1 Model

The controller is designed for the following 3-state model:

$$\begin{bmatrix} \dot{y} \\ \dot{\psi} \\ \dot{r} \end{bmatrix} = \begin{bmatrix} 0 & u_0 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & -\frac{a^2 C_{\alpha f} + b^2 C_{\alpha r}}{I_z u_0} \end{bmatrix} \begin{bmatrix} y \\ \psi \\ r \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \frac{a C_{\alpha f}}{I_z} \end{bmatrix} \delta_f + \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 0 & \frac{b C_{\alpha r} - a C_{\alpha f}}{I_z u_0} \end{bmatrix} \begin{bmatrix} r_{road} \\ v \end{bmatrix} \tag{1}$$

and implemented on the 4-state model

$$\begin{bmatrix} \dot{y} \\ \dot{v} \\ \dot{\psi} \\ \dot{r} \end{bmatrix} = \begin{bmatrix} 0 & 1 & u_0 & 0 \\ 0 & -\frac{C_{\alpha f} + C_{\alpha r}}{m u_0} & 0 & \frac{b C_{\alpha r} - a C_{\alpha f}}{m u_0} - u_0 \\ 0 & 0 & 0 & 1 \\ 0 & \frac{b C_{\alpha r} - a C_{\alpha f}}{I_z u_0} & 0 & -\frac{a^2 C_{\alpha f} + b^2 C_{\alpha r}}{I z u_0} \end{bmatrix} \begin{bmatrix} y \\ v \\ \psi \\ r \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{C_{\alpha f}}{m} \\ 0 \\ \frac{a C_{\alpha f}}{I_z} \end{bmatrix} \delta_f + \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix} r_{road} \tag{2}$$

2 Disturbance assumptions

Maximal road curvature:

$$r_{road} \in [-\alpha \frac{g}{u_0}, \alpha \frac{g}{u_0}] \tag{3}$$

Modeling error due to setting $v = 0$:

$$v \in [-1, 1] \tag{4}$$

3 Specifications

Don't exit the lane:

$$\square(y \in [-0.9, 0.9]) \tag{5}$$

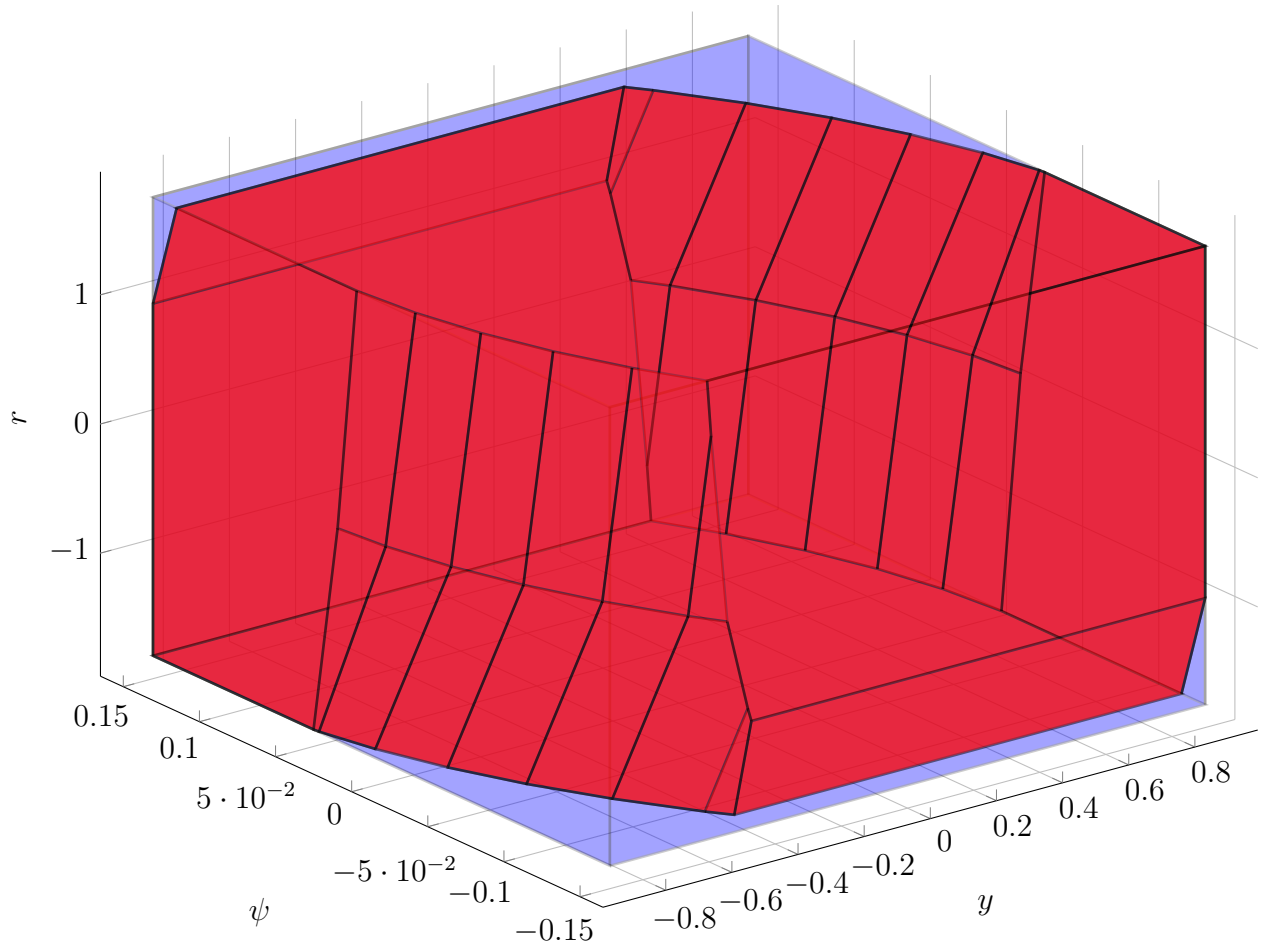

Figure 1: Invariant set (red) inside safe set (blue).

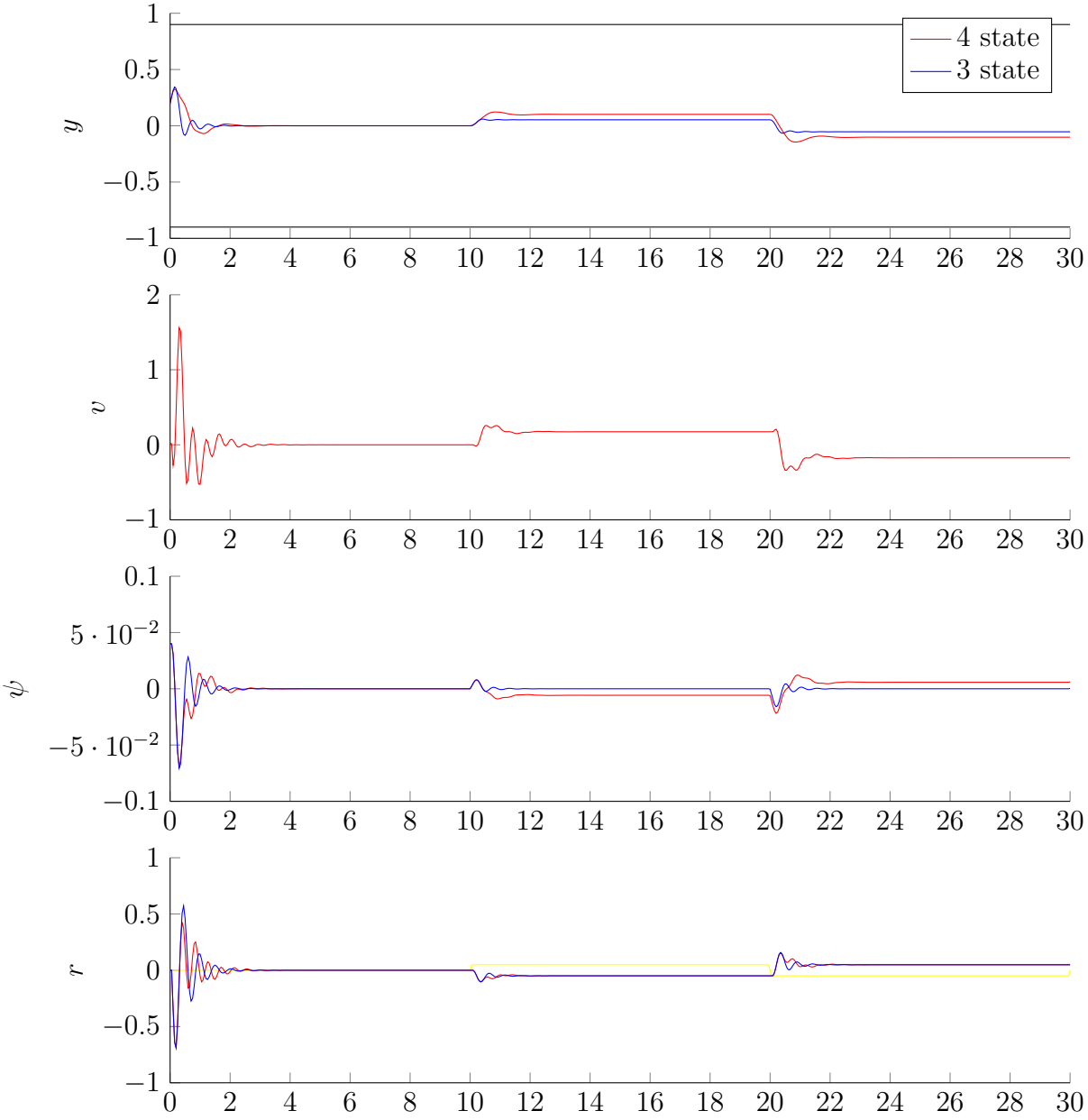

Figure 2: Car states in simulation. Yellow line is r_{road}.

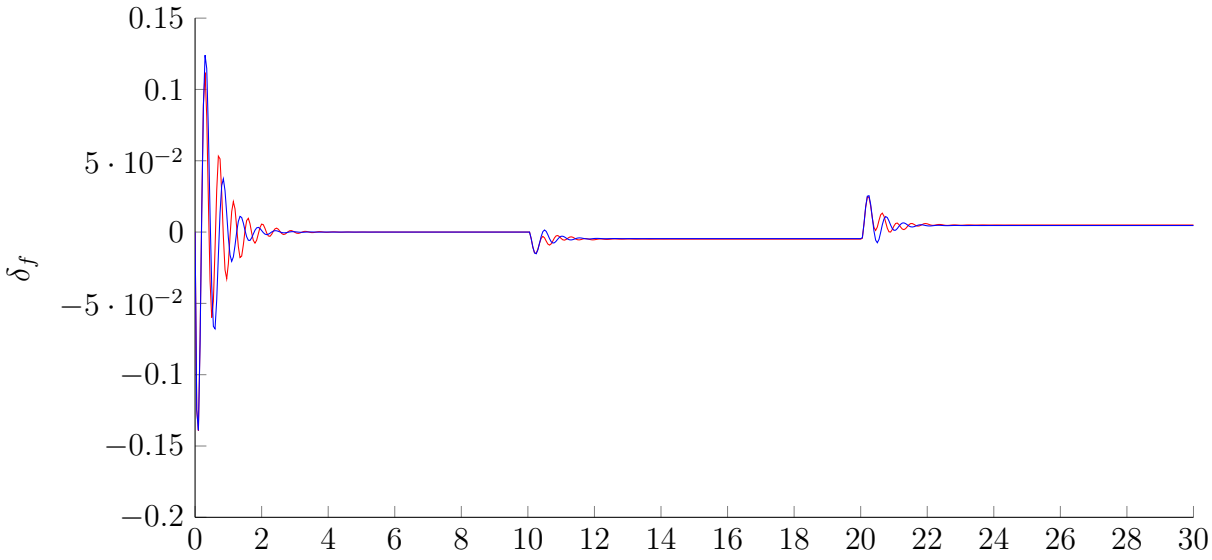

Figure 3: Input: steering angle.