PROJECT: Precision Underwater Positioner

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Title: Motor Sizing calculations

UNITS: $kip \equiv 1000 \cdot lbf$ $ksi \equiv \frac{kip}{in^2}$ $psi \equiv \frac{lbf}{in^2}$ $k \equiv kip$ $ksf \equiv \frac{kip}{ft^2}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $plf \equiv \frac{lbf}{ft}$

PROPERTIES & ASSUMTIONS:

Weight of probe head $F_1 \equiv 30 \cdot lbf$

Weight of motor(s) $F_2 \equiv 5 \cdot lbf$

Weight of linkage + arm1 $F_3 := 5 \cdot lbf$

Weight of linkage + arm1+ arm2 $F_4 := 5 \cdot lbf$

Total Weight at M1 $W1 := F_1 + F_2 + F_3$

Total Weight at M2 $W2 := F_1 + F_2 + F_3 + F_4$

Length 1= length of first joint: $L_1 := 6 \cdot in$

Length 2 = total length: $L_2 := 18 \cdot in$

Typical Motor weight $M_W := .5 \cdot kg$

$M_W = 1.102\,lb$

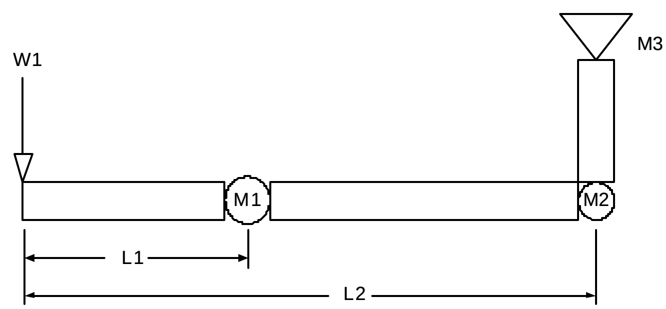
$W1 = 40\,lbf$

$W1 = 177.925\,newton$

$W1 = 18.143\,kgf$

$L_1 = 0.152\,m$

$L_2 = 0.457\,m$



CALCULATION:

Moment found at motor 1

$M_1 := L_1 \cdot W1$

$M_1 = 20\,ft\,lbf$

$M_1 = 240\,in \cdot lbf$

$M_1 = 27.116\,newton \cdot m$

Moment found at motor 2

$M_2 := L_2 \cdot W2$

$M_2 = 67.5\,ft \cdot lbf$

$M_2 = 810\,in \cdot lbf$

$M_2 = 91.516\,newton \cdot m$

Polar Moment of Inertia of a mass = J_M

Distance to center axis of probe head housing $L_{PH} := 16in$

Radius of housiiing $r := 2.5 \cdot in$ $D := 5.0 \cdot in$

Density of material $\rho := \dfrac{.16 \cdot lbf}{in^3}$

Mass of object $M := W1$ $M = 40\,lbf$

Polar moment of inertia $j := \dfrac{\pi \cdot D^4}{32}$ $j = 61.359\,in^4$

Polar moment of inertia of a mass $J_M := \dfrac{\rho \cdot L_{PH}}{g} \cdot j$ $J_M = 1.091\,lb\,ft^2$

Torque required to accelerate an inertia

$v_{max} := \dfrac{2 \cdot 2 \cdot \pi}{60 \cdot sec}$ $v_{max} = 0.209\,\dfrac{rad}{sec}$

$a_{max} := \dfrac{v_{max}}{2 \cdot sec}$ $a_{max} = 0.105\,\dfrac{rad}{sec^2}$

Inertial torque: $\tau_{inertial} := J_M \cdot a_{max}$ $\tau_{inertial} = 0.043\,lbf \cdot in$