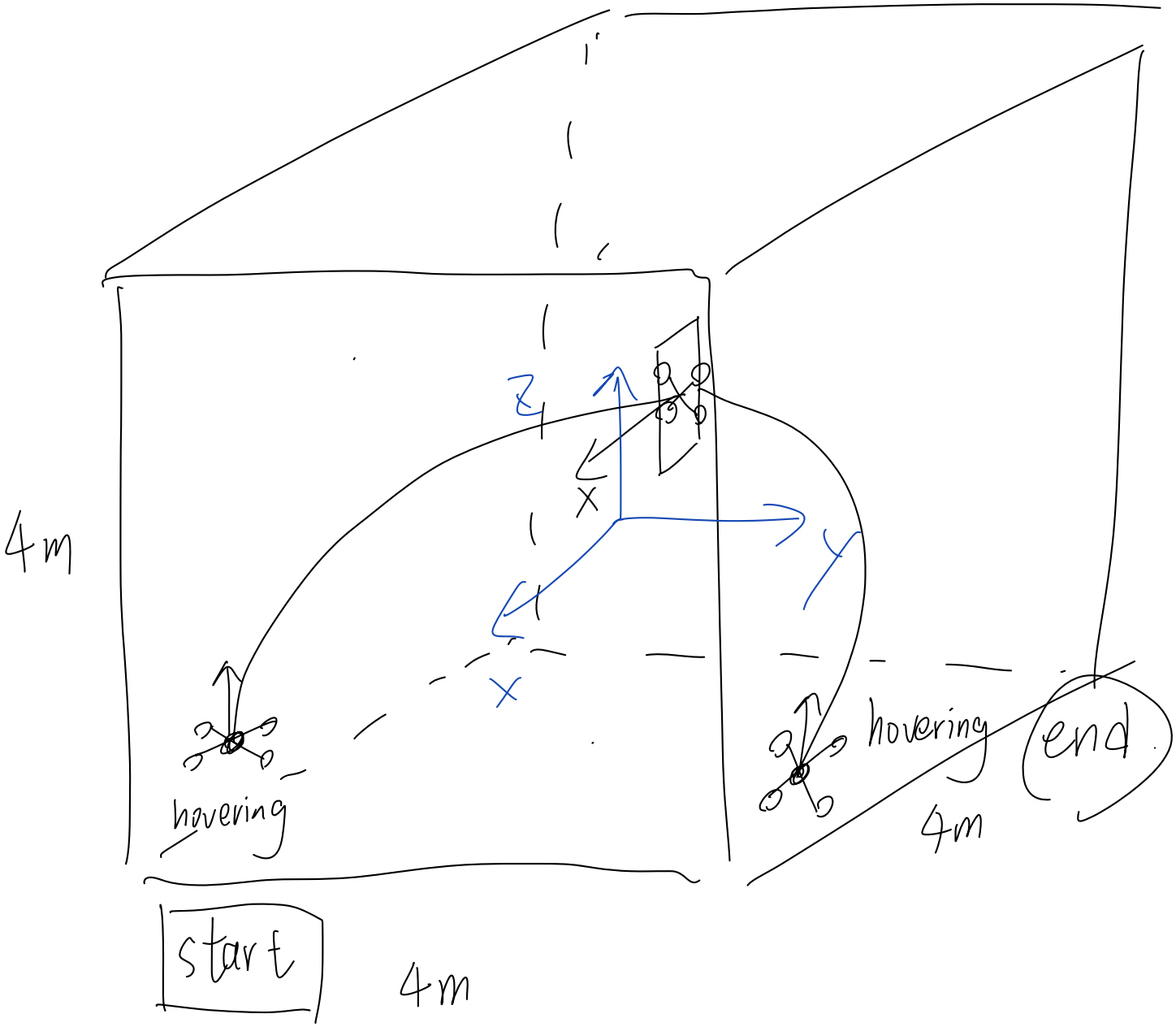
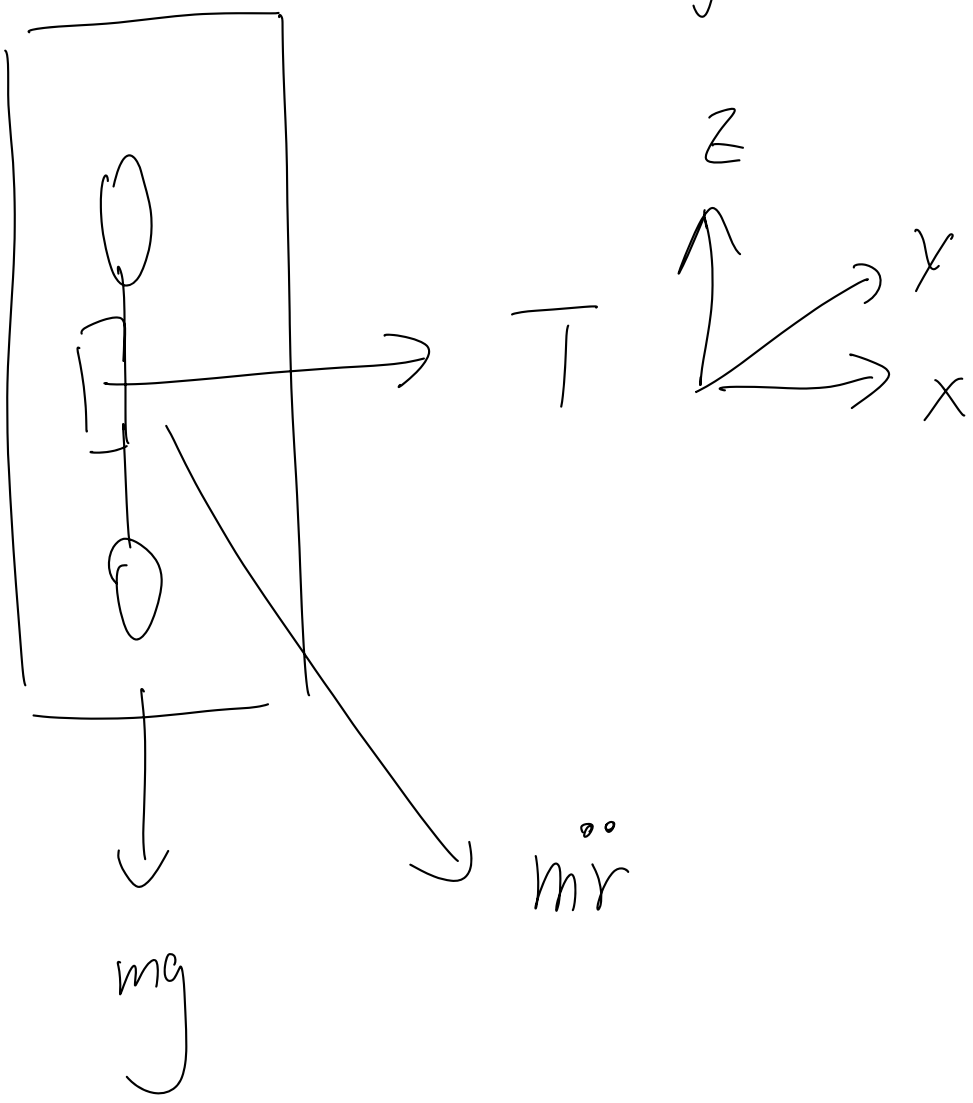
Set up



Dynamics at the gate → (0, 0, 0)

at origin



$$m\ddot{r}_f^x = T$$

$$\ddot{r}_f^x = \frac{1}{m}T$$

$$\ddot{r}_f^y = 0$$

$$m\ddot{r}_f^z = -mg$$

$$\ddot{r}_f^z = -g$$

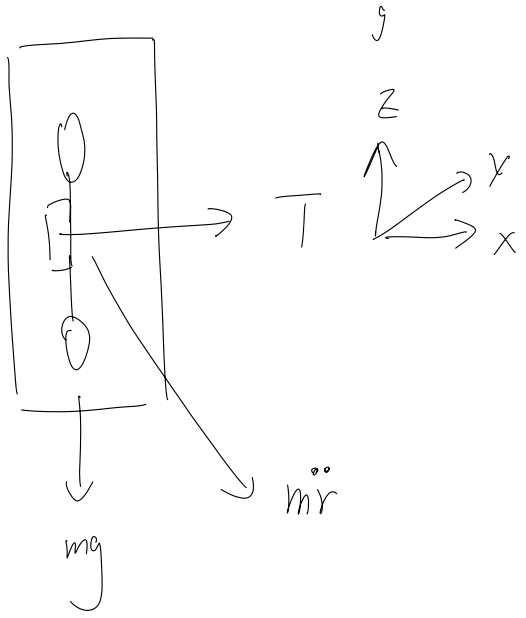
Boundary Conditions.

hovering

1. $\vec{r}_0$ known
2. $\dot{\vec{r}}_0 = \vec{0}$
3. $\ddot{\vec{r}}_0 = \vec{0}$
4. $\vec{\omega}_0 = \vec{0}$ $\rightarrow$ $\dddot{\vec{r}}_0 = \vec{0}$
5. $\vec{\alpha}_0 = \vec{0}$

at gate

6. $\vec{r}_f$ known
7. $\dot{\vec{r}}_f = (0, \dot{y}, 0)$
8. $\ddot{\vec{r}}_f = (\frac{T}{m}, 0, -g)$
9. $\vec{\omega}_f = \vec{0}$ $\rightarrow$ $\dddot{\vec{r}}_f = \vec{0}$
10. $\vec{\alpha}_f = \ldots$



minimum snap trajectory

→ use 7-th - order polynomial

$$\vec{r}(t) = \sum_{i=0}^{7} \vec{a}_i t^i$$

$$\dot{\vec{r}}(t) = \sum_{i=0}^{7} i\,\vec{a}_i t^{i-1}$$

$$\ddot{\vec{r}}(t) = \sum_{i=0}^{7} i(i-1)\,\vec{a}_i t^{i-2}$$

$$\dddot{\vec{r}}(t) = \sum_{i=0}^{7} i(i-1)(i-2)\,\vec{a}_i t^{i-3}$$

Set up matrix

$$\begin{bmatrix} 1 & & & & & & & & \\ & 1 & & & & & & & \\ & & 2 & & & & & & \\ & & & 6 & & & & & \\ 1 & t_1 & t_1^2 & \cdots & t_1^7 & & & & \\ & 1 & 2t_1 & \cdots & 7t_1^6 & & & & \\ & & 2 & \cdots & 42t_1^5 & & & & \\ & & & 6 & \cdots & 210t_1^4 & & & \end{bmatrix} \begin{bmatrix} \vec{a}_0 \\ \vec{a}_1 \\ \vec{a}_2 \\ \vec{a}_3 \\ \vec{a}_4 \\ \vec{a}_5 \\ \vec{a}_6 \\ \vec{a}_7 \end{bmatrix} = \begin{bmatrix} \vec{r}_0 \\ \vec{v}_0 \\ \vec{a}_0 \\ \vec{j}_0 \\ \vec{r}_1 \\ \vec{v}_1 \\ \vec{a}_1 \\ \vec{j}_1 \end{bmatrix}$$

a : 8×3

$n \times 8$

t : $\begin{bmatrix} 1 & t & \cdots & t^7 \end{bmatrix}$

$n \times 8$ $\quad$ 8×3 $\quad$ $n \times 3$

$\vec{r}(t) = [t] * [a] = \begin{bmatrix} \vdots & \vdots & \vdots \\ x & y & z \\ \vdots & \vdots & \vdots \\ 1 & \vdots & \vdots \end{bmatrix}$