m 驱动轮转子质量

M 机体质量

I_W 驱动轮转子转动惯量

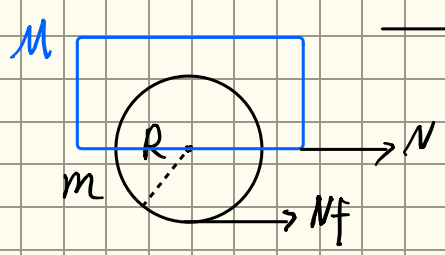
I 整车转动惯量

T 驱动轮输出力矩

w 自转角速度 (rad/s)

V_{yaw} 自线线速度

N 驱动轮对机体的力，Nf 地面对驱动轮产生



假设有神秘力量使得机体一定水平

对驱动轮

$$m\ddot{x} = Nf - N$$

$$I\cdot\frac{\ddot{x}}{R} = T - NfR$$

$$\ddot{x} = \frac{T - NR}{\frac{I_W}{R} + mR} \quad ①$$

对机体

$$N = M\cdot\ddot{x} \quad ②$$

②代入①

$$\ddot{x} = \frac{T - M\ddot{x}R}{\frac{I_W}{R} + mR} \quad ③$$

$$\left(\frac{I_W}{R} + mR\right)\cdot\ddot{x} = T - M\ddot{x}R$$

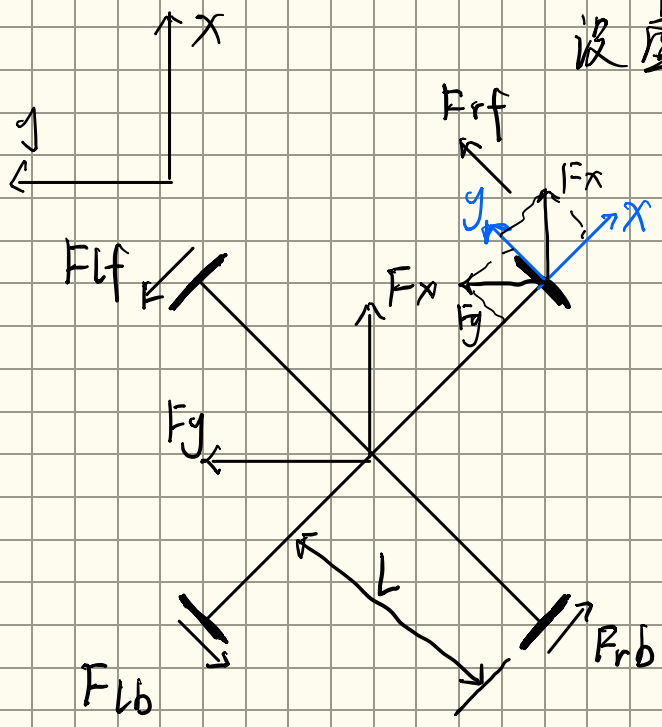
$$\left(\frac{I_W}{R} + mR + MR\right)\cdot\ddot{x} = T$$

$$\int_a^b f'(t)dt = f(b) - f(a)$$

$$\ddot{x} = \frac{1}{\frac{I_W}{R} + (m+M)R}\,T \quad ④$$

$$\int f'(t)dt = f(x) + C$$

$$\dot{x} = \frac{1}{\Sigma}\cdot\frac{1}{\frac{I_W}{R} + (m+M)R}\cdot T^2 \quad ⑤$$



x, y 车辆系

x, y 轮系

设虚拟力 $F_x = \frac{I}{R}$ ⑥

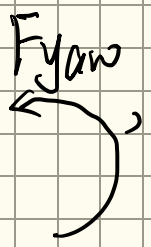
$$\dot{x} = \frac{1}{2} \cdot \frac{R^2}{\frac{I_w}{R} + (m+M)R} F_x^2 \quad ⑦$$

同理 $F_y = \frac{I}{R}$ ⑧

$$\dot{y} = \frac{1}{2} \frac{R^2}{\frac{I_w}{R} + (m+M)R} \cdot F_y^2 \quad ⑨$$

整车回转情况下

$$F_{yaw} = I \cdot \frac{w}{L} \quad ⑩$$



$$F_{rf} = \frac{1}{4}\left(\frac{\sqrt{2}}{2}F_x + \frac{\sqrt{2}}{2}F_y\right) + \frac{1}{4}F_{yaw} \quad ⑪$$

$$F_{lf} = \frac{1}{4}\left(-\frac{\sqrt{2}}{2}F_x + \frac{\sqrt{2}}{2}F_y\right) + \frac{1}{4}F_{yaw} \quad ⑫$$

$$F_{lb} = \frac{1}{4}\left(-\frac{\sqrt{2}}{2}F_x - \frac{\sqrt{2}}{2}F_y\right) + \frac{1}{4}F_{yaw} \quad ⑬$$

$$F_{rb} = \frac{1}{4}\left(\frac{\sqrt{2}}{2}F_x - \frac{\sqrt{2}}{2}F_y\right) + \frac{1}{4}F_{yaw} \quad ⑭$$

⑥ ⑦ ⑧ ⑨ ⑩ 代入 ⑪ ⑫ ⑬ ⑭

求 $\dot{x}$ $\dot{y}$ 、V_{yaw} 状态运动下4个电机的力

$$Frf = \frac{\sqrt{2}}{8}(Fx + Fy) + J \cdot \frac{V\_yaw}{L}$$

$$= \frac{\sqrt{2}}{8}\left\{\frac{\sqrt{2\left[\frac{Iw}{R} + (m+M)R\right]}}{R}\left(\sqrt{\dot{x}} + \sqrt{\dot{y}}\right)\right\} + J \cdot \frac{V\_yaw}{L}$$

$$= \underbrace{\frac{1}{4}\sqrt{\frac{Iw}{R^3} + \frac{m+M}{R}}}_{K}\left(\sqrt{\dot{x}} + \sqrt{\dot{y}}\right) + J \cdot \frac{V\_yaw}{L}$$

$$\begin{cases} Frf = K\left(\sqrt{\dot{x}} + \sqrt{\dot{y}}\right) + J \cdot \frac{V\_yaw}{L} \\ Lf = K\left(-\sqrt{\dot{x}} + \sqrt{\dot{y}}\right) + J \cdot \frac{V\_yaw}{L} \\ Flb = K \cdot \left(-\sqrt{\dot{x}} - \sqrt{\dot{y}}\right) + J \cdot \frac{V\_yaw}{L} \\ Frb = K \cdot \left(\sqrt{\dot{x}} - \sqrt{\dot{y}}\right) + J \cdot \frac{V\_yaw}{L} \\ K = \frac{1}{4}\sqrt{\frac{Iw}{R^3} + \frac{m+M}{R}} \end{cases}$$

$$Trf = R \cdot Frf \qquad K' = \frac{1}{4}\sqrt{\frac{Iw}{R} + (m+M)R}$$