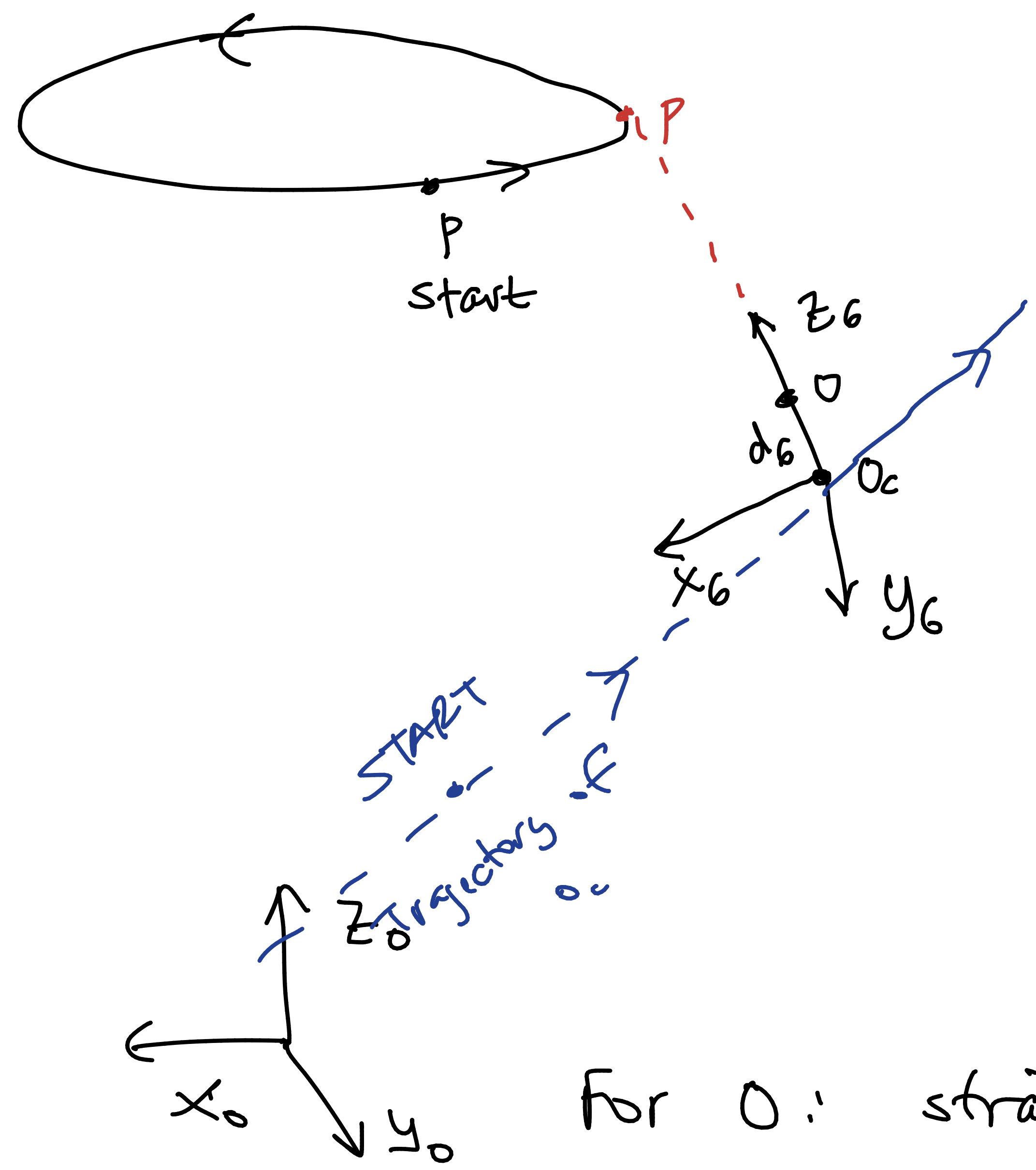


Task:

- o follows a desired space curve
- Keeps line of sight with p

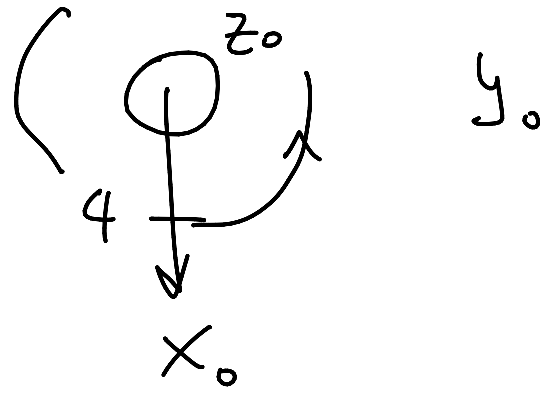
Data :

- Robot dimensions d_1, d_6
- space curve data
  $o_x(t), \; o_y(t), \; o_z(t)$
  $p_x(t), \; p_y(t), \; p_z(t)$

For O: straight line

$$\begin{bmatrix} o_x(t) \\ o_y(t) \\ o_z(t) \end{bmatrix} = \underbrace{\begin{bmatrix} 1/2 \\ 1/2 \\ 3/2 \end{bmatrix}}_{\text{start}} + \frac{t}{4} \underbrace{\begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix}}_{\text{direction}}$$

For p: $p_x(t) = 4\cos(\omega t)$
$p_y(t) = 4\sin(\omega t)$
$p_z(t) = 10$



$$z_6(t) = \frac{p - o}{\|p - o\|} = \begin{bmatrix} z_{61}(t) \\ z_{62}(t) \\ z_{63}(t) \end{bmatrix}$$

take $$x_6(t) = \frac{\begin{bmatrix} 0 \\ -z_{63}(t) \\ z_{62}(t) \end{bmatrix}}{\| \cdot \|}$$, $y_6(t) = z_6 \times$

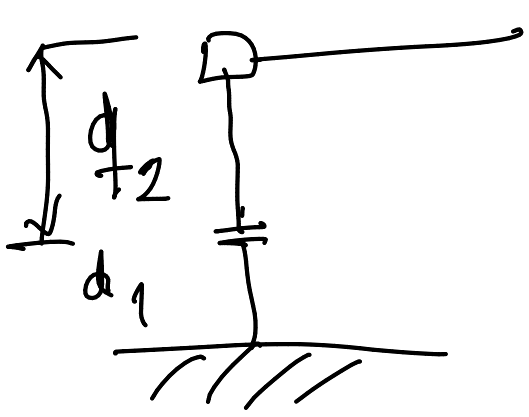
$$R(t) = \begin{bmatrix} x_6 \cdot x_0 & y_6 \cdot x_0 & \cdots \\ & & \\ x_6 \cdot z_0 & \cdots & z_6 \cdot z_0 \end{bmatrix}$$

<u>Method</u> : $H_6^0(q) = \left[\begin{array}{c|c} R & o_c^0 \\ \hline 0 & 1 \end{array}\right]$ $o^0 = \begin{bmatrix} o_x \\ o_y \\ o_z \end{bmatrix}$

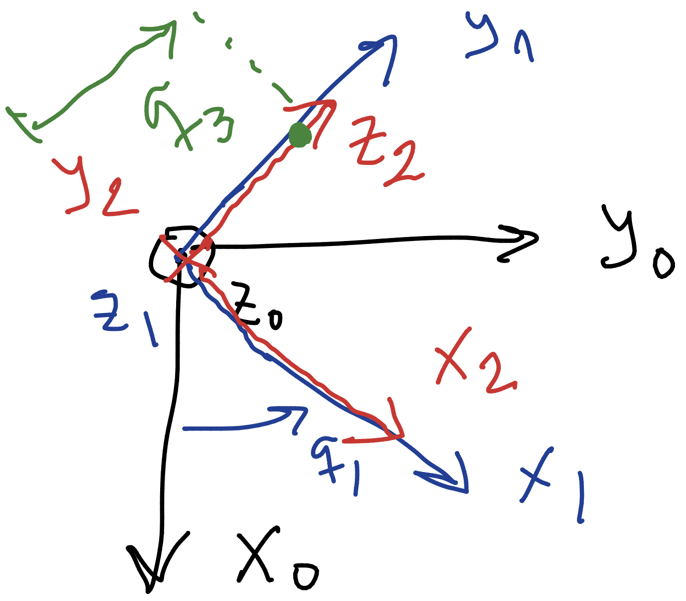
$$q = \begin{bmatrix} q_1(t) \\ q_2(t) \\ \vdots \\ q_6(t) \end{bmatrix}$$

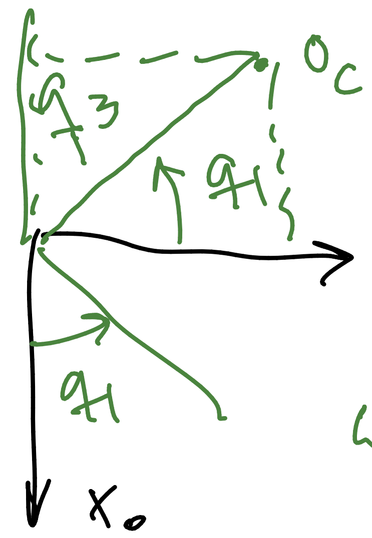
$$\begin{bmatrix} o_{cx} \\ o_{cy} \\ o_{cz} \end{bmatrix} = \begin{bmatrix} o_x - d_6 R_{13} \\ o_y - d_6 R_{23} \\ o_z - d_6 R_{33} \end{bmatrix}$$

$o_{cz} = d_1 + q_2 \rightarrow q_2 = o_{cz} - d_1$



Note :





$$\begin{cases} y_c = q_3 \cos q_1 \\ x_c = -q_3 \sin q_1 \end{cases}$$

when $q_1, q_3 > 0$, o_c will be in 2nd quadrant

→ use $q_1 = \tan^{-1}\left(\frac{-x_c}{y_c}\right)$

$q_3 = \sqrt{x_c^2 + y_c^2}$

$$R_6^0 = R = \underbrace{R_3^0}_{} R_6^3$$

fcn of q_1, q_2, q_3 only (known!)

$R_z(q_1)$

Solve: $\underset{\smile}{R_6^3} = (R_3^0)^{-1} R$ ✓ ✓ ✓

use Euler to get $\begin{bmatrix} q_4 \to \phi \\ q_5 \to \theta \\ q_6 \to \psi \end{bmatrix}$

See Matlab ExampleInvK.m

Quadratic function: $x = \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix}$

$$f(x) = x^T S x = [x_1 \; \dots \; x_n] \begin{bmatrix} & & \\ & S & \\ & & \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix}$$

$$= \underset{\downarrow\, 0}{s_{11} x_1^2} + \underset{\downarrow\, 0}{s_{22} x_2^2} \dots \underset{\downarrow\, 0}{s_{nn} x_n^2} + \cancel{x_1 x_2} + \cancel{x_2 x_3} \dots \cancel{-x_1 x_2} \cancel{-x_2 x_3} \dots$$

in a skew symm. matrix

$f(x) = 0$ when S is skew-symm.

A : any matrix

$$A = \underbrace{\left(\frac{A + A^T}{2}\right)}_{\text{symm.}} + \underbrace{\left(\frac{A - A^T}{2}\right)}_{\text{sk. symm.}}$$