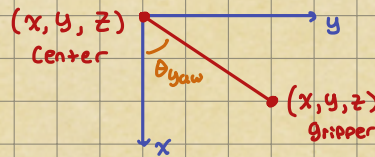


1) $x_{grip} = x_{w-grip} + 0.15$
 $y_{grip} = y_{w-grip} - 0.15$
 $z_{grip} = z_{w-grip} - 0.01$

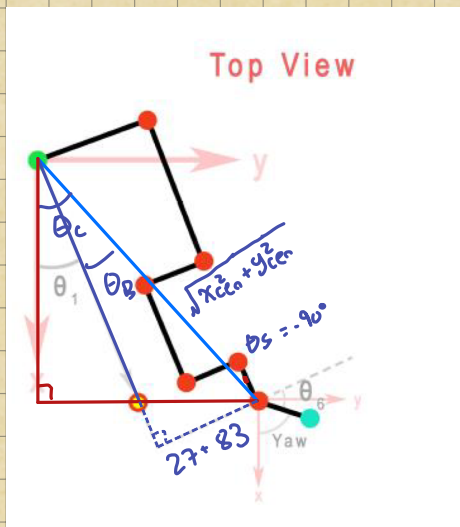
Offsetting the gripper
 Position by the amount
 needs to reference it to the base frame

$$\theta_s = -90^\circ$$

2) $x_{cen} = x_{grip} - 0.0535 \cos(\theta_{yaw})$
 $y_{cen} = y_{grip} - 0.0535 \sin(\theta_{yaw})$
 $z_{cen} = z_{grip}$



3)



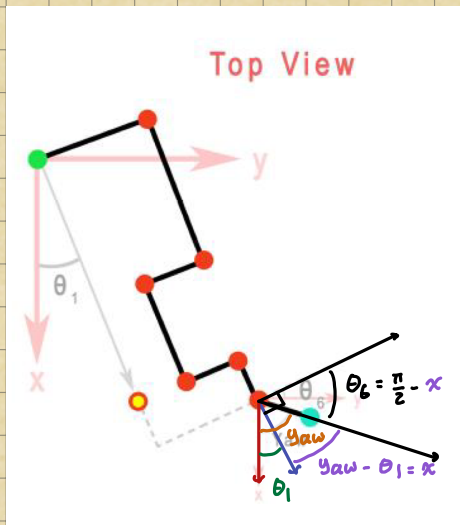
$$\theta_c = \arctan(y_{cen}/x_{cen})$$

$$\theta_B = \arcsin(110/\sqrt{x_{cen}^2 + y_{cen}^2})$$

$$\theta_1 = \theta_c - \theta_B$$

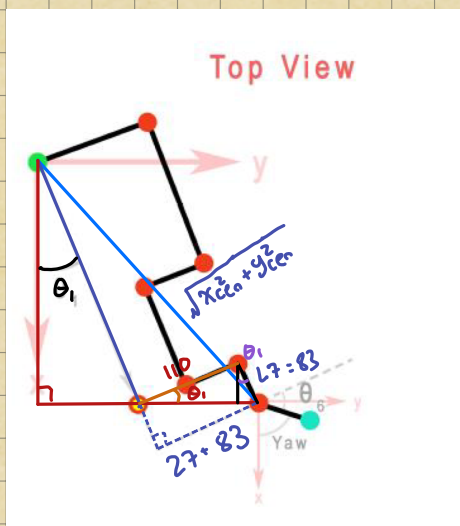
$$\theta_1 = \arctan(y_{cen}/x_{cen}) - \arcsin(110/\sqrt{x_{cen}^2 + y_{cen}^2})$$

4)



$$\theta_6 = \pi/2 - (\theta_{yaw} - \theta_1)$$

5)



$$z_{3end} = z_{cen} + 59 + 82 = z_{cen} + 141$$

$$x_1 = x_{cen} - 83 \cos \theta_1$$

$$y_1 = y_{cen} - 83 \sin \theta_1$$

$$x_{3end} = x_1 + 110 \sin \theta_1$$

$$y_{3end} = y_1 - 110 \cos \theta_1$$

6)

Figure 3. Top view of UR3

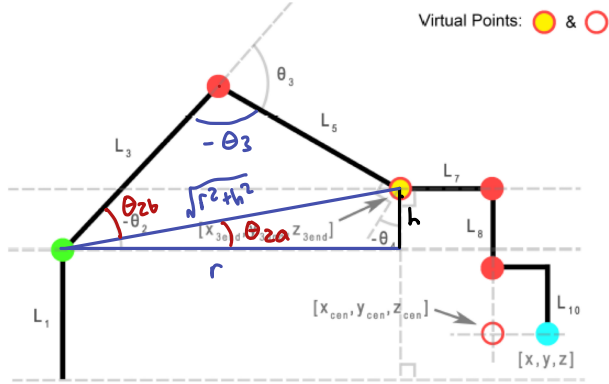


Figure 4. Side view of UR3

$$r = \sqrt{x_{3end}^2 + y_{3end}^2}$$

$$h = z_{3end} - L_1$$

$$2ab = 2L_3L_5 \quad a = L_3 \quad b = L_5 \quad c = r - h$$

$$r^2 + h^2 = L_3^2 + L_5^2 + 2L_3L_5 \cos(\theta_3)$$

$$\theta_3 = \arccos\left(\frac{r^2 + h^2 - L_3^2 - L_5^2}{2L_3L_5}\right)$$

$$\theta_{2a} = \arctan(h/r)$$

$$L_5^2 = L_3^2 + (\sqrt{r^2 + h^2})^2 - 2L_3\sqrt{r^2 + h^2} \cos(\theta_{2b})$$

$$\theta_{2b} = \arccos\left(\frac{L_5^2 - L_3^2 - r^2 - h^2}{-2L_3\sqrt{r^2 + h^2}}\right)$$

$$-\theta_2 = \arctan(h/r) + \arccos\left(\frac{L_5^2 - L_3^2 - r^2 - h^2}{-2L_3\sqrt{r^2 + h^2}}\right)$$

$$\theta_4 = -\theta_3 - \theta_2$$

Top View

