4/21/23

Regis

* $\text{degree} = \left(\frac{x - 1500}{1000}\right) \cdot 90$

$y = x - 90$

-27 is to 63 $\quad x - 90 = y$

what 63 is to -27

* desired angle $\rightarrow$ $\boxed{\text{leg1, leg3}}$ $\quad$ angle $- 90 = y$ $\rightarrow$ $\boxed{\text{leg2, leg4}}$

* $\text{deg} = \left(\frac{x-1500}{1000}\right) 90 \Rightarrow \frac{\text{deg}}{90} = \frac{x-1500}{1000} \Rightarrow \frac{\text{deg} \cdot 1000}{90}$

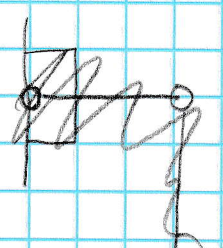
$\frac{100\,\text{deg}}{9} = x - 1500 \Rightarrow \frac{100\,\text{deg}}{9} + 1500 = x$ where x = position signal

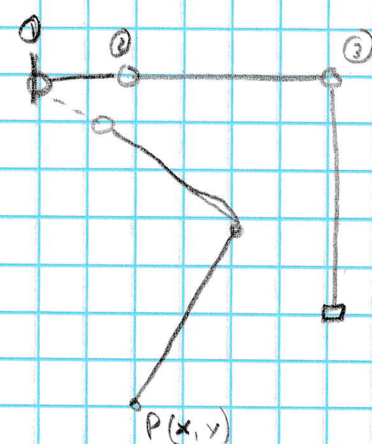
deg

-90 = 500

0 = 1500

90 = 2500





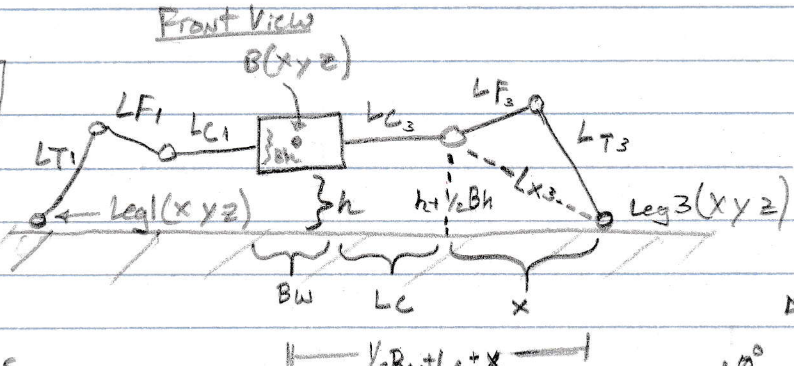
movement

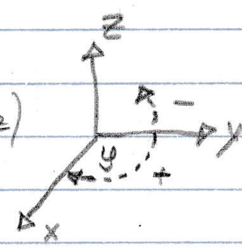
① (0, 0) → (0, 0)

② (2, 0) → (1.5, -1)

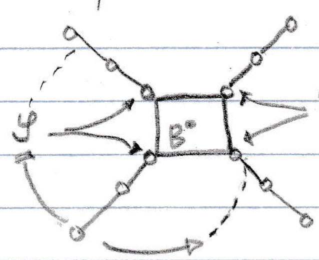
③ (6, 0) → (-3, 4)

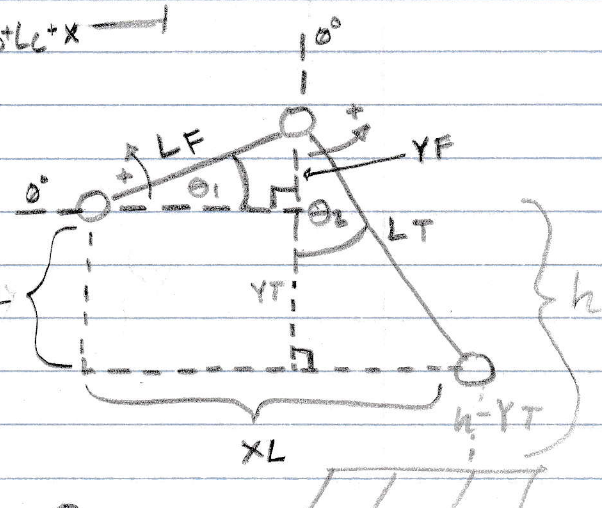
$$
\begin{array}{c|ccc}
 & C & F & T \\
\hline
① & \varphi(xy)_1 & \theta_{1F} & \theta_{1T} \\
② & \varphi(x,y)_2 & \theta_{2F} & \theta_{2T} \\
③ & \varphi(xy)_3 & \theta_{3F} & \theta_{3T} \\
④ & \varphi(xy)_4 & \theta_{4F} & \theta_{4T}
\end{array}
$$





Cylindrical Coordinates



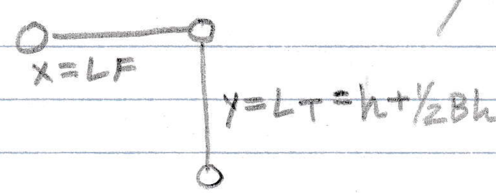


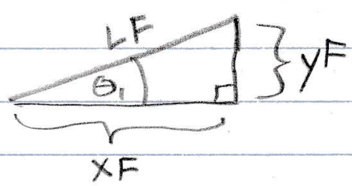
* where radius, r
$r = \frac{1}{2}Bw + Lc + X$

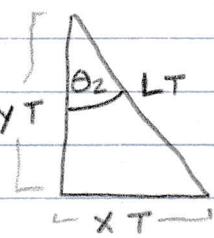
* where Angle $\varphi = \varphi$

→ How is Radius length related to θ_1 and θ_2?

* when in Default position $\theta_1, \theta_2 = \emptyset$







* $YT = LT \sin\theta_2$
* $XT = LT \cos\theta_2$

* $Y_F = LF \sin\theta_1$
* $XF = LF \cos\theta_1$ so...

$$
* \left|\begin{array}{l}
XL = XF + XT \rightarrow LF\cos\theta_1 + LT\cos\theta_2 \\
YL = YT - YF \rightarrow LT\sin\theta_2 - LF\sin\theta_1
\end{array}\right.
$$

&....

$$
\left|\begin{array}{l}
r = \frac{1}{2}Bw + Lc + (LF\cos\theta_1 + LT\cos\theta_2) \\
\varphi = \text{angle}
\end{array}\right.
$$

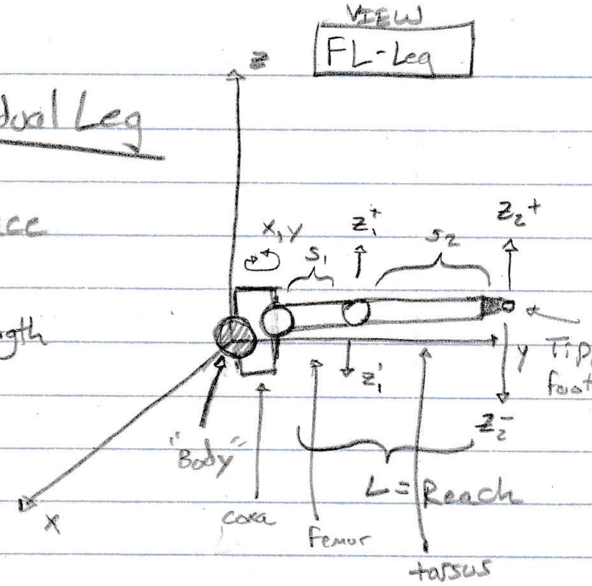
$h = YL = LT\sin\theta_2 - LF\sin\theta_1$

$B = (0,0,h)$, $Leg3 = (\frac{1}{2}Bw + Lc + (LF\cos\theta_1 + LT\cos\theta_2), \varphi - h(LT\sin\theta_2 - LF\sin\theta_1), ?)$

← what about when leg is up?

4/25/2023

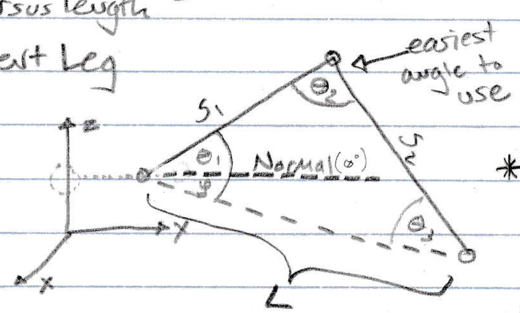
* Regis - Matrix Control for Individual Leg



* coxa controls x, y location in 3-D space
* Femur, tarsus = s_1, s_2
  - → for straight leg, Reach from body = length of femur + length of tarsus.

s_1 = femur length
s_2 = tarsus length
$\Big\} \rightarrow s_1 + s_2 = L$

→ For Bent Leg



* L = ?

*Only in yz plane when coxa = $(0, 2)_{x,y}$
(when coxa @ 90° to Body)

$*(\theta_1 + \varphi) + \theta_2 + \theta_3 = 180°$

L* $\tan\theta_3 = \tan\left(\frac{s_1}{s_2}\right) \rightarrow \tan^{-1}\left(\frac{s_1}{s_2}\right) = \theta_3$

→ θ_2 is known

inputs — computed (known)

$*\varphi = ?$ .... $(\theta_1 + \varphi) + \theta_2 + \theta_3 = 180° \rightarrow 180° - \theta_1 - \theta_2 - \theta_3 = \varphi$

where φ is angle of depression below normal line (0° of femur motor).

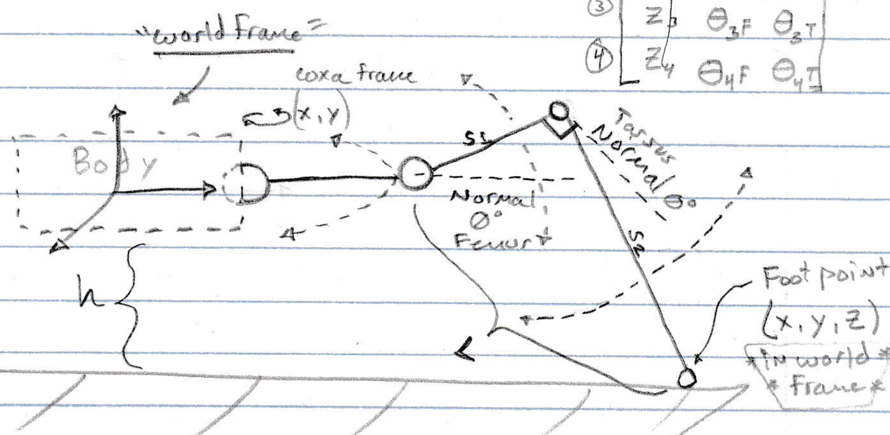
$$L = \text{hypotenuse} = \sqrt{s_1^2 + s_2^2}$$

* For 4 legs

$$\begin{array}{c|ccc} & C & F & T \\ \hline ① & z_1 & \theta_{1F} & \theta_{1T} \\ ② & z_2 & \theta_{2F} & \theta_{2T} \\ ③ & z_3 & \theta_{3F} & \theta_{3T} \\ ④ & z_4 & \theta_{4F} & \theta_{4T} \end{array}$$

* World Frame:

start point: $(x_1, y_1, z_1) = (0, 0, h)$



5/5/2023

position = [0, 0, 0] = Body_Frame [Bx, By, Bz]

$$\text{Angle\_Array} = \begin{bmatrix} Ca1 & Fa1 & Ta1 \\ Ca2 & Fa2 & Ta2 \\ Ca3 & Fa3 & Ta3 \\ Ca4 & Fa4 & Ta4 \end{bmatrix} \quad \text{Servo\_Array} \begin{bmatrix} \text{Leg 1} \\ \text{Leg 2} \\ \text{Leg 3} \\ \text{Leg 4} \end{bmatrix} = \begin{bmatrix} 7, & 6, & 5 \\ 12, & 25, & 24 \\ 23, & 4, & 27 \\ 16, & 21, & 20 \end{bmatrix}$$

servo pins for signal

$$\text{Desired\_Angle\_Array} = \begin{bmatrix} Cda1 & Fda1 & Tda1 \\ Cda2 & Fda2 & Tda2 \\ Cda3 & Fda3 & Tda3 \\ Cda4 & Fda4 & Tda4 \end{bmatrix}$$

Leg 1 - Positive
Leg 2 - Negative
Leg 3 - Positive
Leg 4 - Negative

signal conversion matrix

$$\begin{array}{c} \begin{bmatrix} - & + & - \\ + & + & + \\ + & + & + \\ - & - & - \end{bmatrix} \end{array} \begin{array}{l} \text{leg 1 - Front RH} \\ \text{leg 2 Back RH} \\ \text{leg 3 - Front LH} \\ \text{leg 4 - Back LH} \end{array}$$

```
For [i,i] in Angle_Array:
  while Angle_Array[i,i] < Desired_Angle_Array[i,i]
        ~~Angle_Array[i,i] = Angle_Array[i,i] += 1~~
        Adjustment_Array [i,i] +/- 0.1

     --> Angle_Array + Adjustment Array
         motor signal out
          sleep(speed)
repeat
```