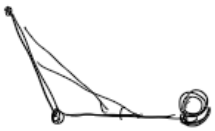
13. Lezione 9 novembre

lunedì 9 novembre 2020
14:57

RIEPILOGO

INIZIO ...

imparare a valutare le forze muscolari, reaz. giunto probl. STATICA



$\bar{t}$ conf. bloccata, coord. punti, angoli; geometria NOTA

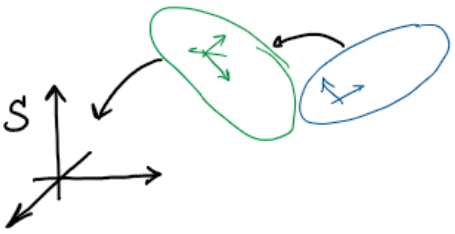
→ IMPARATO come risolvere pb. iperstatici × F_m, reaz. giunto con metodi ottimizzazione e riduzione (2D/3D)

POI configurazione generica, variabili tempo/spazio

necessità di determinare dati geometria $\bar{t}$, punti, angoli

→ IMPARATO uso coordinate omogenee (T),

- sdr per definire posa corpi rigidi



$$T_{SL} = \left[\begin{array}{c|c} R_{SL} & [O_L]_S \\ \hline \underline{0}^T & 1 \end{array}\right]$$

- Matrici R/T con doppio significato ↗ cambio SDR ↘ spost/rot fisica

$\underline{p}(1) = R\,\underline{p}(0)$ → nel SDR "OPPOSTO"

scelto SDR

$[\bar{R}]_S = R_{SS^*}[R]_{S^*}R_{SS^*}^T$

RAPPRESENTAZIONI ORIENTAMENTO

- asse angolo

$\underline{r}, \theta \rightleftharpoons R$

num. param. $\begin{cases} \underline{r}, \theta \rightarrow 4 \quad (|\underline{r}| = 1) \\ R \rightarrow 9 \end{cases}$

ma gdl = 3 per orientamento ...

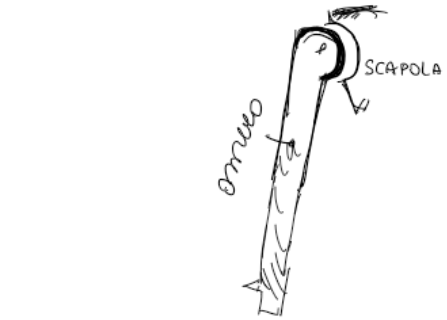
- angoli Eulero

$\underline{\lambda} \rightleftharpoons R$

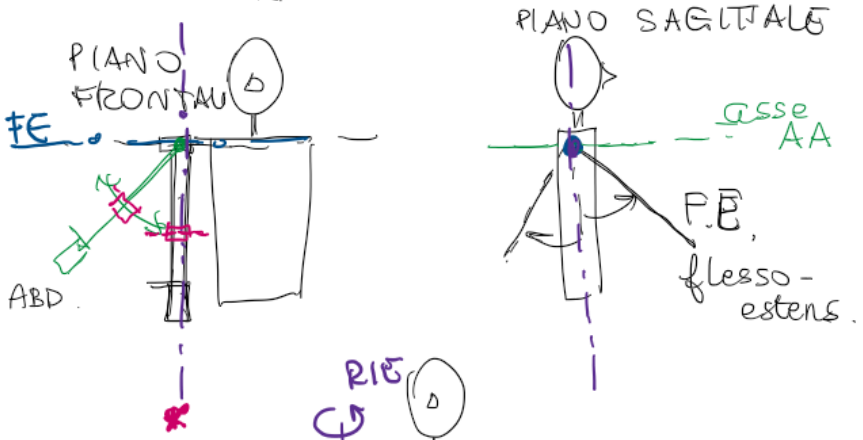
SEQU. DI 3 ROT, 3 ANGOLI

SI POSSONO USARE SEQUENZE DIVERSE PER STESSO ORIENTAMENTO

esempio SPALLA: giunto sferico → qualsiasi rotazione



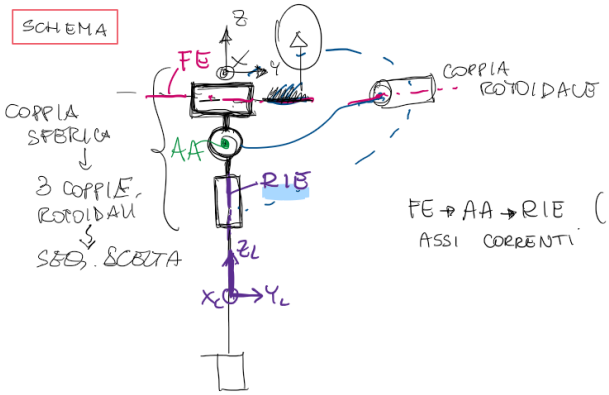
3 GRADI DI MOBILITÀ



ROT. INT / ESTERNA

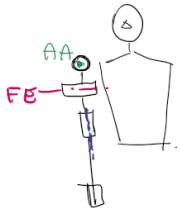
SI VISUALIZZA MEGLIO CON GOMITO FLESSO

- quale sequenza per orientare braccio nello spazio.



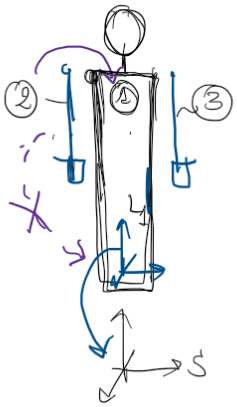
$$R_{SL}(\theta_{FE}, \theta_{AA}, \theta_{RIE}) = R_y(\theta_{FE}) \cdot R_x(\theta_{AA}) R_z(\theta_{RIE})$$

2 opzioni + spalla è anca + USATE



$$R'_{SL}(\theta'_{FE}, \theta'_{AA}, \theta'_{RIE}) = R_x(\theta'_{AA}) R_y(\theta'_{FE}) R_z(\theta'_{RIE})$$

GINNASTA



- 1 CORPO → RIFERISCE A TERRA

$T_{SL_1}(t)$ passaggio $L1 \to S$ ai vari frame

$T_{L_1L_2}(t)$

$T_{L_1L_3}(t)$

- $T_{SL_2} = T_{SL_1}\, T_{L_1L_2}$

spalla destra

- $T_{L_1L_2}\left(\theta^D_{FE}, \theta^D_{AA}, \theta^D_{RIE}\right) =$

$$\left[\begin{array}{c|c} R_{L_1L_2}\left(\theta^D_{FE}, \theta^D_{AA}, \theta^D_{RIE}\right) & \left[O_{L_2}\right]_{L_1} \\ \hline 0^T & 1 \end{array}\right]$$

MATR. OMOGENEA POSIZIONA 2 RISP. 1

spalla sinistra

- $T_{L_1L_3}\left(\theta^S_{FE}, \theta^S_{AA}, \theta^S_{RIE}\right)$

t — movimento assegnato / unico

T_{SL_1} 6GDL

$\left[O_{L_1}\right]_S$, $R_{SL_1}(\alpha_1, \beta_1, \gamma_1)$ ZYX

$x_{O_1}, y_{O_1}, z_{O_1}$

$T_{SL_1}(t)$

$T_{SL_2}(x_{O_1}, y_{O_1}, z_{O_1}, \ldots)$

MOVIMENTO SIMULARE

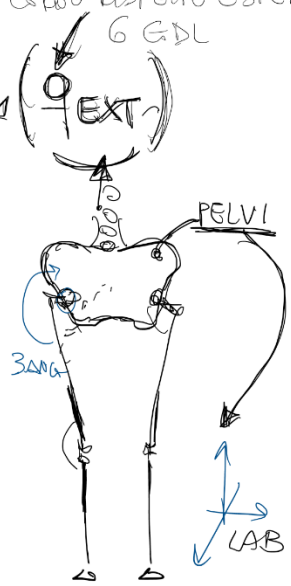
$x_{O_1}(t)$ $\alpha_1(t)$

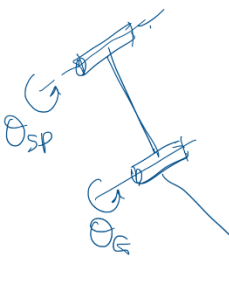
$y_{O_1}(t)$ $\beta_1(t)$

$z_{O_1}(t)$ $\gamma_1(t)$

VAR. X POSIZIONI CORPO RISPETTO ESTERNO 6 GDL

$T_{SL_1}\left(q_{EXT}\right)$





θ_{SP} θ_G ⇒ SI ASSEGNANO X DEFINIRE MODELLO

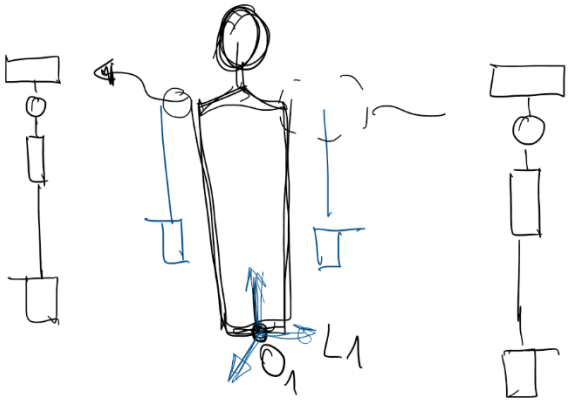
- variazione angoli ai giunti nel tempo definiscono il vostro movimento.

$T_{SL_i}(q_{EXT}, q_{INT}) = T_{SL_i}(q)$ ~ modello

$q = (q_{EXT}, q_{INT})$

T_{SL_i}: S = terna fissa; L_i = corpo e modello

$q(t)$ ~ MOVIMENTO



$q =$ ARRAY

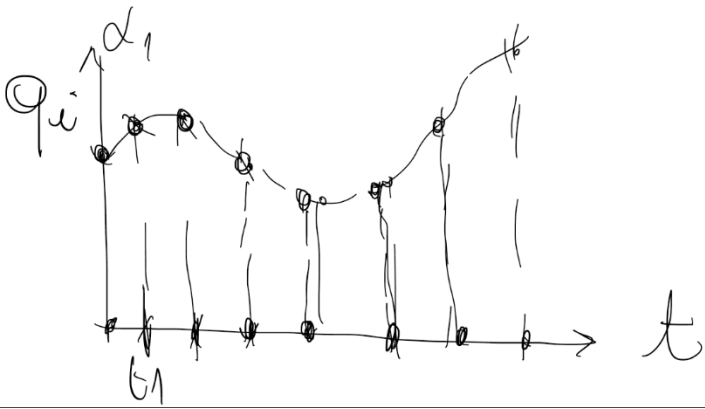
$\begin{bmatrix} x_{O_1} \\ y_{O_1} \\ z_{O_1} \\ \alpha_1 \\ \beta_1 \\ \gamma_1 \\ \vartheta^D_{PIE} \\ \vartheta^D_{AN} \\ \vartheta^D_{RIN} \\ \vartheta^S_{PIE} \\ \vartheta^S_{AA} \\ \vartheta^A_{RIE} \end{bmatrix}$ } 3 T, 3 R

? GDL

6 GDL EXT

6 GDL INT < 3 SD, 3 SS

12 GDL



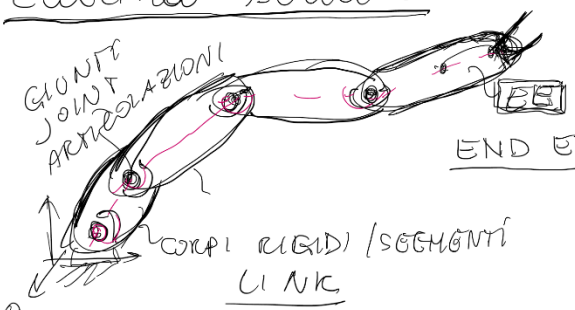
$q(0)$ $q(t_1)$ $q(t_2)$

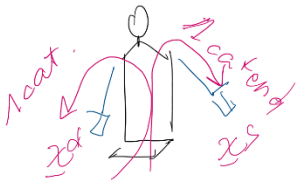
CINEMATICA DIRETTA

q → MODELLO T → x POSIZIONE DEI VARI CORPI

q: VARIABILI DI GIUNTO — COORDINATES

- catena seriale





q, $T_{0EE}(q)$, q, $x = \begin{bmatrix} x_{0E} \\ y_{0E} \\ z_{0E} \\ \lambda \end{bmatrix}$ $\begin{bmatrix} R_{EE} \\ \end{bmatrix}_0$

$T_{0EE}(q)$: 4×4, 12 SCAL.

x: RAPPRES. MINIMO POSA EE

λ → ANG. EUL. × SEQ. SCELTA

6 ELEM.

$R_{0EE} \xrightarrow{\text{SEQ.}} \lambda$

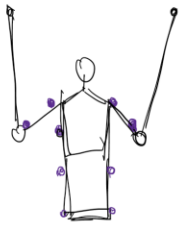
$x(q)$ cinematica diretta

NOTI ANGOLI GIUNTI → POSIZIONE EE.

- BRACCIO $\theta^D_{FE} = 45°$ $\theta^D_{AA} = 30°$ $\theta^D_{RIG} = +20°$

q^D → dove sta mano (x) bracciо

Cinematica Inversa



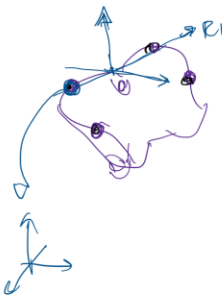
- configurazione assegnata

$\underline{x}^d$, $\underline{x}^s$ NOTI

? q

$\underline{x} \rightarrow q$

in analisi movimento si rilevano coord. punti $\rightarrow \underline{x} \rightarrow q$

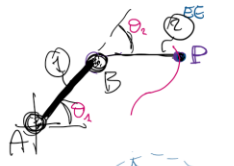


{Punti}$_S$ → {Punti}$_{SL}$ (calcolata)

RILIEVO SPERIM.

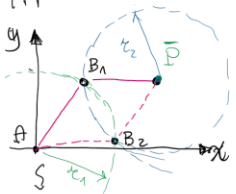
ROBOTICA → MANIPOLATORE PLANARE R, R

2 GDL



CIN DIRETTA $(\theta_1, \theta_2) \rightarrow \bar{P}$

CINEM. INVERSA $\bar{P} \rightarrow ?\ (\theta_1, \theta_2)$



? B

② – ① RIGIDI

$r_1 = \overline{AB}$

$r_2 = \overline{PB}$

2 soluz. cin. inversa

gomito alto B_1

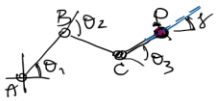
" basso B_2

ergonomia

BISTURI

3 GDL

R – R – R

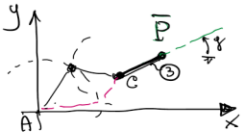


CINEM. INVERSA

$q = (\theta_1, \theta_2, \theta_3)$

$P \rightarrow \bar{P}$

$\gamma = \bar{\gamma}$



? B, C

$\overline{PC} = r_3$

B → R, R (GLA. – G.B)

GDL braccio → 7

MANO → 6

1 GdL "ridondante"

↳ ∞ posizionare LINK INT. X CE IN POSA ASSEGNARE