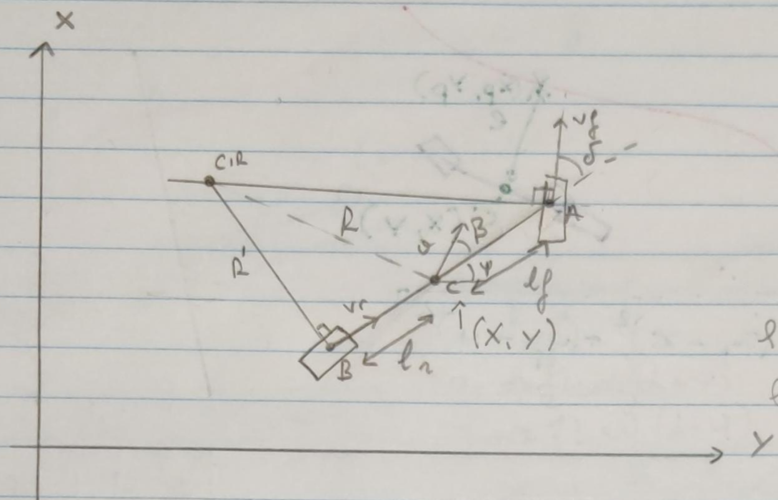
Bicycle Kinematic model

low speed



ψ : Yaw

δ : angle roue avant

β : slip angle (angle de la vitesse du véhicule)

$l_f + l_r = L$

$l_f = l_r$

$$\begin{cases} \dot{X} = v \cos(\psi + \beta) \\ \dot{Y} = v \sin(\psi + \beta) \\ \dot{\psi} = v \dfrac{\cos(\beta)}{L} \tan(\delta) \end{cases}$$

avec $\beta = \arctan\left(\dfrac{\tan(\delta)}{2L}\right)$

petit angle $\delta \sim 0 \Rightarrow \tan(\delta) \sim \delta \sim 0 \Rightarrow \beta \sim 0$

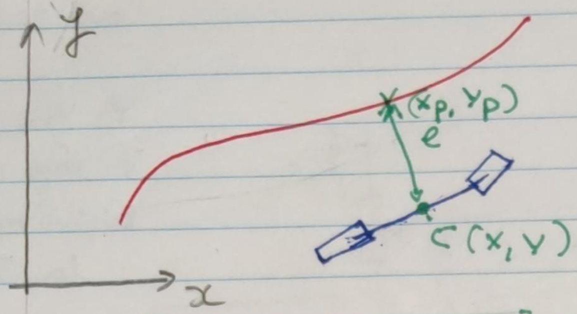
$$\boxed{\begin{aligned} \dot{X} &= v \cos(\psi) \\ \dot{Y} &= v \sin(\psi) \\ \dot{\psi} &= \frac{v}{L} \delta \end{aligned}}$$

entrée : v, ψ, δ sortie $\dot{X}$, $\dot{Y}$, $\dot{\psi}$ $\rightarrow$ X, Y, ψ

discrétisé

$$X_{t+1} = x_t + v\cos(\psi)\,\Delta t$$
$$Y_{t+1} = y_t + v\sin(\psi)\,\Delta t$$
$$\psi_{t+1} = \psi_t + \frac{v}{L}\,\delta\,\Delta t$$

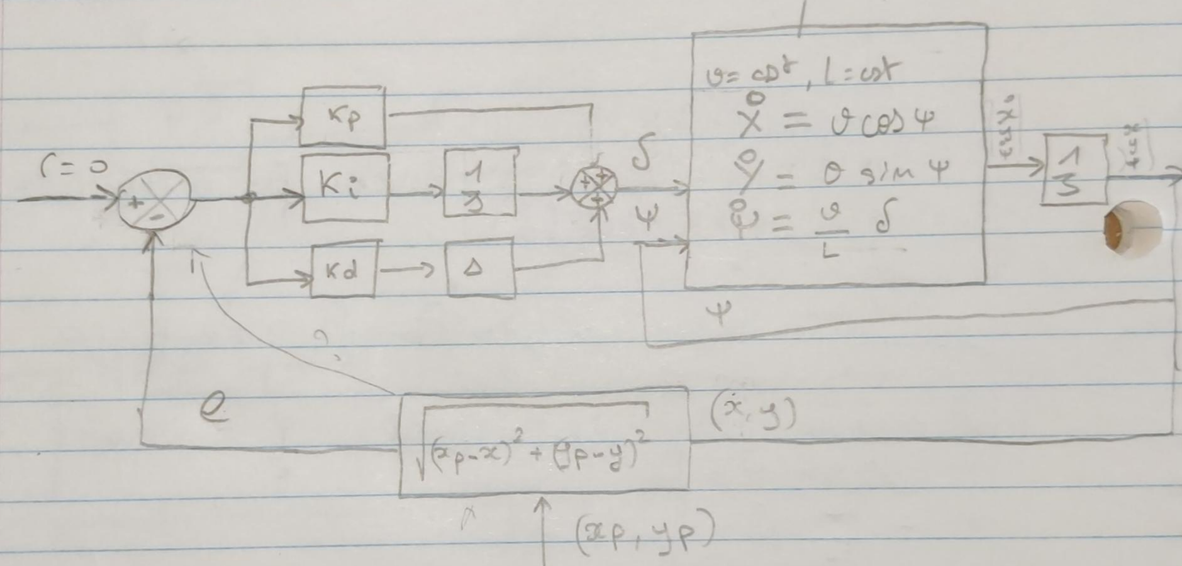
PID Control



$$e = \sqrt{(x_p - x)^2 + (y_p - y)^2}$$

θ

discretizar



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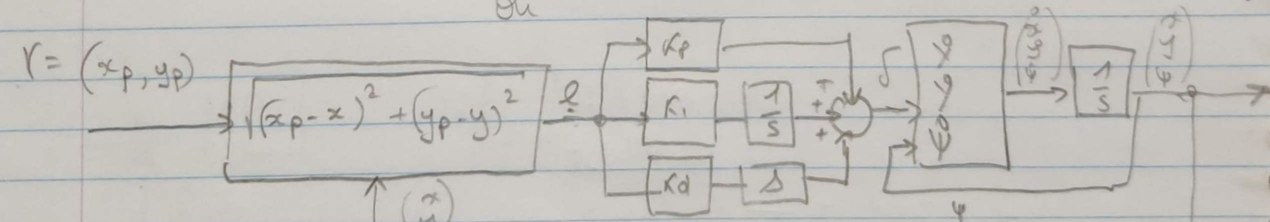
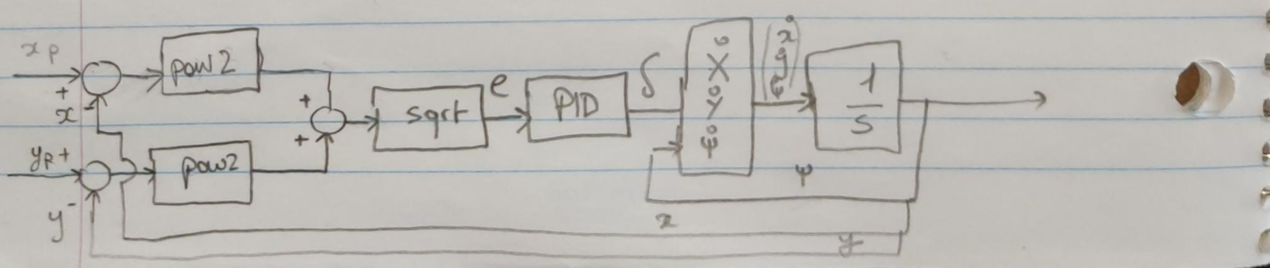
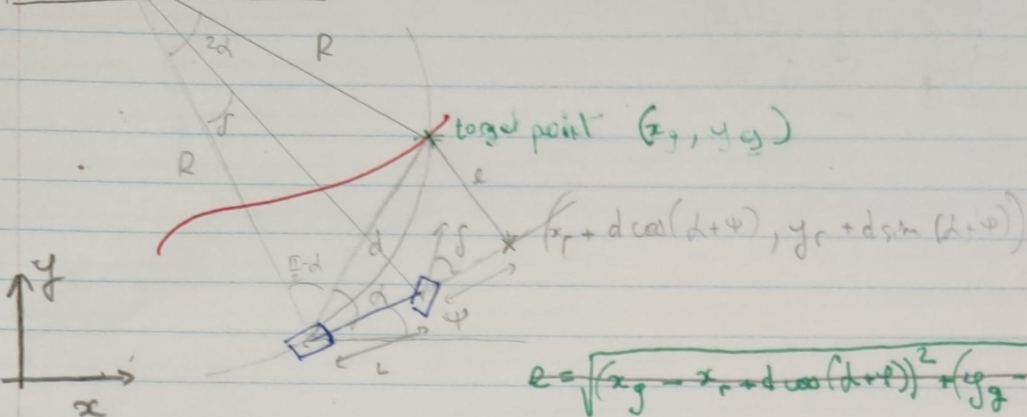


$A = (x_p - x)^2$



Pure Pursuit

d: look ahead Distance



$$\cancel{e = \sqrt{(x_g - x_r + d\cos(\alpha+\psi))^2 + (y_g - y_r + d\sin(\alpha+\psi))^2}}$$

$$\delta = \tan^{-1}\left(\frac{2L\sin\alpha}{d}\right)$$

$$x_r = (x - \tfrac{1}{2}L\cos)(\alpha+\psi)$$

$$y_r = (y - \tfrac{1}{2}L\sin)(\alpha+\psi)$$

$$e = \sqrt{(x_g - (d+x-\tfrac{1}{2}L)\cos(\alpha+\psi))^2 + (y_g - (d+y-\tfrac{1}{2}L)\sin(\alpha+\psi))^2}$$

petit angle δ

petit angle δ et α

$$\delta \simeq \frac{2L\sin\alpha}{d} \qquad \delta \simeq \frac{2L\alpha}{d}$$

et $\sin\alpha = \frac{e}{d}$ ~ $\alpha = \frac{e}{d}$

$$\Rightarrow \delta \simeq \frac{2L}{d^2}e$$

← similaire à un proportionnel qui dépend de d^2