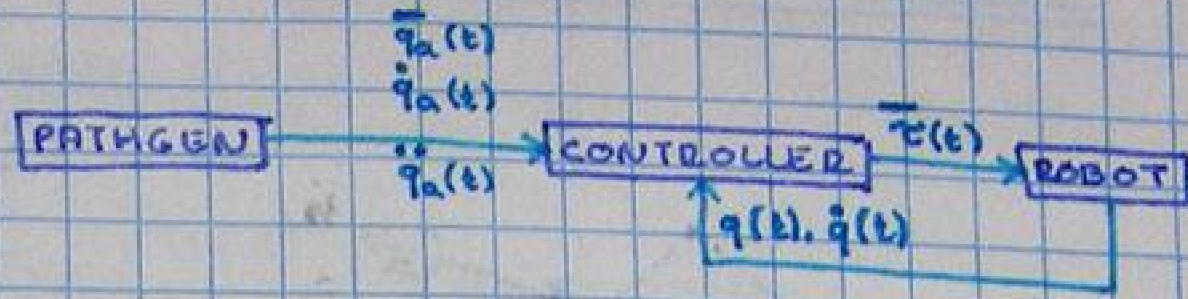
2009. 03. 25.

Pálya generálás - PATHGEN
Kontroller - CONTROLLER



S-függvény (flad, idő, állapotváltozók)

m — matlab
C — C

$\dot{q}_a(t) := \dot{\bar{q}}_a(t), \ldots$

Embedded-function / Beágyazott függvény (csak meghatározott függvények hívására)

$$\boxed{\bar{\bar{H}}(\bar{q})\ddot{\bar{q}} + \bar{h}(\bar{q}, \dot{\bar{q}}) = \bar{\tau}}$$

1.) Kiszámított nyomatékok módszere / Computed Torque Technic (CTT)

Robot: $\bar{\bar{H}}\ddot{\bar{q}} + \bar{h} = \bar{\tau}$

CTT szabályozás: $\bar{\tau} := \bar{\bar{H}}\bar{u} + \bar{h}$

ZR: $\bar{\bar{H}}\ddot{\bar{q}} + \bar{h} = \bar{\bar{H}}\bar{u} + \bar{h}, \quad \exists \bar{\bar{H}}^{-1}$

$\ddot{\bar{q}} = \bar{u} \iff \ddot{q}_i = u_i$ szétcsatolt kettős integrál

Decentralizált szabályozók: $u_i := \ddot{q}_{ai} + \mathrm{PID}$

$\ddot{q}_{ai} = u_i := \ddot{q}_{ai} + k_{Pi}(q_{ai} - q_i) + k_{Ii}\int_0^t [q_{ai}(\tau) - q_i(\tau)]d\tau + k_{Di}(\dot{q}_{ai} - \dot{q}_i)$

$e_i := q_{ai} - q_i$ (hiba)

$$\boxed{e_i''' + k_{Di}e_i'' + k_{Pi}e_i' + k_{Ii}e_i = 0}$$

KE: $s^3 + k_{Di}s^2 + k_{Pi}s + k_{Ii} = 0$ stabil és gyors

↳ karakterisztikus egyenlet

$(1 + sT)^3 = 1 + 3sT + 3s^2T^2 + s^3T^3 = 0$

$\Rightarrow /:T^3 \Rightarrow$

$s^3 + \underbrace{\frac{3}{T}}_{k_{Di}}s^2 + \underbrace{\frac{3}{T^2}}_{k_{Pi}}s + \underbrace{\frac{1}{T^3}}_{k_{Ii}} = 0$

pl.: $T = 50$ ms, $i = 1, 2, 3$
$T = 25$ ms, $i = 4, 5, 6$

Valóságban: → névleges modell $\hat{\bar{\bar{H}}}, \hat{\bar{h}}$
→ valódi modell $\bar{\bar{H}}, \bar{h}$

$\bar{\bar{H}}\ddot{\bar{q}} + \bar{h} = \hat{\bar{\bar{H}}}\bar{u} + \hat{\bar{h}}$

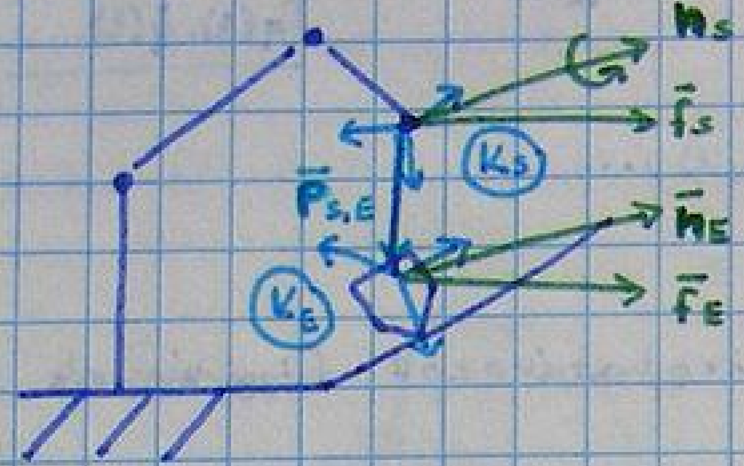
$$\boxed{\ddot{\bar{q}} = \bar{\bar{H}}^{-1}(\hat{\bar{h}} - \bar{h}) + \bar{\bar{H}}^{-1}\hat{\bar{\bar{H}}}\bar{u}}$$

csak közelítőleg szétcsatolt!

Felső szint: $\bar{\tau} := \hat{\bar{\bar{H}}}(\bar{q})\bar{u} + \hat{\bar{h}}(\bar{q}, \dot{\bar{q}})$

Decentralizált lineáris: $u_i := \ddot{q}_{ai} + \mathrm{PID}$

Erő és nyomaték áthelyezés:



Bázisfüggetlen alak:

$$\bar{f}_S = \bar{f}_E$$
$$\bar{n}_E = \bar{n}_S + \bar{f}_S \times \bar{p}_{S,E}$$

Bázisfüggő alak:

$$K_S \xrightarrow{\bar{\bar{T}}_{S,E}} K_E$$
$$\bar{f}_S \qquad \bar{f}_E = ?$$
$$\bar{n}_S \qquad \bar{n}_E = ?$$

$$\bar{f}_E = \bar{\bar{A}}_{SE}^T \bar{f}_S$$

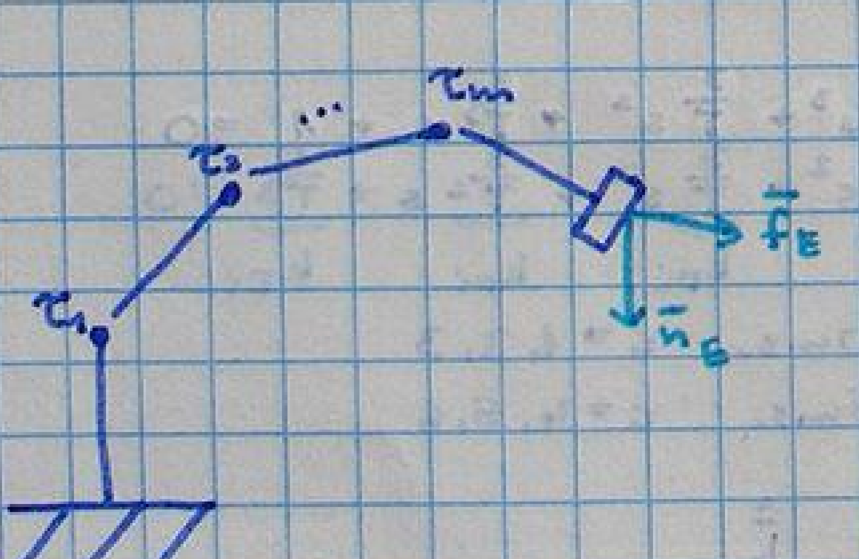
$$\bar{n}_E = \bar{\bar{A}}_{SE}^T \{ \bar{n}_S + \underbrace{\bar{f}_S \times \bar{p}_{SE}}_{-\bar{p}_{SE} \times \bar{f}_S} \} = \bar{\bar{A}}_{SE}^T \bar{n}_S + \underbrace{\bar{\bar{A}}_{SE}^T [\bar{p}_{SE} \times]^T}_{([\bar{p}_{SE}\times]\bar{\bar{A}}_{SE})^T} \bar{f}_S = ([\bar{p}_{SE}\times]\bar{\bar{A}}_{SE})^T \bar{f}_S + \bar{\bar{A}}_{SE}^T \bar{n}_S$$

$$\begin{pmatrix} \bar{f}_E \\ \bar{n}_E \end{pmatrix} = \begin{bmatrix} \bar{\bar{A}}_{SE}^T & \bar{\bar{O}} \\ ([\bar{p}_{SE}\times]\bar{\bar{A}}_{SE})^T & \bar{\bar{A}}_{SE}^T \end{bmatrix} \begin{pmatrix} \bar{f}_S \\ n_S \end{pmatrix}$$

$$K_1 \xrightarrow{\bar{\bar{T}}_{1,2}} K_2$$

$$\begin{pmatrix} \bar{f}_1 \\ \bar{n}_1 \end{pmatrix} \longrightarrow \begin{pmatrix} \bar{f}_2 \\ \bar{n}_2 \end{pmatrix} = \begin{bmatrix} \bar{\bar{A}}_{12}^T & \bar{\bar{O}} \\ ([p_{12}\times]\bar{\bar{A}}_{12})^T & \bar{\bar{A}}_{12}^T \end{bmatrix} \begin{pmatrix} \bar{f}_1 \\ \bar{n}_1 \end{pmatrix}$$

Ekvivalens csuklónyomatékok:



$$\bar{\bar{F}}_E = \begin{pmatrix} \bar{f}_E \\ \bar{n}_E \end{pmatrix}, \quad \bar{\tau} = \begin{pmatrix} \tau_1 \\ \vdots \\ \tau_m \end{pmatrix}, \quad \begin{pmatrix} \bar{v} \\ \bar{\omega} \end{pmatrix} = \bar{\bar{J}} \dot{\bar{q}}$$

$$\downarrow$$

$$\delta \bar{x} = \bar{\bar{J}} \delta \bar{q} \qquad \bar{x} = \begin{pmatrix} \bar{p} \\ t_\varphi \end{pmatrix}$$

$$\langle \bar{F}, \underbrace{\delta x}_{\bar{\bar{J}}\delta\bar{q}} \rangle = \langle \bar{\tau}, \delta \bar{q} \rangle$$

$$T$$

$$\langle \bar{\bar{J}}^T \bar{F}, \delta \bar{q} \rangle = \langle \bar{\tau}, \delta \bar{q} \rangle, \quad \forall \delta \bar{q} \Rightarrow \boxed{\bar{\tau} = \bar{\bar{J}}^T \bar{F}}$$