Arm Constraints

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1 Arm Constraints

1.1 Features

The feature matrix of a motor module is given by

$$F_m = \begin{bmatrix} \tau_{stall}^{(1)} & \tau_{stall}^{(2)} & \tau_{stall}^{(3)} \\ \omega_{free}^{(1)} & \omega_{free}^{(2)} & \omega_{free}^{(3)} \\ P^{(1)} & P^{(2)} & P^{(3)} \\ M^{(1)} & M^{(2)} & M^{(3)} \end{bmatrix} \tag{1}$$

where $\tau_{stall}^{(i)}$ is the stall torque in Newton-meters for motor i, $\omega_{free}^{(i)}$ is the free speed in radians per second for motor i, $P^{(i)}$ is the price of motor i, and $M^{(i)}$ is the mass in kilograms of motor i.

1.2 Required Tip Force and Velocity

V is the tip velocity (given as `requiredTipVelocityMeterPerSec`). F is the tip force (given as `requiredTipForceNewtons`). R_j is the r parameter of link j (the `dh-A` parameter). The arm is mounted $90\,\mathrm{deg}$ off vertical.

The torque-speed curve of a motor is given by:

$$\omega_i(\tau; \tau_{stall}^{(i)}, \omega_{free}^{(i)}) = \frac{(\tau_{stall}^{(i)} - \tau)\omega_{free}^{(i)}}{\tau_{stall}^{(i)}} \tag{2}$$

$$\tau_1 \geq F(R_1 + R_2 + R_3) + G(M_2 R_1 + M_3(R_1 + R_2)) \tag{3}$$

$$\tau_2 \geq F(R_2 + R_3) + M_3 G R_2 \tag{4}$$

$$\tau_3 \geq F R_3 \tag{5}$$

$$\omega_1(\tau_1) \geq \frac{V}{R_1 + R_2 + R_3} \tag{6}$$

$$\omega_2(\tau_2) \geq \frac{V}{R_2 + R_3} \tag{7}$$

$$\omega_3(\tau_3) \geq \frac{V}{R_3} \tag{8}$$

1.3 Optimization Goal

We want to optimize for price (lowest price).