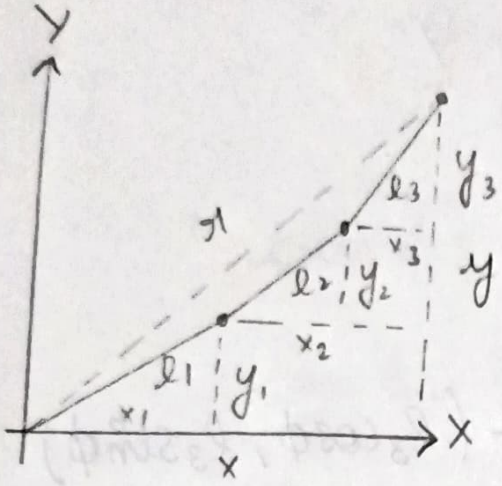
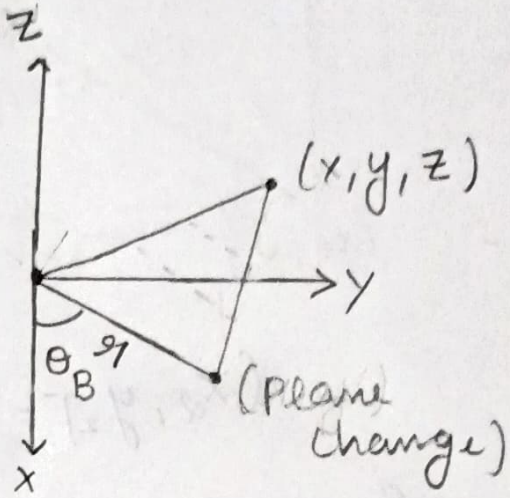
Adding a Base Rotation :

Front Plane



Top angle.



we solve this as "RRR"

$$X = l_1 C\theta_1 + l_2 \cos(\theta_1+\theta_2) + l_3 \cos(\theta_1+\theta_2+\theta_3)$$

$$Y = l_1 S\theta_1 + l_2 \sin(\theta_1+\theta_2) + l_3 \sin(\theta_1+\theta_2+\theta_3)$$

$$r^2 = x^2 + y^2$$

$$r = (x^2+y^2)^{1/2}$$

$$Z = Z \text{ required}$$

Now we are going to add the 3R over the rotating Base so Now the Y in RRR becomes Z

$$Z = l_1 S\theta_1 + l_2 S(\theta_1+\theta_2) + l_3 S(\theta_1+\theta_2+\theta_3)$$

$$x_{new} = x(old) * \cos(\theta_b)$$

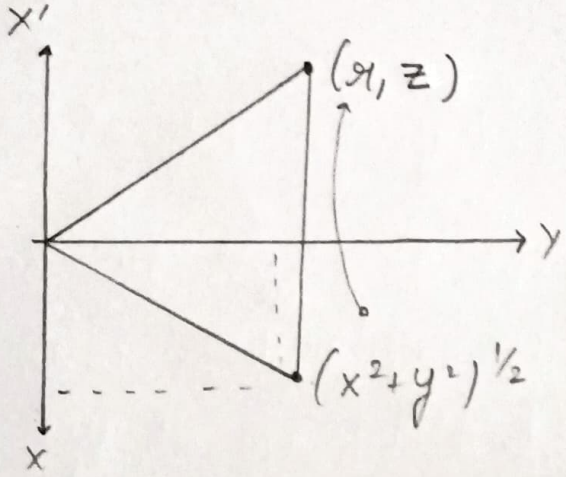
$$y_{new} = y_{old} * \sin(\theta_b)$$

Solving inverse kinematics:

$$\theta_{base} = \tan^{-1}\left(y/x\right)$$

Now we know 1 angle need 3 more

ϕ is constrained (SO2 more)



Now we can do the similar as RRR config

$$x_2, y_2 = \underbrace{x_3, y_3}_{(r,z)} - (l_3\cos\phi, l_3\sin\phi)$$

$$r = (x_{rec}^2 + y_{rec}^2)^{1/2}$$

then we solve as we do for 2R configuration.

$$\theta_1 = \tan^{-1}(y/x) - \tan^{-1}(k_2/k_1)$$

then θ_2 by Pythagorous.