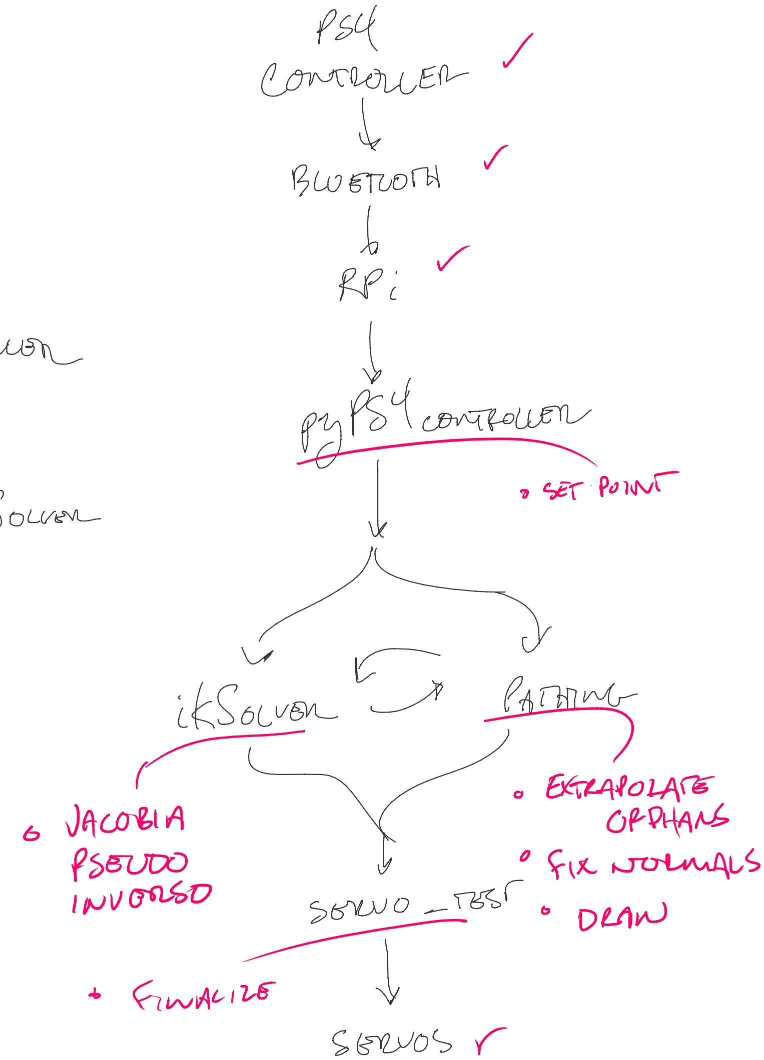
Arm notes

Wednesday, December 29, 2021 7:48 PM



ARM

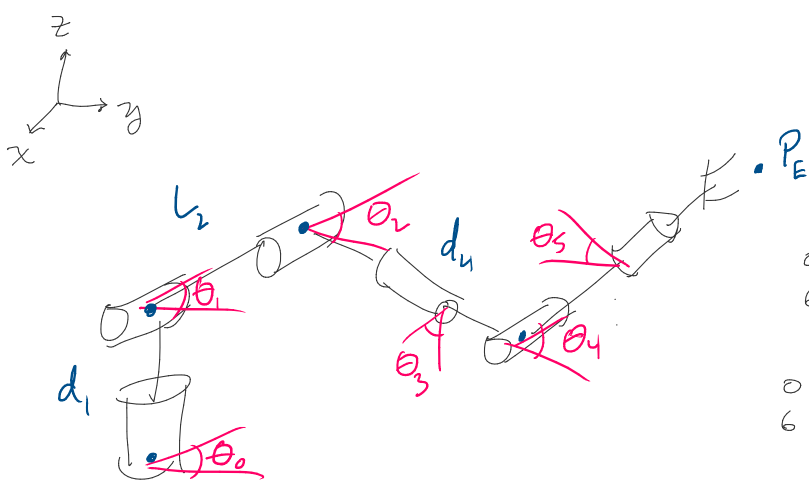
SERVOS → SERVO_TEST

CONTROLLER → pyPS4controller

RPi → BLUETOOTH →

INVERSE KINEMATICS → ik Solver

PATHING → PATHING



$${}^0_6T = \begin{bmatrix} R & P_E \\ 0\,0\,0 & 1 \end{bmatrix}$$

$${}^0_6T = {}^0_1T \cdot {}^1_2T \cdot {}^2_3T \cdot {}^3_4T \cdot {}^4_5T \cdot {}^5_6T$$

ACTUALLY T SHOULD BE H

x, y, z

$P_0 = 0, 0, 0$

$P_1 = 0, d_1, 0$

$$H^2_0 = H^1_0 \cdot H^2_1$$

$$= \begin{bmatrix} R^1_0 & P^1_0 \end{bmatrix} \begin{bmatrix} R^2_1 & P^2_1 \end{bmatrix}$$

$P_1 = 0, d_1, 0$

$P_2 = \sim$

$P_3 = x_3, y_3, z_3$

$P_4 = \sim$

$P_{EE} =$ GIVEN

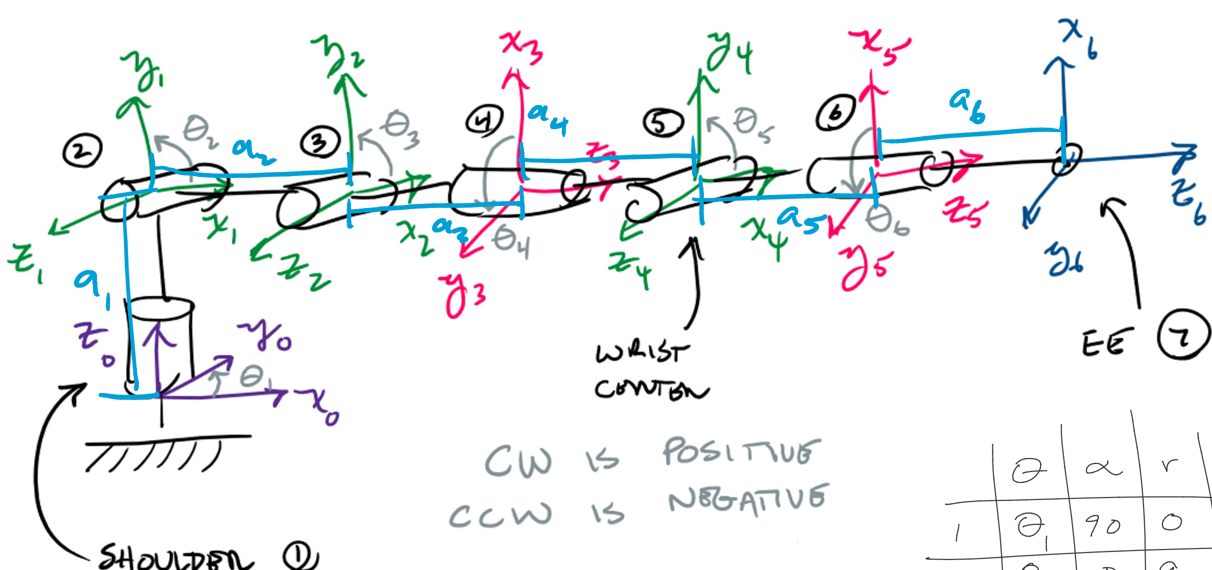
$$= \begin{bmatrix} R_0^1 & P_0^1 \\ 000 & 1 \end{bmatrix} \begin{bmatrix} R_1^2 & P_1^2 \\ 000 & 1 \end{bmatrix}$$

$$\begin{matrix} a & b & c & x \\ d & e & f & y \\ g & h & i & z \\ 0 & 0 & 0 & 1 \end{matrix} \qquad \begin{matrix} a & b & c \\ d & e & f \\ g & h & i \end{matrix}$$

$$P_0^2 = \begin{bmatrix} x_0 + a_0 x_1 + b_0 y_1 + c_0 z_1 \\ y_0 + d_0 x_1 + e_0 y_1 + f_0 z_1 \\ z_0 + g_0 x_1 + h_0 y_1 + i_0 z_1 \end{bmatrix}$$

$$R_{i-1}^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (d_n^0 - d_{i-1}^0) \qquad R_1^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (d_2^0 - d_1^0)$$

$\uparrow$
$n =$ MAX FRAMES



CW IS POSITIVE
CCW IS NEGATIVE

	θ	α	r	d
1	θ_1	90	0	a_1
2	θ_2	0	a_2	0
3	θ_3	90	a_3	0
4	θ_4	90	0	a_4
5	θ_5	90	a_5	0
6	θ_6	0	0	a_6

$$H_n^{n-1} = \begin{bmatrix} R_n^{n-1} & r_n C\theta_n \\ & r_n S\theta_n \\ & d_n \end{bmatrix}$$

$$H^{n-1}_{n} = \begin{bmatrix} K^{n-1}_{n} & & & r_n c\theta_n \\ & & & r_n s\theta_n \\ & & & d_n \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

5	θ_5	90	a_5	0
6	θ_6	0	0	a_6

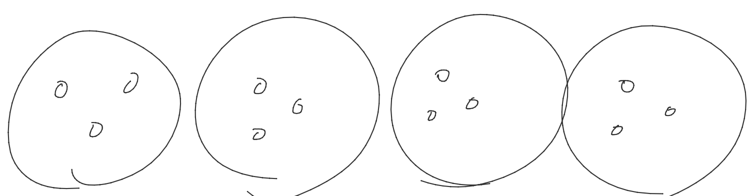
$$H^{0}_{1} = \begin{bmatrix} \cdots & 0 \\ & 0 \\ & a_1 \\ & 1 \end{bmatrix} \qquad H^{3}_{4} = \begin{bmatrix} \cdots & 0 \\ & 0 \\ & a_4 \\ & 1 \end{bmatrix}$$

$$H^{1}_{2} = \begin{bmatrix} \cdots & a_2 c\theta_2 \\ & a_2 s\theta_2 \\ & 0 \\ & 1 \end{bmatrix} \qquad H^{4}_{5} = \begin{bmatrix} \cdots & a_5 c\theta_5 \\ & a_5 s\theta_5 \\ & 0 \\ & 1 \end{bmatrix}$$

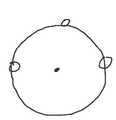
$$H^{2}_{3} = \begin{bmatrix} \cdots & a_3 c\theta_3 \\ & a_3 s\theta_3 \\ & 0 \\ & 1 \end{bmatrix} \qquad H^{5}_{6} = \begin{bmatrix} \cdots & 0 \\ & 0 \\ & a_6 \\ & 1 \end{bmatrix}$$

$$J = \begin{bmatrix} R^0_0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (d^0_2 - d^0_0) & R^0_1 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (d^0_2 - d^0_1) & \cdots \\ R^0_0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & R^0_1 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \end{bmatrix}$$

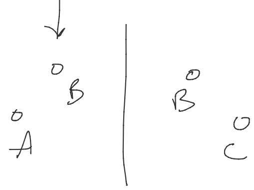
ENCIRCLE



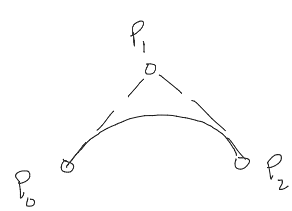
FIND CENTER

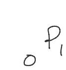


INTERPOLATE



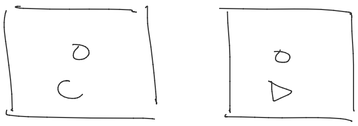
QUADRATIC





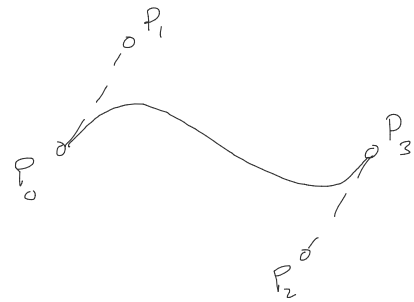
EXTRA

EXTRA-POLATE

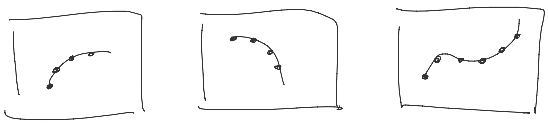


F G

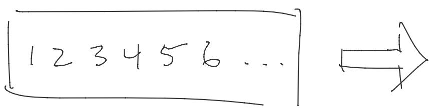
CUBIC



SAMPLE



PATH



A

ANGELA SODEMANN

$$\det\left(J(\vec{\theta})\right) = \begin{vmatrix} p_i^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times \left(d_n^0 - d_i^0\right) & \cdots \\ R_i^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \cdots \end{vmatrix}, \quad i \in [0, n]$$

$n = 5$

$$J(\vec{\theta}) \in \mathbb{R}^{n \times n}$$

$$\vec{\theta} \in \mathbb{R}^{n}$$

B

OTHER

$$\det\left(J(\vec{\theta})\right) = \begin{vmatrix} \frac{\partial}{\partial \theta_0} p_0^0 & \cdots & \frac{\partial}{\partial \theta_n} p_n^0 \end{vmatrix}$$

PSEUDO INVERSE A^+, $A \in \mathbb{R}^{m \times n}$

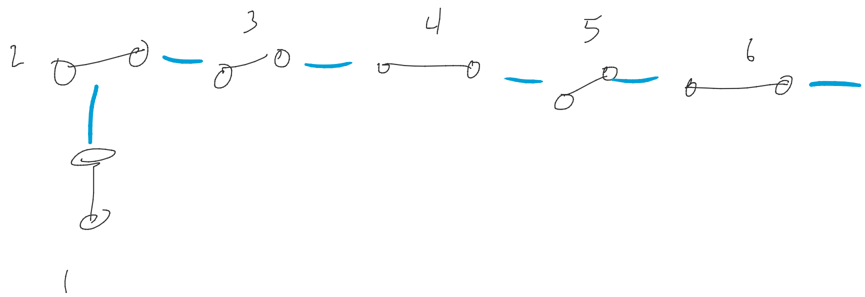
$$A^+ = (A^T A)^{-1} A^T$$

$A = USV^T$ SINGULAR VALUE DECOMPOSITION

$\mathcal{U}$ & $V \in \mathbb{R}^{n \times n}$, ORTHOGONAL

$S \in \mathbb{R}^{m \times n}$, DIAGONAL w/ REAL, NON-NEG. SINGULAR VALUES

$$\longrightarrow \quad A^{+} = V(S^{T}S)^{-1}S^{T}\mathcal{U}^{T}$$



$$J = \begin{bmatrix} R_0^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (p_n^0 - p_0^0) & \cdots & R_{n-1}^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \times (p_n^0 - p_{n-1}^0) \\ R_0^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} & \cdots & R_{n-1}^0 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \end{bmatrix} = \begin{bmatrix} J_v \\ J_w \end{bmatrix}$$