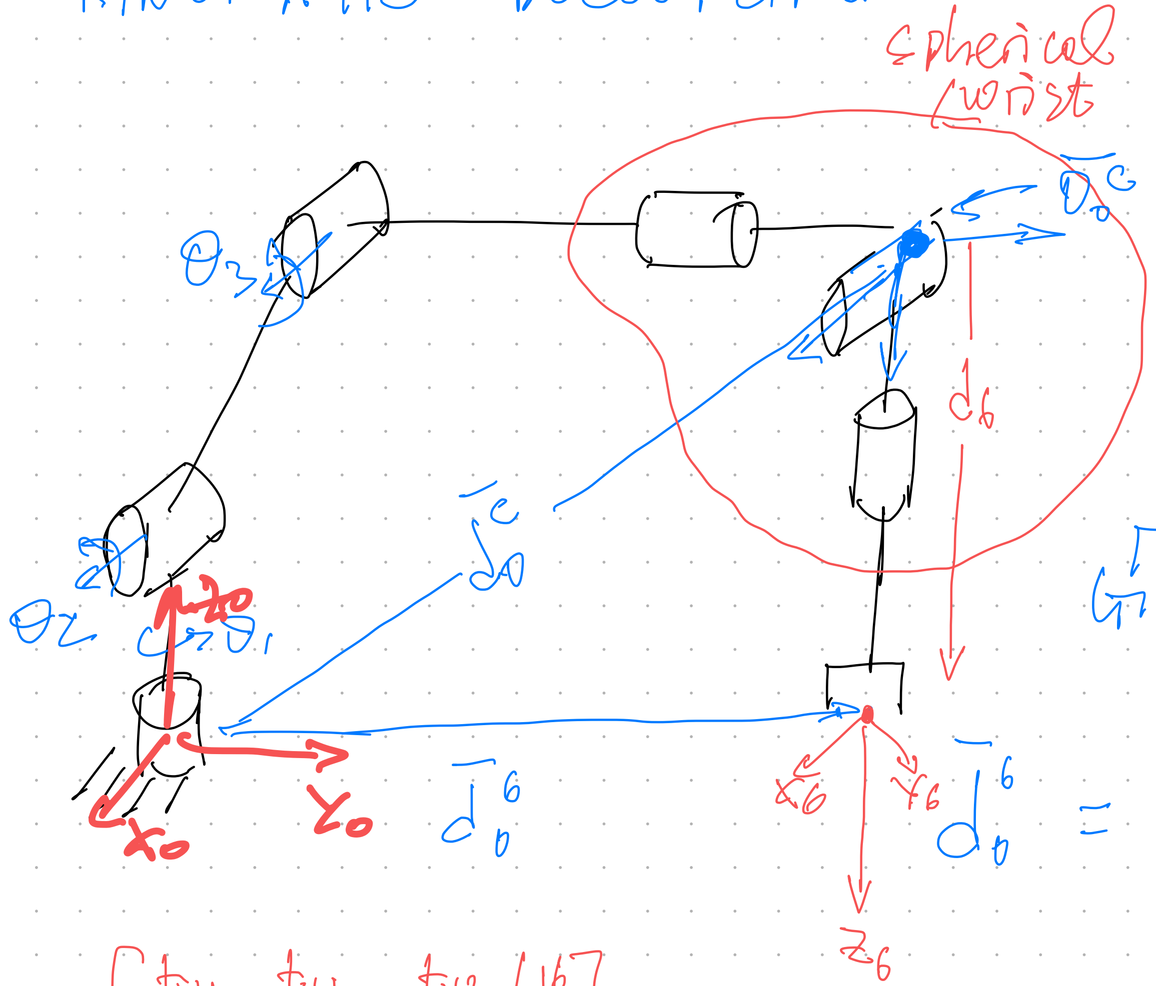
KINEMATIC DECOUPLING

by Mark Spong, Vidyasagar



$$\bar{d}_0^c = f(\theta_1, \theta_2, \bar{\theta}_3)$$

$$A_0^6 = \left[\begin{array}{c|c} R_0^6 & \bar{d}_0^6 \\ \hline 0 \quad 0 \quad 0 & 1 \end{array}\right]$$

Given $\rightarrow d_0^6(\theta_1, \dots \theta_6) \longrightarrow$ compute $\bar{o}_0^c$

$$\bar{d}_0^6 = \bar{d}_0^c + d_6 R_0^6 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

unit vector along z_6

$$T_0^6 = \left[\begin{array}{ccc|c} t_{11} & t_{12} & t_{13} & d^6_{0x} \\ & & t_{23} & d^6_{0y} \\ & & t_{33} & d^6_{0z} \\ \hline & & 0 & 1 \end{array}\right]$$

$$\boxed{\bar{d}_0^c = \begin{bmatrix} d^6_{0,x} \\ d^6_{0,y} \\ d^6_{0,z} \end{bmatrix} - d_6 \begin{bmatrix} t_{13} \\ t_{23} \\ t_{33} \end{bmatrix}}$$

Computed

$\downarrow$

$\bar{d}_0^c \longrightarrow$ Inverse Kinematics $\theta_1, \theta_2, \theta_3$

Given $\theta_1, \theta_2, \theta_3 \longrightarrow A_0^3 = \left[\begin{array}{ccc|c} & R_0^3(\theta_1,\theta_2,\theta_3) & & \bar{d}_0^c \\ \hline 0 & 0 & 0 & 1 \end{array}\right]$

$\downarrow$

$R_0^3 \leftarrow$ compute

$$A_0^6 = A_0^3 A_3^6$$

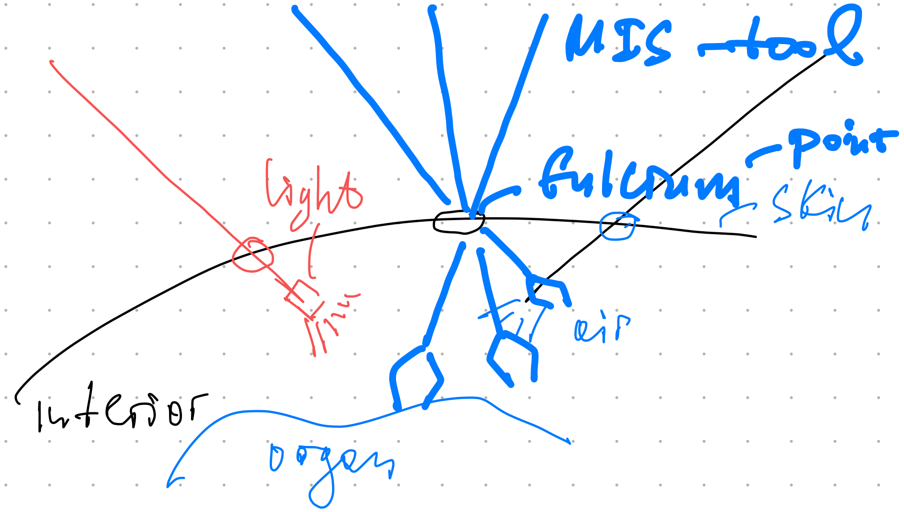
$$\left[\begin{array}{ccc|c} t_{11} & t_{12} & t_{13} & \bar{d}_0^6 \\ & & \vdots & \\ & & t_{33} & \\ \hline & & & 1 \end{array}\right] = \left[\begin{array}{c|c} R_0^3 & \bar{d}_0^c \\ \hline & 1 \end{array}\right] \left[\begin{array}{c|c} R_3^6 & - \\ & - \\ & - \\ \hline & 1 \end{array}\right]$$

given — just computed — unknown

$$R_3^6 = \left[R_0^3\right]^{-1} \begin{bmatrix} t_{11} & t_{12} & t_{13} \\ & & t_{23} \\ & & t_{33} \end{bmatrix}$$

$\theta_4, \theta_5, \theta_6$

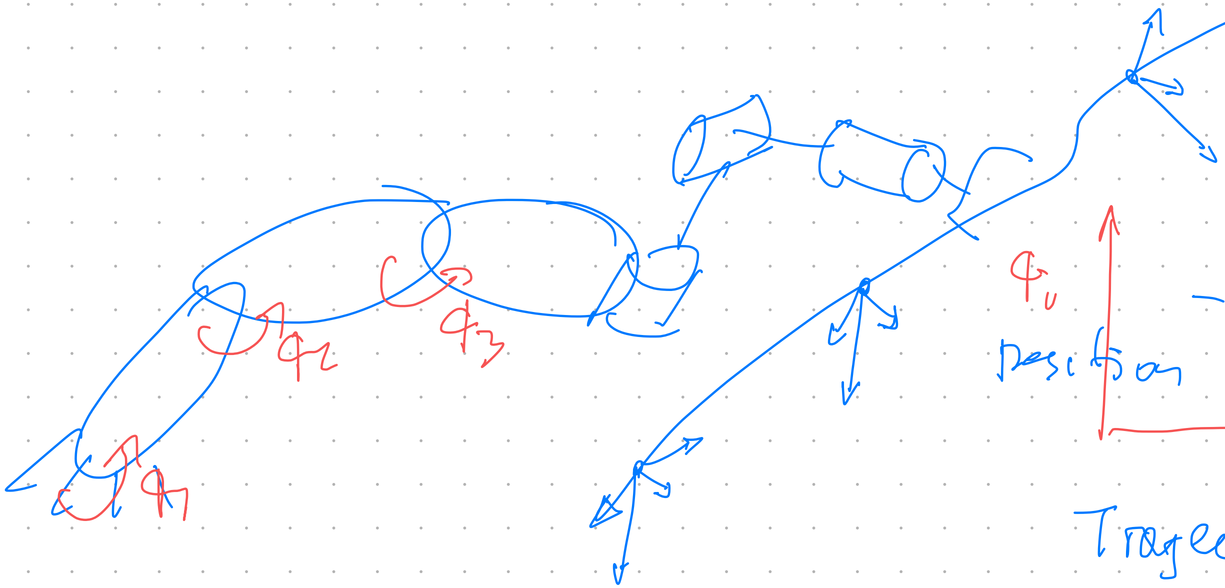
$$\boxed{R_3^6 = \left(R_0^3\right)^T \begin{bmatrix} t_{11} & t_{12} & t_{13} \\ & & \vert \\ & & t_{33} \end{bmatrix}}$$

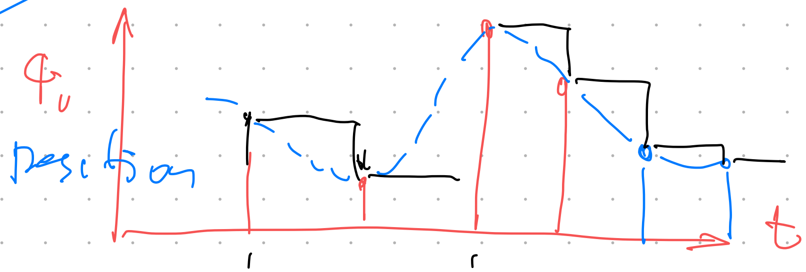


MINIMAL INVASIVE SURGERY

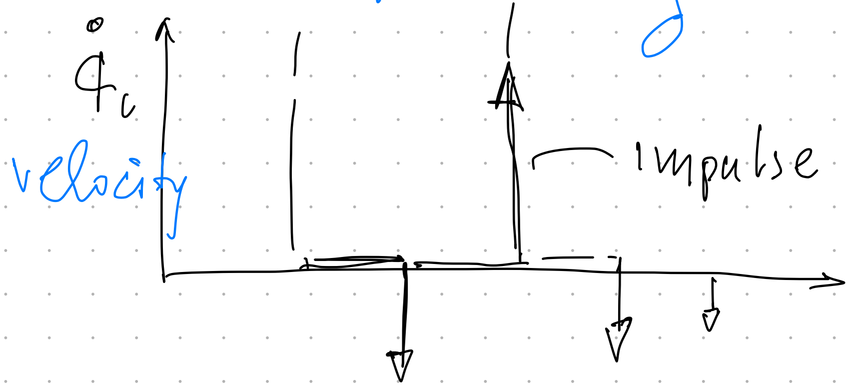
Joint coordinate(s)

$q_i(t)$, $i=1, \dots 6$





Trajectory planning



acceleration

JERK