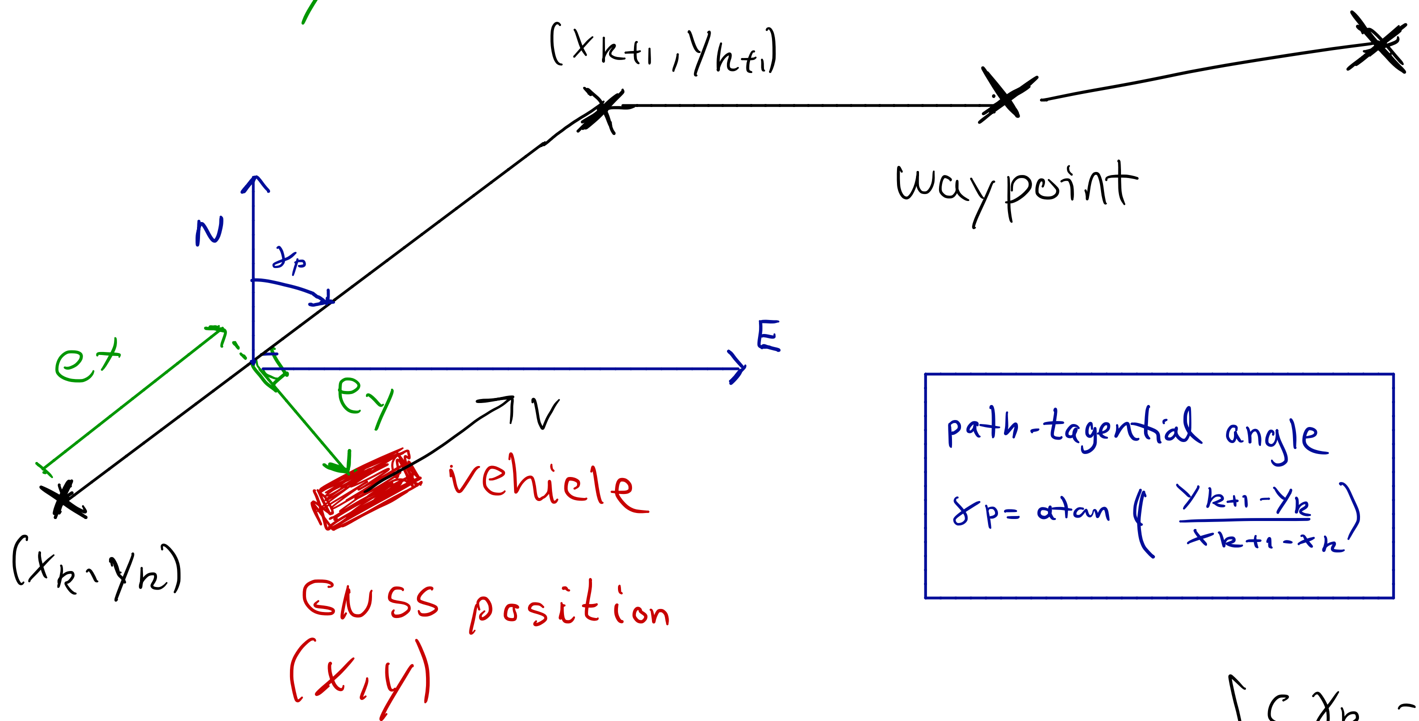
Cross-track and along-track errors

e_y — e_x



path-tagential angle

$$\gamma_p = \text{atan}\left(\frac{y_{k+1} - y_k}{x_{k+1} - x_k}\right)$$

$$\begin{bmatrix} e_x \\ e_y \end{bmatrix} = R^T(\gamma_p) \begin{bmatrix} x - x_k \\ y - y_k \end{bmatrix} \qquad R(\gamma_p) = \begin{bmatrix} c\gamma_p & -s\gamma_p \\ s\gamma_p & c\gamma_p \end{bmatrix}$$

$$\begin{bmatrix} \dot{e}_x \\ \dot{e}_y \end{bmatrix} = R^T(\gamma_p) \begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix} = R^T(\gamma_p) R(\psi) \begin{bmatrix} u \\ v \end{bmatrix} \qquad R(\psi) = \begin{bmatrix} c\psi & -s\psi \\ s\psi & c\psi \end{bmatrix}$$

$$= R(\psi - \gamma_p) \begin{bmatrix} u \\ v \end{bmatrix}$$

$$\dot{e}_y = u \sin(\psi - \gamma_p) + v \cos(\psi - \gamma_p)$$

$$= \underbrace{\sqrt{u^2 + v^2}}_{V} \sin(\psi - \gamma_p + \beta_v)$$

crab angle

$$\beta_v = \text{atan}2(v, u)$$

Speed

$$V = \sqrt{u^2 + v^2}$$

$$\boxed{\dot{e}_y = V \sin(\chi - \gamma_p)}$$

$\chi \rightarrow \chi_d$ (autopilot)

$$\dot{e}_y = V \sin(\chi_d - \gamma_p)$$

$$\chi_d = \gamma_p + \text{LOS algorithm}$$