

$$u = -k e_{rr} + \delta_f$$

u 会突变, 会抖动会鬼畜, 原因有二:

① θ_r 发生了突变

② 规划曲线 k 发生了突变

③ 侧偏刚度 C_f, C_r 发生了突变 (真实)

$$e_{rr} = \begin{pmatrix} e_d \\ \dot{e}_d \\ e_\varphi \\ \dot{e}_\varphi \end{pmatrix}$$

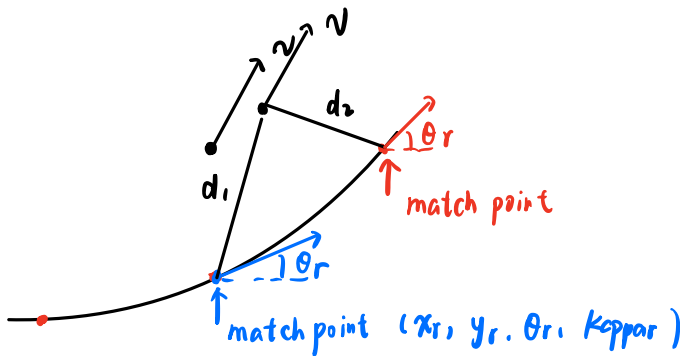
$$e_d = (\vec{x} - \vec{x}_r) \cdot \vec{n}_r \quad \vec{n}_r = \begin{pmatrix} -\sin\theta_r \\ \cos\theta_r \end{pmatrix}$$

$$\dot{e}_d = v_x \sin(\varphi - \theta_r) + v_y \cos(\varphi - \theta_r)$$

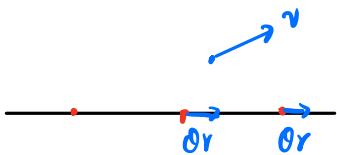
$$e_\varphi = \varphi - \theta_r$$

$$\dot{e}_\varphi = \dot{\varphi} - \underbrace{kappa} \cdot \frac{v_x \cos(\varphi - \theta_r) - v_y \sin(\varphi - \theta_r)}{1 - \underbrace{kappa} \cdot e_d}$$

$$\delta_f = f(\underbrace{kappa}, v_x, a, b, C_f, C_r)$$



当匹配点切换时, θ_r 会发生突变, 从而导致 e_{rr} 突变, 这就是转弯时抖动的根源

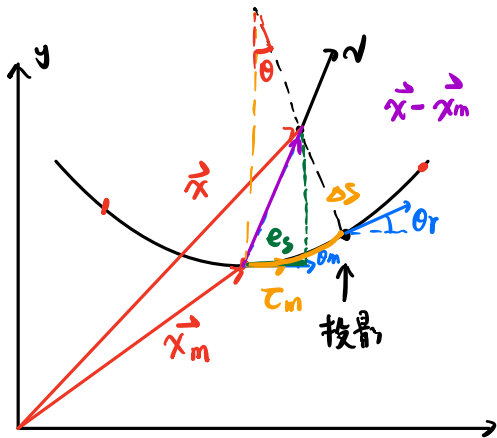


解决办法: ① 规划的密一些 \times

$$\textcircled{2} \theta_r = \theta_m + k \cdot e_s \quad (\text{我}) \quad \checkmark$$

$$\theta_r = \theta_m$$

apollo

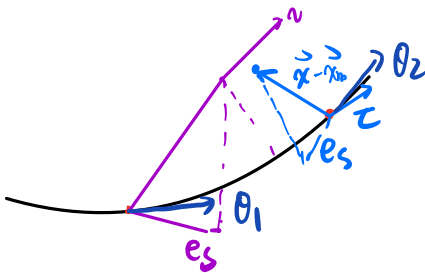


$$e_s = (\vec{x} - \vec{x}_m) \cdot \vec{\tau}_m$$

$$k \cdot e_s = \frac{e_s}{R} \quad R \text{ 为曲率半径}$$

$$\text{真实的 } \theta_r = \theta_m + \frac{\Delta s}{R} \approx k \cdot e_s$$

$$\theta_r = \theta_m + k \cdot e_s$$



e_s 会随着运动而不断变化 θ_r 也会不断变化
 $(\vec{x} - \vec{x}_m) \cdot \vec{e} < 0$

$$\theta_r = \theta_1 + k \cdot e_s \uparrow$$

$$\theta_r = \theta_2 + k \cdot e_s$$

$$\theta_2 > \theta_1 \quad e_s \text{ 要成负的}$$

$$\theta_1 = 1 \quad \theta_2 = 2$$

$$\begin{pmatrix} u \\ a \\ e \end{pmatrix}$$

$$1.1.1$$

$$1.2.2$$

$$2.1.2$$

$$2.2.4$$

