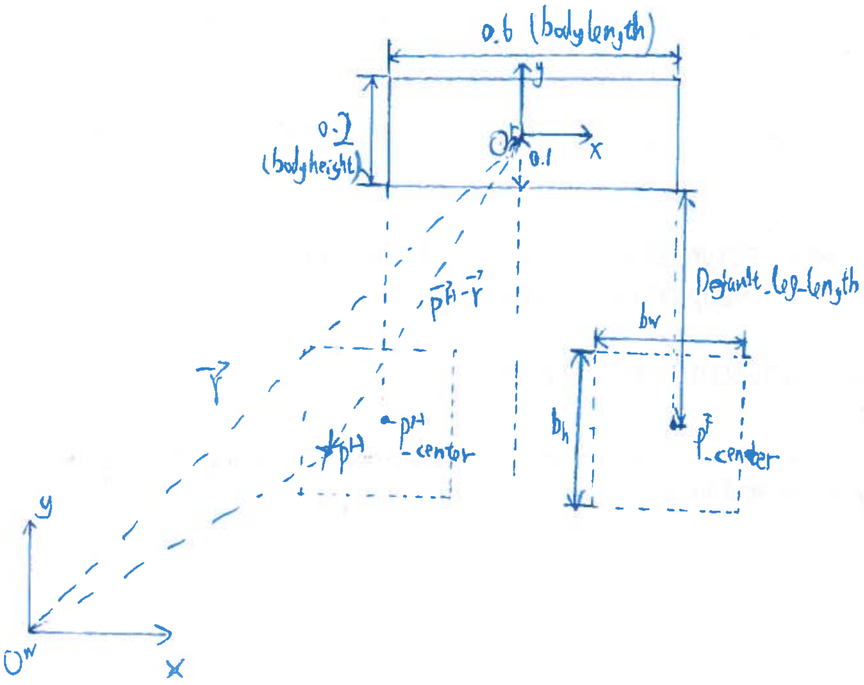
Kinematics Constraint - Bounding Box Formulation - Used in Winkler's work



O^r: origin of the robot frame

O^w: origin of the world fra

$\vec{r}$: robot CoM state

$\vec{P^H} - \vec{r}$: End-effector vector in world frame

$R(\theta)(\vec{P^H} - \vec{r})$: transform to robot fra

$R(\theta)$: rotation matrix

b_w: width of the bounding box

b_h: height of the bounding box

Center Position of front leg: $P^F\_center = \left(\frac{1}{2}\cdot \text{body\_length},\ -(\frac{1}{2}\text{body height} + \text{default\_leg\_length})\right)$
(in local robot frame)

Center Position of Hind leg: $P^H\_center = \left(-\frac{1}{2}\text{body\_length},\ -(\frac{1}{2}\text{body height} + \text{default\_leg\_length})\right)$
(in local robot frame)

Kinematics Constraint: ~~R(θ)·[P~~ ~~R(θ)·[P^F - P^F_center]~~

$$|R(\theta)\cdot[\vec{P^F} - \vec{r}] - \vec{P^F}\_center| \le \vec{b}$$

$$\vec{b} = [b_w, b_h]^T$$

$$\Downarrow$$

$$-\vec{b}/2 \le R(\theta)\cdot(\vec{P} - \vec{r}) - \vec{P^F}\_center \le \vec{b}/2$$

$$-\begin{bmatrix} b_w \\ b_h \end{bmatrix}/2 \qquad \le \begin{bmatrix} b_w \\ b_h \end{bmatrix}/2$$

$$\text{Leg\_vector}^r = [PF_x - x;\ PF_y - y]$$

$$\begin{bmatrix} \cos(\theta)\cdot(PF_x - x) + \sin(\theta)\cdot(PF_y - y) \\ -\sin(\theta)(PF_x - x) + \cos(\theta)\cdot(PF_y - y) \end{bmatrix}$$