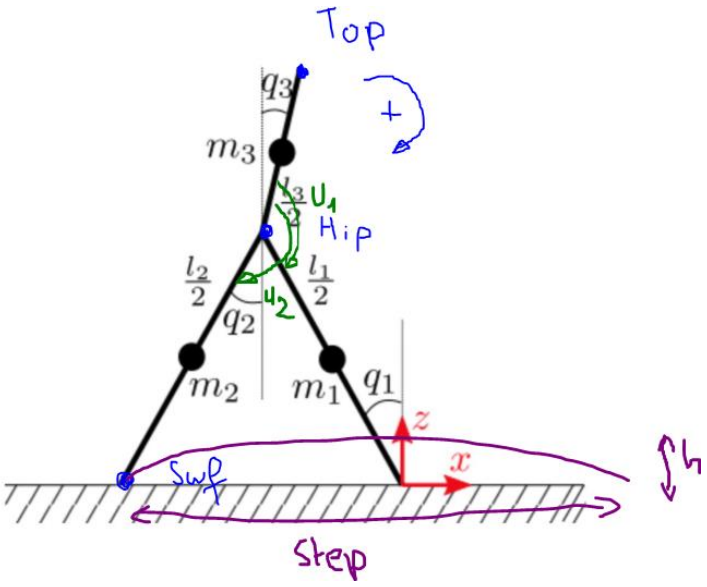

Task projection

1. **Hip Task**

   Control in speed in X axis

$$x_{hip} = l_1 \sin(q_1)$$
$$z_{hip} = l_1 \cos(q_1)$$
$$J_{hip} = \begin{bmatrix} l_1 \cos(q_1) & 0 & 0 \\ -l_1 \sin(q_1) & 0 & 0 \end{bmatrix}$$
$$f_{hip} = \begin{bmatrix} kdx_{hip}(v_{hipRef} - dx_{hip}) \\ 0 \end{bmatrix}$$
$$u_{hip} = B^{+} J_{hip} f_{hip}$$

2. **Top Task**

   Control with damp between Hip and top:

$$x_{top} = l_1 \sin(q_1) + l_3 \sin(q_3)$$
$$z_{top} = l_1 \cos(q_1) + l_3 \cos(q_3)$$
$$J_{top} = \begin{bmatrix} l_1 \cos(q_1) & 0 & l_3 \cos(q_3) \\ -l_1 \sin(q_1) & 0 & -l_3 \sin(q_3) \end{bmatrix}$$
$$f_{top} = \begin{bmatrix} kpx_{top}(x_{hip} - x_{top}) \\ kpz_{top}((z_{hip} + l_3) - z_{top}) \end{bmatrix}$$
$$u_{top} = B^{+} J_{top} f_{top}$$

   Other possibility control in angle on u1 directly:

$$u_{1angle} = kpa(angle_{ref} - q_3) + kda(0 - dq_3)$$

3. **Swing foot Task**

   Trajectory to follow:

$$z_{target} = h \sin\left(\frac{\pi}{stepLength}(x_{swf} - x0_{swf})\right)$$

   Control position for z and speed for x:

$$x_{swf} = l_1 \sin(q_1) - l_2 \sin(q_2)$$
$$z_{swf} = l_1 \cos(q_1) - l_2 \cos(q_2)$$
$$J_{swf} = \begin{bmatrix} l_1 \cos(q_1) & -l_2 \cos(q_2) & 0 \\ -l_1 \sin(q_1) & l_2 \sin(q_2) & 0 \end{bmatrix}$$
$$f_{top} = \begin{bmatrix} kdx_{swf}(v_{swfRef} - dx_{swf}) \\ kpz_{swf}(z_{target} - z_{swf}) \end{bmatrix}$$
$$u_{swf} = B^{+} J_{swf} f_{swf}$$

4. **Control total:**

   Normal:

$$u = u_{hip} + u_{top} + u_{swf}$$

   If angle:

$$u = u_{hip} + \begin{bmatrix} u_{1angle} \\ 0 \end{bmatrix} + u_{swf}$$