Bicycle Model Reference

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0.1 Vehicle Dynamics

$$\dot{v}_x = \frac{f_{Fx}\cos\delta - f_{Fy}\sin\delta + f_{Rx}}{m} + v_y\dot{\psi}, \tag{1a}$$

$$\dot{v}_y = \frac{f_{Fx}\sin\delta + f_{Fy}\cos\delta + f_{Ry}}{m} - v_x\dot{\psi}, \tag{1b}$$

$$\ddot{\psi} = \frac{(f_{Fy}\cos\delta + f_{Fx}\sin\delta)\,\ell_F - f_{Ry}\ell_R}{I_z}, \tag{1c}$$

$$\dot{\omega}_F = -\frac{r_F}{I_{wF}} f_{Fx}, \tag{1d}$$

$$\dot{\psi} = \dot{\psi}, \tag{1e}$$

$$\dot{X} = v_x\cos\psi - v_y\sin\psi, \tag{1f}$$

$$\dot{Y} = v_x\sin\psi + v_y\cos\psi \tag{1g}$$

0.2 Tire Friction

$$\sigma_{xj} = -\frac{v_{xj} - \omega_j r_j}{v_{xj}}, \tag{2a}$$

$$\sigma_{yj} = \arctan\frac{v_{yj}}{|v_{xj}|}, \tag{2b}$$

$$\mu_{ij} = D\sin\left(C\arctan\left(B\sigma_{ij} - E(B\sigma_{ij} - \arctan B\sigma_{ij})\right)\right), \tag{2c}$$

$$f_{ij} = f_{zj}\mu_{ij} \tag{2d}$$