SexticArm Documentation

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1 Inverse Kinematics

1.1 Rotation Matrices

$$
{}^0R_3 = \begin{pmatrix}
\cos\theta_1\cos\theta_2\cos\theta_3 - \cos\theta_1\sin\theta_2\sin\theta_3 & -\sin\theta_1 & \cos\theta_1\cos\theta_2\sin\theta_3 + \cos\theta_1\sin\theta_2\cos\theta_3 \\
\sin\theta_1\cos\theta_2\cos\theta_3 - \sin\theta_1\sin\theta_2\sin\theta_3 & \cos\theta_1 & \sin\theta_1\cos\theta_2\sin\theta_3 + \sin\theta_1\sin\theta_2\cos\theta_3 \\
-\sin\theta_2\cos\theta_3 - \cos\theta_2\sin\theta_3 & 0 & -\sin\theta_2\sin\theta_3 - \cos\theta_2\cos\theta_3
\end{pmatrix}
$$

$$
{}^3R_6 = \begin{pmatrix}
\cos\theta_4\cos\theta_5\cos\theta_6 - \sin\theta_4\sin\theta_6 & -\cos\theta_4\cos\theta_5\sin\theta_6 - \sin\theta_4\cos\theta_6 & \cos\theta_4\sin\theta_5 \\
\sin\theta_4\cos\theta_5\cos\theta_6 + \cos\theta_4\sin\theta_6 & -\sin\theta_4\cos\theta_5\sin\theta_6 + \cos\theta_4\cos\theta_6 & \sin\theta_4\sin\theta_5 \\
-\sin\theta_5\cos\theta_6 & \sin\theta_5\sin\theta_6 & \cos\theta_5
\end{pmatrix}
$$

$$
{}^0R_6 = \begin{pmatrix}
\cos\theta_p\cos(\frac{\pi}{2}-\theta_e)\cos\theta_r - \sin\theta_p\sin\theta_r & -\cos\theta_p\cos(\frac{\pi}{2}-\theta_e)\sin\theta_r - \sin\theta_p\cos\theta_r & \cos\theta_p\sin(\frac{\pi}{2}-\theta_e) \\
\sin\theta_p\cos(\frac{\pi}{2}-\theta_e)\cos\theta_r + \cos\theta_p\sin\theta_r & -\sin\theta_p\cos(\frac{\pi}{2}-\theta_e)\sin\theta_r + \cos\theta_p\cos\theta_r & \sin\theta_p\sin(\frac{\pi}{2}-\theta_e) \\
-\sin(\frac{\pi}{2}-\theta_e)\cos\theta_r & \sin(\frac{\pi}{2}-\theta_e)\sin\theta_r & \cos(\frac{\pi}{2}-\theta_e)
\end{pmatrix}
$$

2 Hardware

2.1 Stepper Driver

A4988 Steper Driver
$V_{ref} = I_{max} * 8 * R_{sens}$

Drivers used:
$R_{sens} = 0.1\Omega$

2.2 Stepper Motor

NEMA 17: 17HS4401S
Specification:

- Steps per revolution: 200 steps/rev
- Microstepping: 16
- Maximum torque: 0.42 Nm
- Operating current: 1 A

3 LGCODE

3.1 G0

G0 A1{} A2{} A3{} A4{} A5{} A6{} F{}

Move steppers by angles (in degrees)

3.2 G1

G1 X{} Y{} Z{} P{} E{} R{} F{}

Move steppers to position and orientation (in degrees)

-P
: Angle in polar coordinate

-E
: Angle of elevation [-90..90]

-R
: Rotational angle of the tool head

3.3 G10

G10

Home Steppers – Power off required

3.4 M0

M0 {Serial_Port}

Connect Serial at {Serial_Port}

3.5 M1

M1 {Acceleration}

Set Acceleration for all steppers

4 Serial Commands

4.1 Move

M {A1} {A2} {A3} {A4} {A5} {A6}\n

4.2 Acceleration

A {Acceleration}\n