2: on the 1st frame (R, T) w.r.t. 1st frame

Today SfM on views of unknown plane

2 Visual SfM your position

w.r.t 1st frame

(Gretchen & Hannel)

Visual Inertial Odometry VIO

3 Bundle Adjustment (BA)

(Photogrammetry)

R, T ⇐ direct view

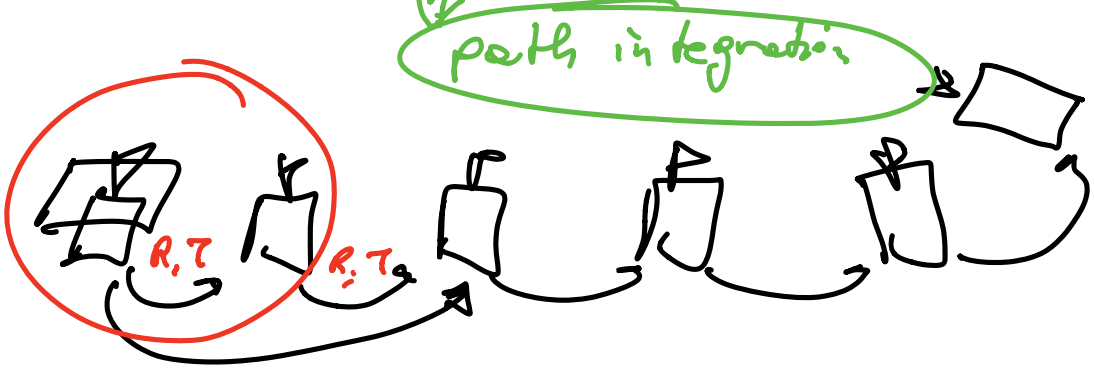
(not motion)

(capture reality sold to EPIC GAMES)

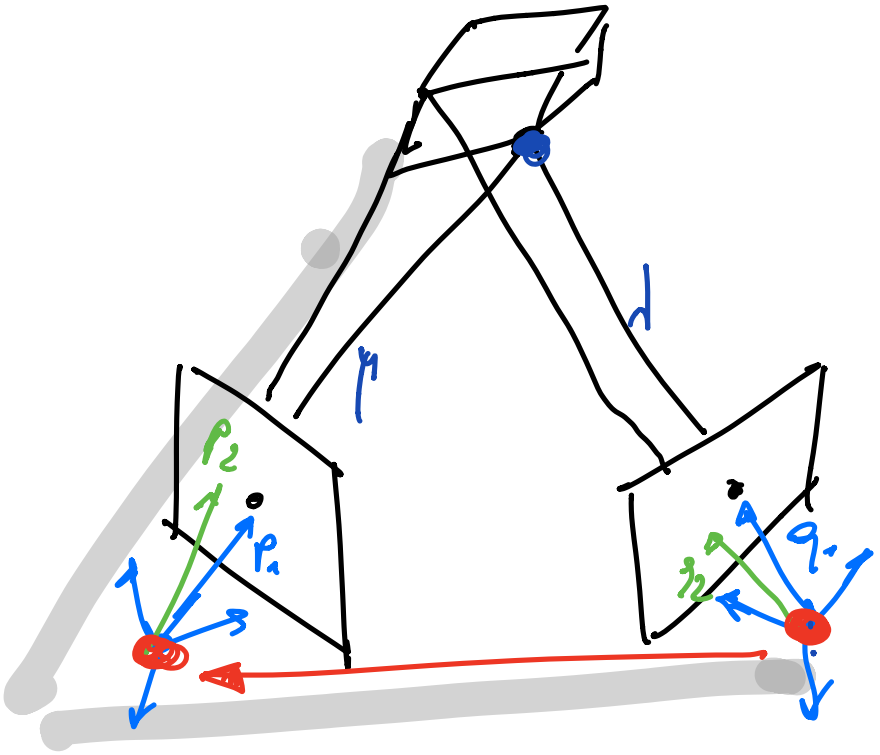
Bundler

Meshroom

Two calibrated views



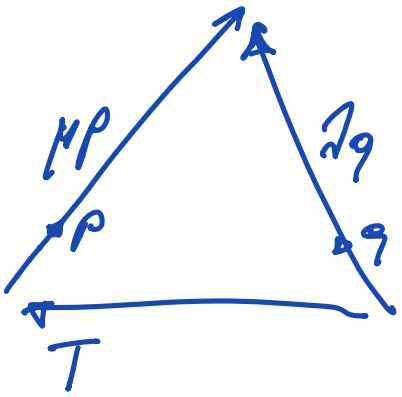
Main challenge: "matching"
"correspondence"
"tracking"



$$\lambda q = R\mu p + T$$

calibrated ←

uncalibrated $\lambda K^{-1} q_{pix} = R_\mu K^{-1} p_{pix} + T$



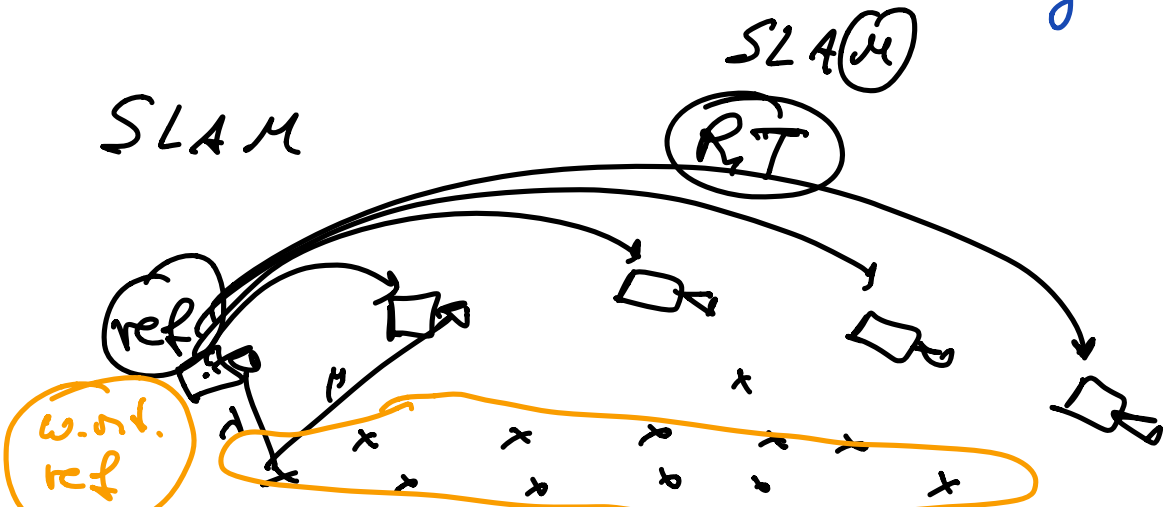
$$Mq = R_M p + T$$

① d, p known (RGB-D, LiDAR) } SLAM
Procrustes (3D-registration)

② only p known : PnP

③ d, p unknown : SfM

④ R, T known d, p unknown : triangulation



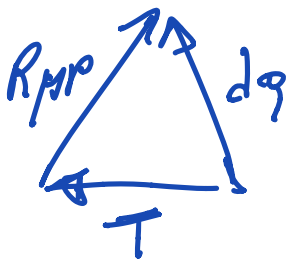
SfM : $\lambda q = R_{yp} p + T$

given: multiple (p_i, q_i)

$(p_{x_i}, p_{y_i}, q_{x_i}, q_{y_i})$

find: R, T, d_i, μ_i

key idea: eliminate d, μ

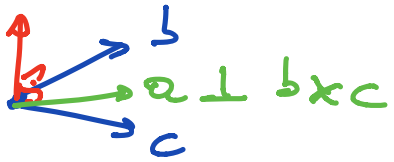


$a, b, c \in \mathbb{R}^3$

coplanar

$\Leftrightarrow$

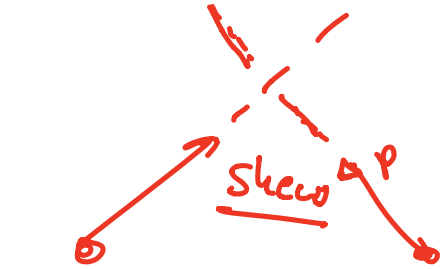
$a^T(b \times c) = 0$



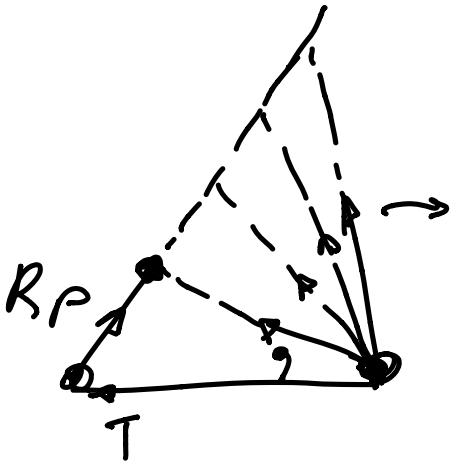
$\lambda q^T(T \times R_{yp} p) = 0$

$q^T(T \times Rp) = 0$

q, p projection of the same point



∄ 3D point projected on p, q !



→ different depth interpretations

plane spanned by q, T, Rp is called epipolar plane.

$$q^T (T \times Rp) = 0$$

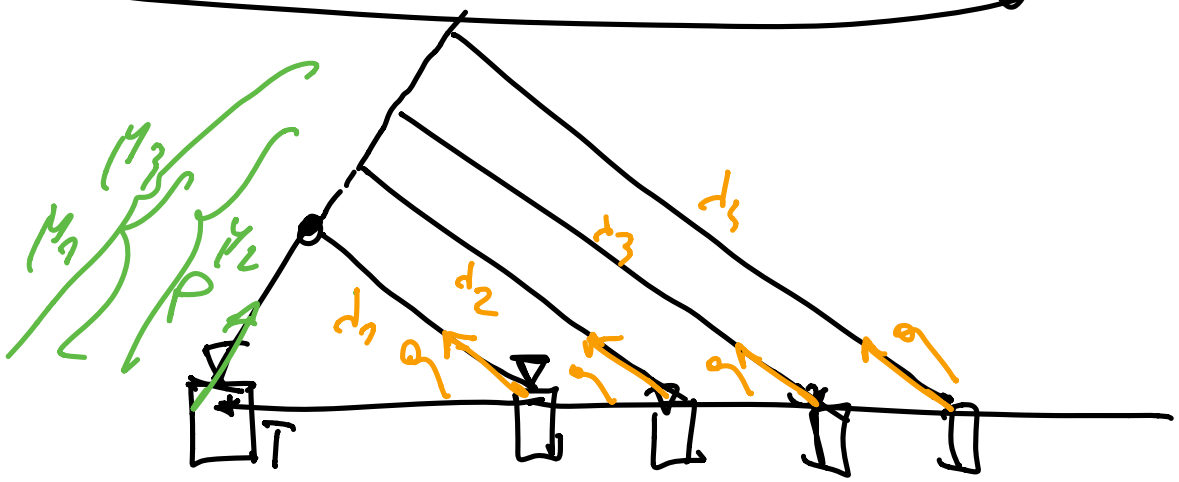
epipolar constraint

one eq ; unknowns 3 R
3 T

but If T is a solution
then $\pm T$ is a solution !

$$q^T(3T \times Rp) = 0$$

translation-depth ambiguity



$$d_1 q = \mu_1 p + T$$

$$2 d_1 q = 2\mu_1 p + 2T$$

many d_i, μ_i, T interpretation for some p, q ?

problem in monocular vision:

- non-predator (birds, horror)
- many humans

① $q^T (T \times R p) = 0$

$\|T\|$ cannot be recovered !

5 unknowns ← 3 R, 2 T

⇒ 5 points would solve the problem

but the equations are non linear in R, T

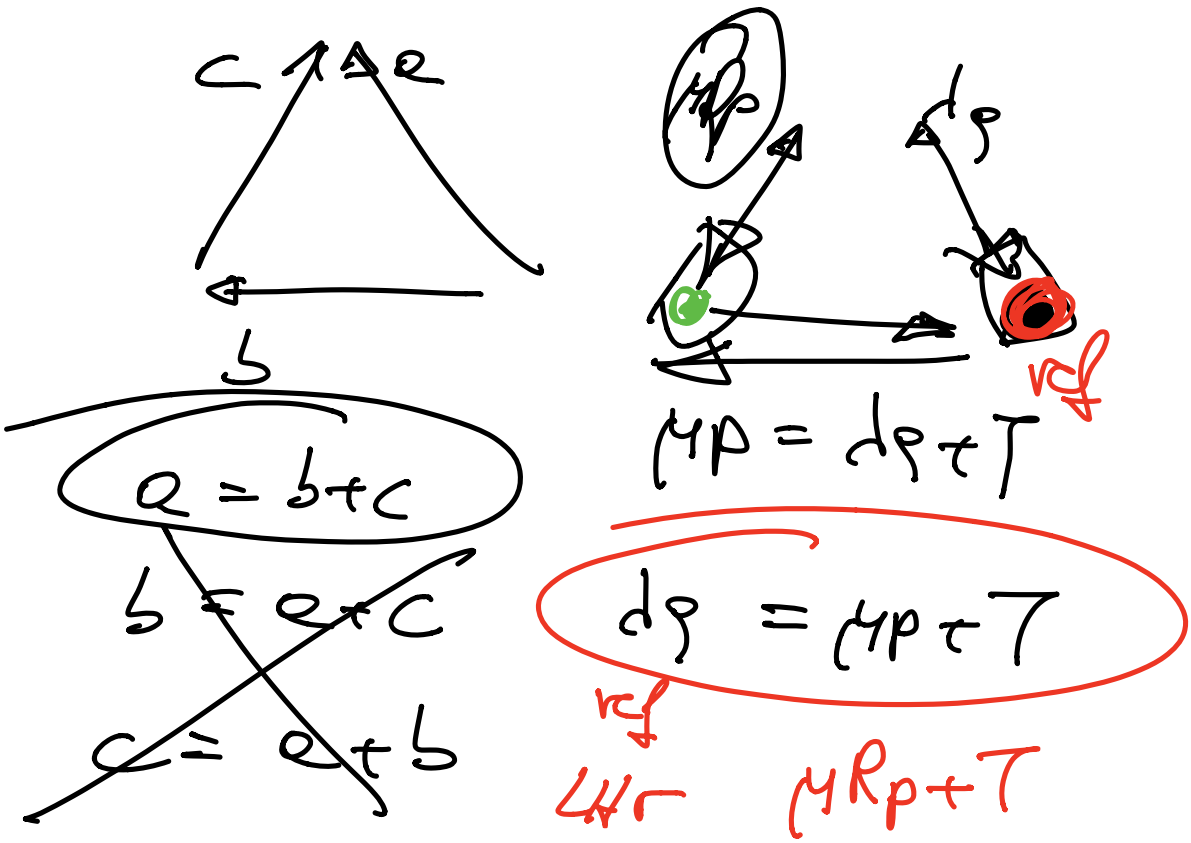
② practice

$\|T\|$ ⇐ IMU (inertial)

$\|T\|$ ⇐ stereo system

"libviso"

$\|T\|$ ⇐ height of camera (see ground points)


c
a
b
a = b + c
b = a + c
c = a + b
μp
dp
ref
μp = dp + T
dp = μp + T
ref
μr
μRp + T