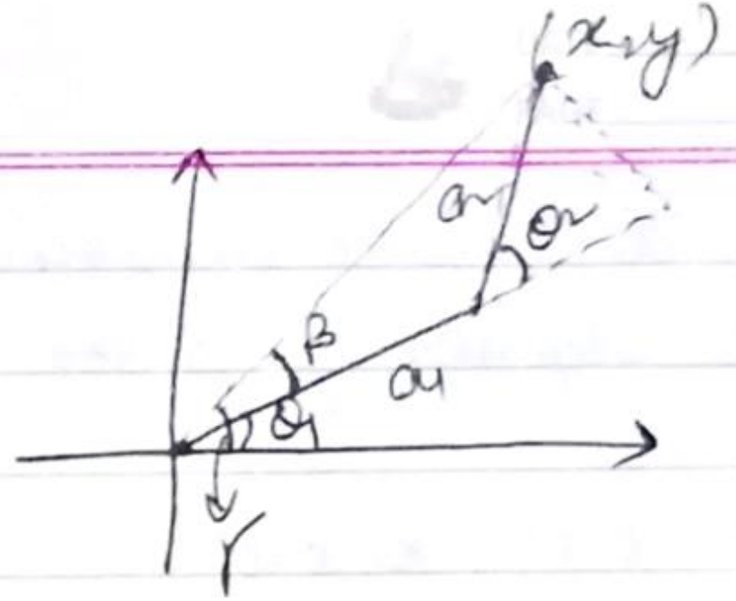

$$x = a_1 \cos(\theta_1) + a_2 \cos(\theta_1 + \theta_2)$$
$$y = a_1 \sin(\theta_1) + a_2 \sin(\theta_1 + \theta_2)$$

$$x^2 + y^2 = a_1^2 + a_2^2 + 2a_1 a_2 \cos(\theta_2)$$

$$\theta_1 = \gamma - \beta$$
$$\gamma = \tan^{-1}\left(\frac{y}{x}\right)$$

$$\tan(\beta) = \frac{a_2 \sin\theta_2}{a_1 + a_2 \cos\theta_2}$$

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2018155-ECE

DH Parameters

	Link	Link length (a_i)	Link Offset (d_i)	Link Twist (α_i)	Joint Angle (θ_i)
1	1	0.2 m	1.5 m	0	θ_1
	2	0.025 m	0	180°	θ_2
	3	0	0	$d_3 = 0$	θ_3
	4	0	0	d_4	0

$$q = [\theta_1 \quad \theta_2 \quad \theta_3 \quad d_4]^T$$

${}^4_0T$ is computed using matlab (symbolically)
last column of it represents origin of (4) wrt (0)
you can inspect it, $T(:,4)$.

$$\Rightarrow \quad x = a_1 \cos(\theta_1) + a_2 \cos(\theta_1 + \theta_2)$$
$$y = a_1 \sin(\theta_1) + a_2 \sin(\theta_1 + \theta_2)$$
$$z = d_1 - d_4 - d_3$$

$$\boxed{z = 1.5 - d_4}$$

$$x^2 + y^2 = a_1^2 + a_2^2 + 2a_1a_2\cos(\theta_2)$$

$$\boxed{\theta_2 = \pm \cos^{-1}\left[\frac{x^2 + y^2 - a_1^2 - a_2^2}{2a_1a_2}\right]} \quad \text{(To resolve ambiguity)}$$

$$\boxed{\theta_1 = \tan^{-1}\left(\frac{y}{x}\right) - \tan^{-1}\left(\frac{a_2\sin(\theta_2)}{a_1 + a_2\cos(\theta_2)}\right)}$$

$$\theta_3 = 0 \quad \forall \quad t \geq 0 \quad \text{(given)}$$

Indexing of matlab array into simulink is done using this formula.

$$ind = 1 + \text{round}(t * 100),$$

t is a discrete variable. it takes values b/w $0 \leq t \leq 20$ with step size of 0.001

Logic : $t = x \times 10^{-3}$

Interpolated array (0 - 20000)

$$t \times 1000 = \frac{x}{10}$$

$$\text{round}(t \times 1000) = x // 10$$

$$1 + \text{round}(t \times 1000) = 1 + x // 10$$

$\Rightarrow$ 0 - 9 $\Rightarrow$ 1

10 - 19 $\Rightarrow$ 2

:

~~19991 - 20000 $\Rightarrow$ 2000~~

19991 - 19999 $\Rightarrow$ 2000

20000 $\Rightarrow$ 2001 (Reason of Expansion of interpolated array).

Similar logic can be defined for t_step_size = 10^(-4).
Run Parameters.m first to load all the model parameter in workspace. Then, run the model.slx to simulate dynamics and at last show_trajectory.m to see plot.