# Investigation of the control characteristics for a driver-vehicle system with steering and throttle control

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**Abstract**. We investigate the control characteristics of a human driver or driving robot of a simple two-wheel vehicle model along a steady-state cornering motion using the "simplified precision model" by McRuer. The aim of this talk is to obtain ranges of driver parameters, that could map human driving behaviour and lead to a stable motion for varied reaction time.

## Vehicle and control model

We investigate the stability of a controlled understeer vehicle along a steady-state cornering motion, according to the model described in [1]. To control the trajectory of the vehicle, the human driver is assumed to either adjust the front steering angle $\delta_F$ or the driving torque $M_R$ of the rear wheels, according to the deviation of a point $P$ ahead of the vehicle from a reference circle, as displayed in Fig. 1. If we denote the deviation of the point $P$ from the reference circle by $\Delta r_P$ and the deviation of the control input $u \in \{\delta_F, M_R\}$ from the stationary value by $\Delta u$, the "simplified precision model" [2] takes the form

$$T_M \frac{d\Delta u(t)}{dt} + \Delta u(t) = c_P \Delta r_P(t-\tau) + c_D \frac{d\Delta r_P}{dt}(t-\tau), \tag{1}$$

with human reaction time $\tau$, delay time $T_M$, and control gain parameters $c_P$ and $c_D$.

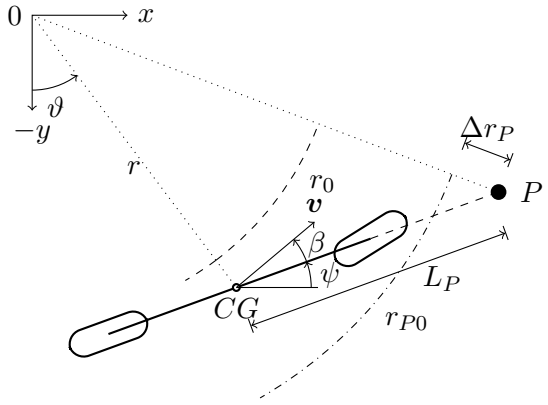


Figure 1: Geometric relations for the driver's preview model: To follow a circle with radius $r_0$, the driver spots a point $P$ at a distance $L_P$ straight ahead of the vehicle, which should move along a circle with radius $r_{P0}$.

According to [3] it is necessary, that the control loop satisfies cross-over conditions, which guarantee that the driver adapts his/her control inputs to individual vehicles characteristics. We could find boundaries of the (human) controller parameters for stable cornering depending on varied reaction time $\tau$.

## References

[1] Steindl, A., Edelmann, J., Plöchl, M.: Limit cycles at oversteer vehicle. Nonlinear Dynamics (2019). https://doi.org/10.1007/s11071-019-05081-8

[2] McRuer, D.T.; Graham, B.; Krendel, E.S.; Reisner, W.: Human Pilot Dynamics in Compensatory Systems, AFFDL-TR-65-15, 1965.

[3] Mitschke, M.; Wallentowitz, H.: Dynamik der Kraftfahrzeuge. Springer 2004.