Project timetable:

- 2003-2004/ Sep-Oct, Sarajevo

Theoretical research :

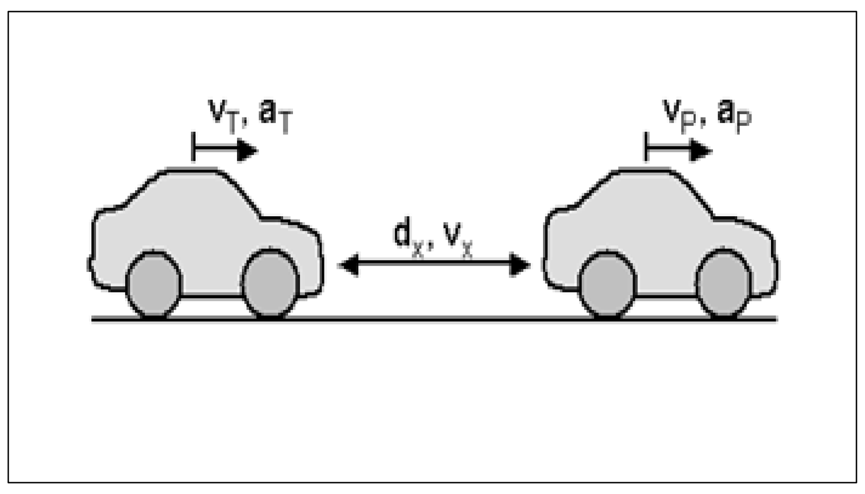
- Field: Artificial Intelligence
- Field: Control Engineering

Practical implementation :

- MATLAB- SIMULINK
- Neural Network Toolbox
- Fuzzy Logic Toolbox
- Genetic Algorithms Toolbox

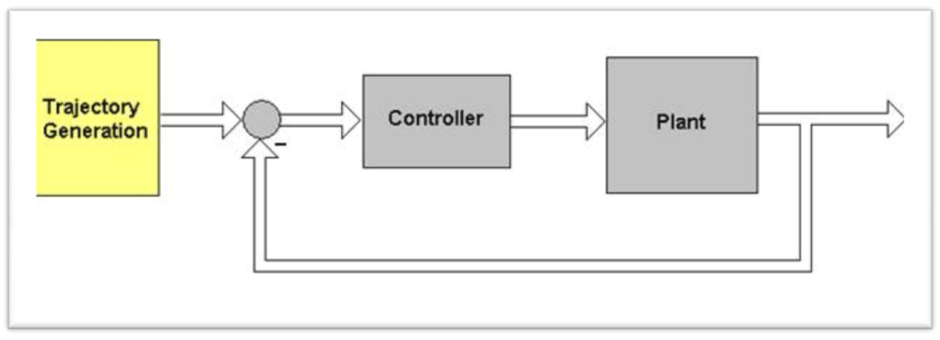
Project description

This project presents capabilities of fuzzy logic in longitudinal vehicle guidance. Two aspects in automated driving are presented. The first is trajectory generation for longitudinal vehicle guidance, where the real driver is replaced by fuzzy inference system. The second aspect is design of fuzzy controller which can be implement for leading ideal trajectory in longitudinal direction. Design of fuzzy system is realized in MATLAB environment where the vehicle dynamic is known. This dynamic is result of identification methods realized on the Institute of Automatic Control at the University of Erlangen-Nürnberg. Experimental results for the longitudinal vehicle guidance have been obtained by use of the Audi test vehicle equipped with sensors and control devices.



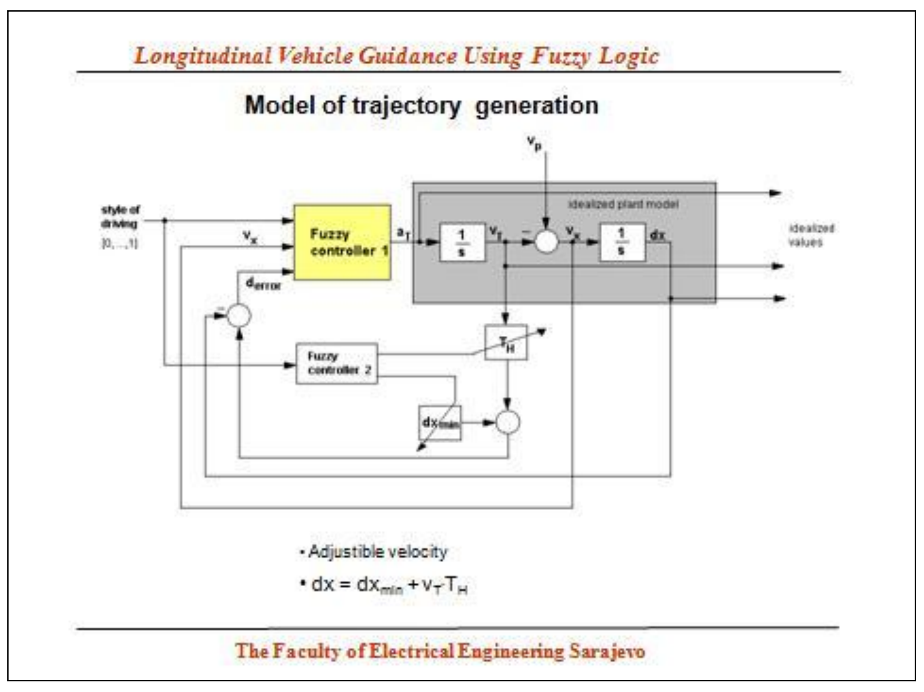
This means that in trajectory generation must be „embedded“ knowledge and experience of a driver. This system is implemented using fuzzy logic. Figure represents control scheme for tracking control.

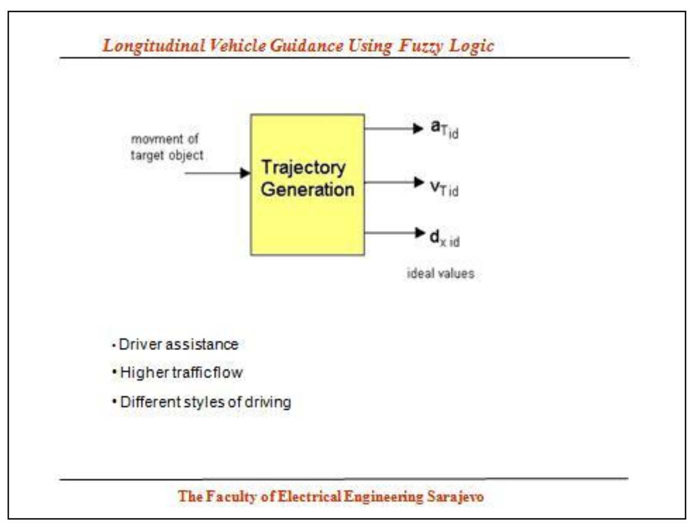
The tracking controller based on fuzzy logic (fuzzy controller) is designed to keep movement of the tracking vehicle closely as possible to generated ideal trajectory.

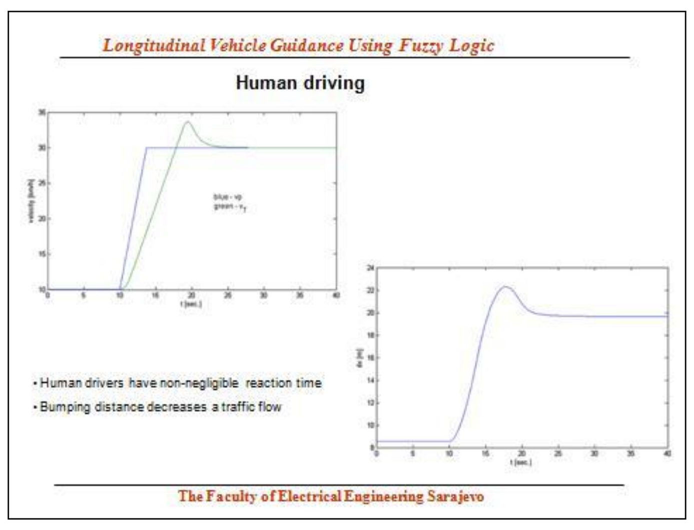


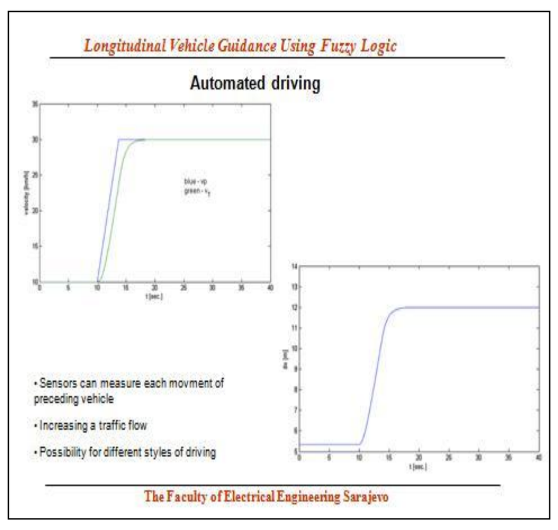
The block diagram of a model for the vehicle longitudinal dynamics and the relative movement in relation to a preceding vehicle is shown on Figure. A desired engine torque T_{ed} and a desired brake torque T_{bd} are adjusted with a certain time delay and with first order dynamics. The resulting torque T_w at the wheels depends on the transmission ratio of the engine torque and the brake torque. Depending on the dynamics wheel radius r_{dyn} this causes the wheel force F_w. Dividing the difference of F_w and the resistance forces by mass m of the vehicle gives acceleration a_T.

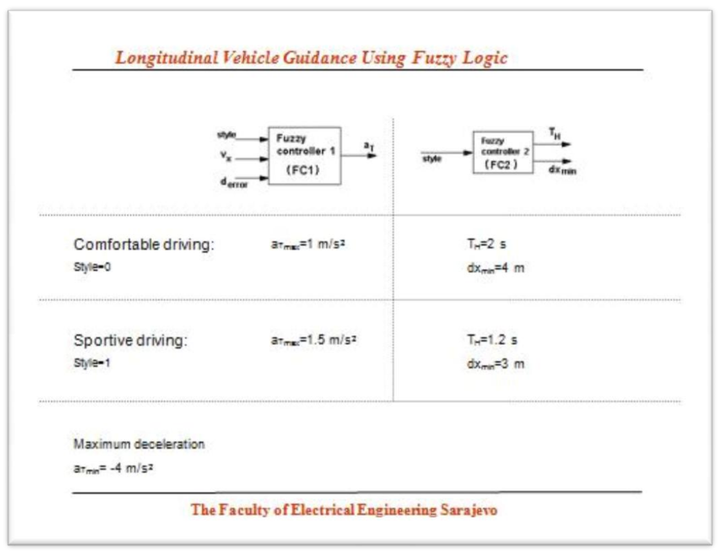
The velocity v_T is obtained from a_T by integration. The relative velocity d_x is the difference between the preceding vehicle's velocity v_p and the velocity v_T of the tracking vehicle. The distance between both vehicles is than obtained by integration.

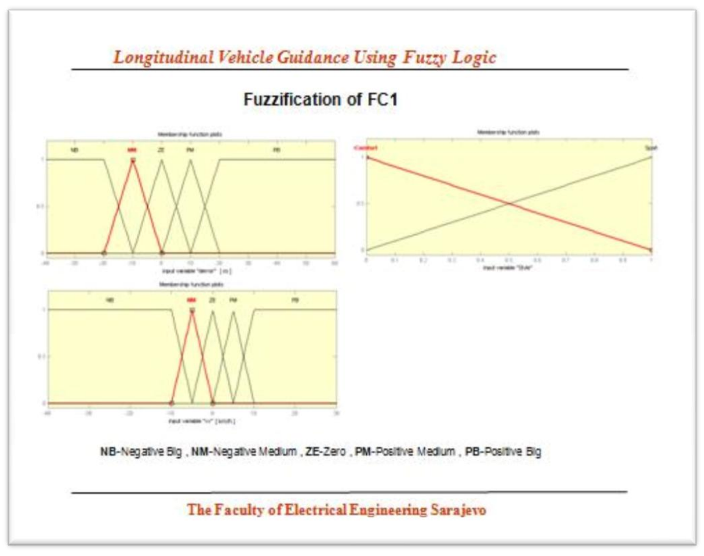


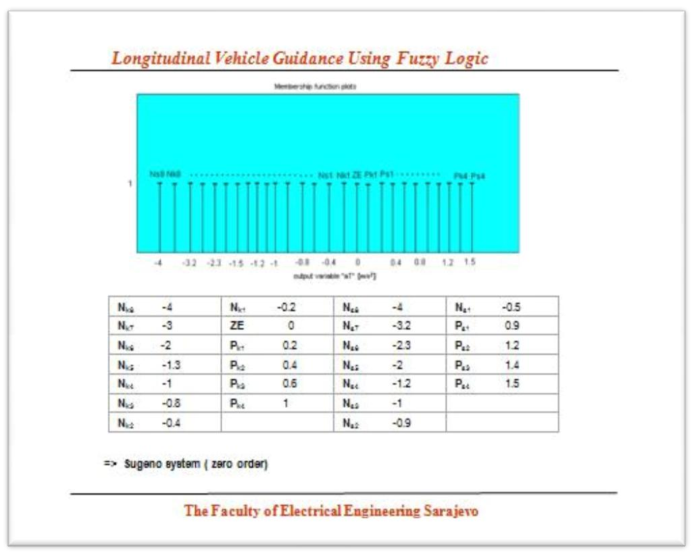


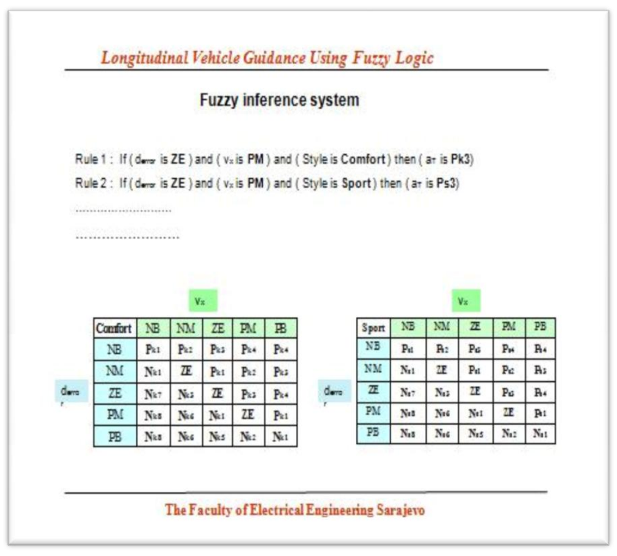


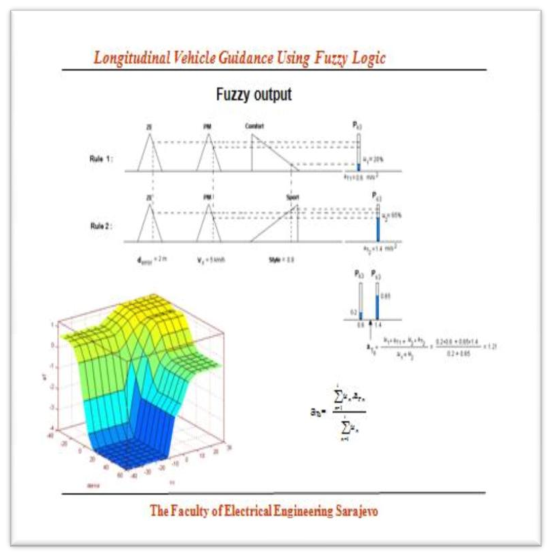


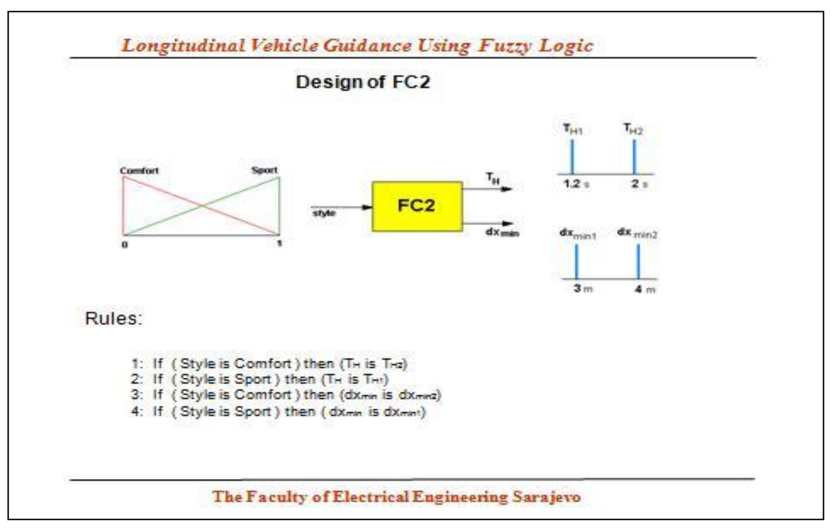


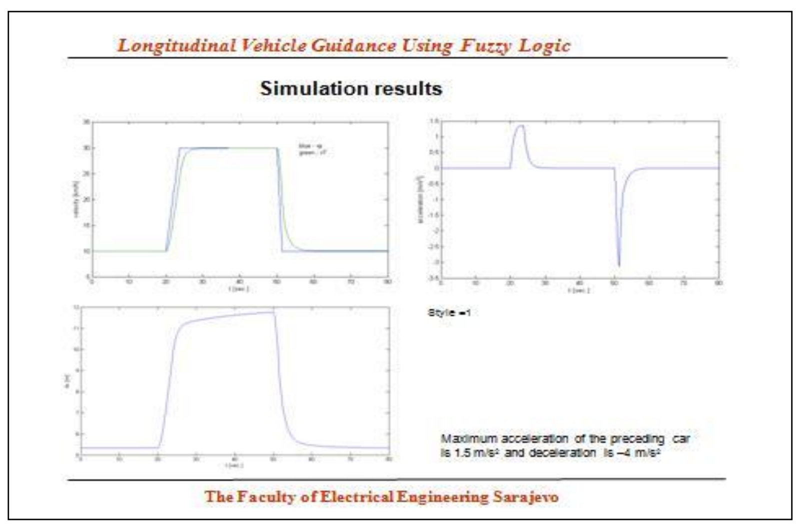


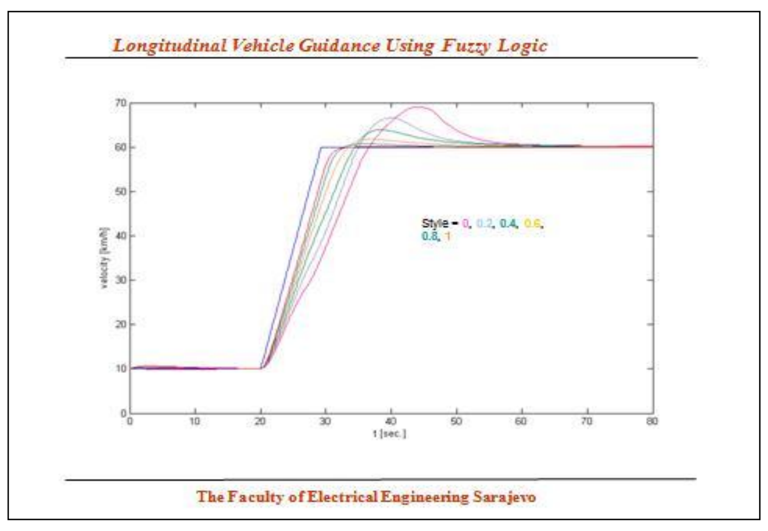


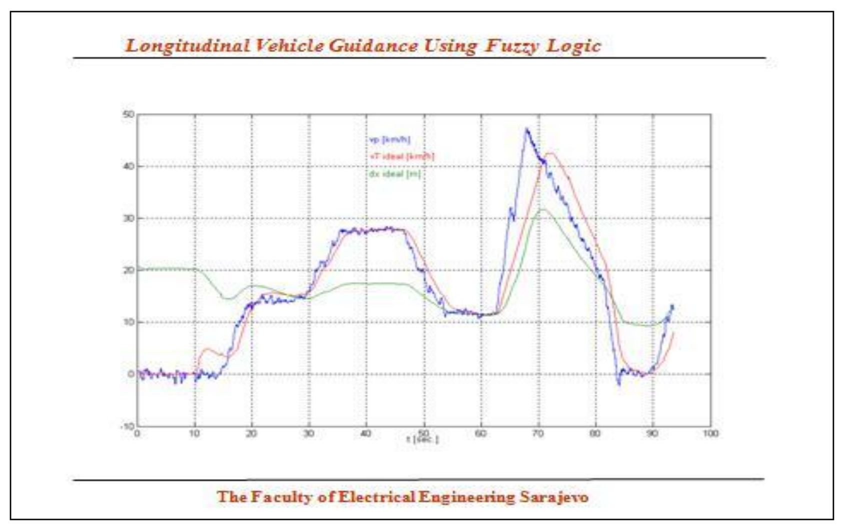






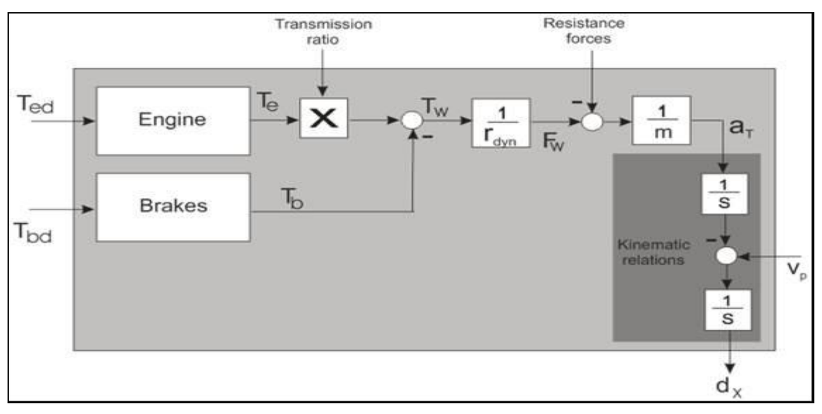


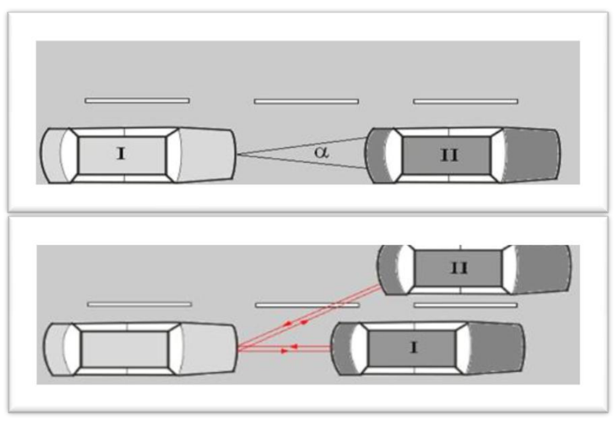


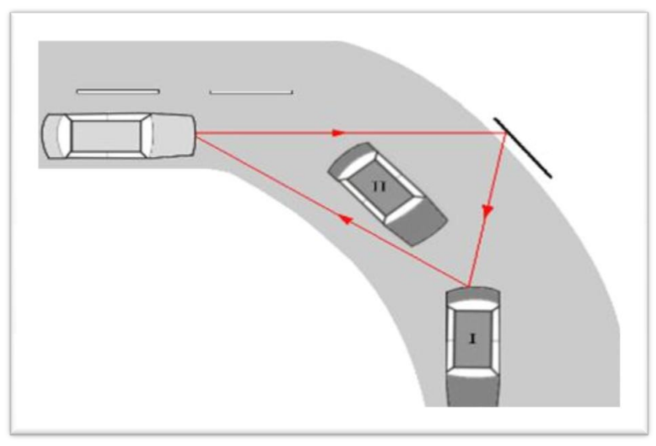


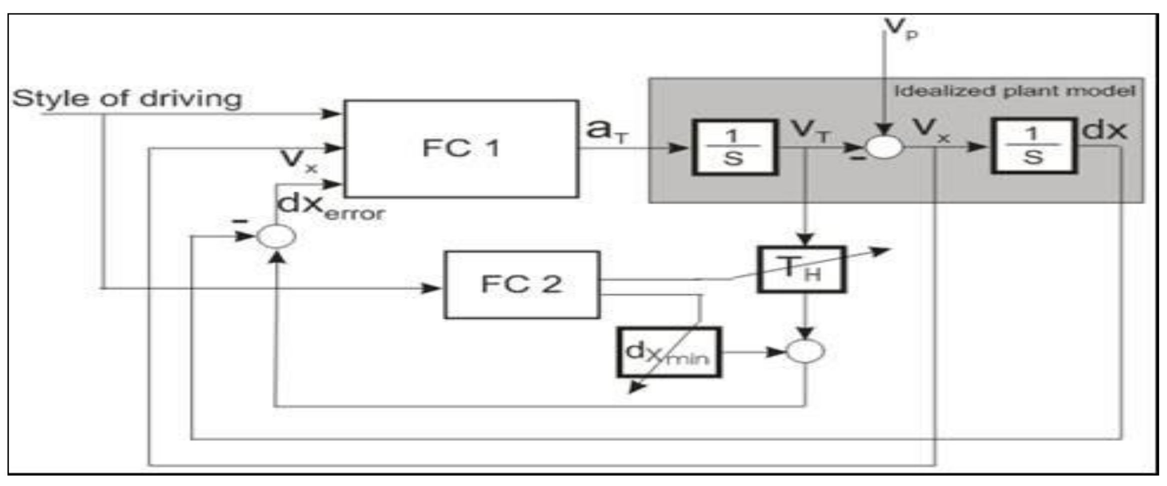
The longitudinal vehicle guidance is based on idea of tracking control. The goal of tracking control is attempt to keep desired distance to the preceding vehicle and also leading desired velocity and acceleration. The distance d_x as well as velocity v_p and acceleration a_p are measured by radar sensor.

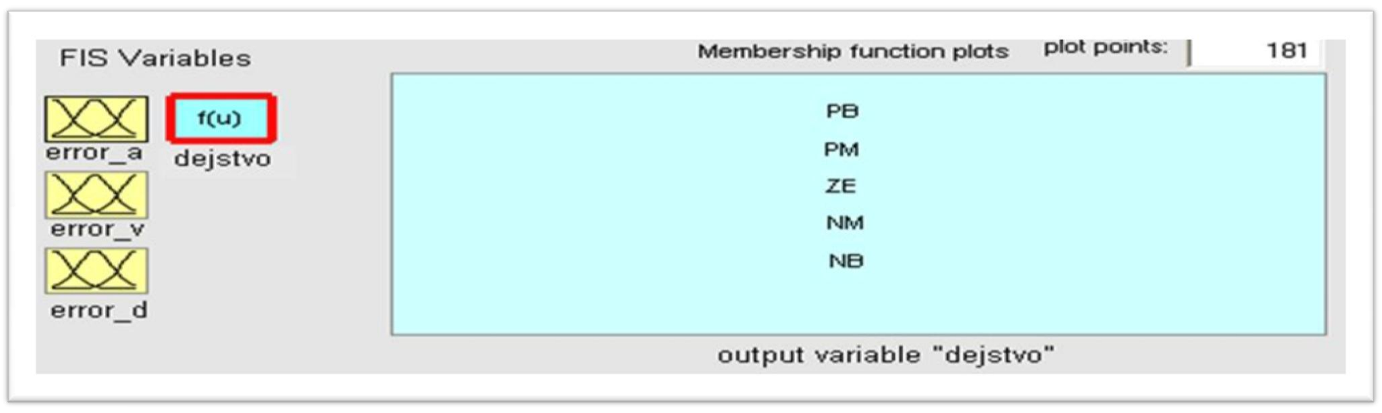
Therefore, in a vehicle must exist a system which can give desired movement of the tracking vehicle based on behavior of the preceding vehicle (velocity V_p). This system of trajectory generation (a_{Tid}, v_{Tid}, d_{xid}) needs to represent driver decision in all specific situations.

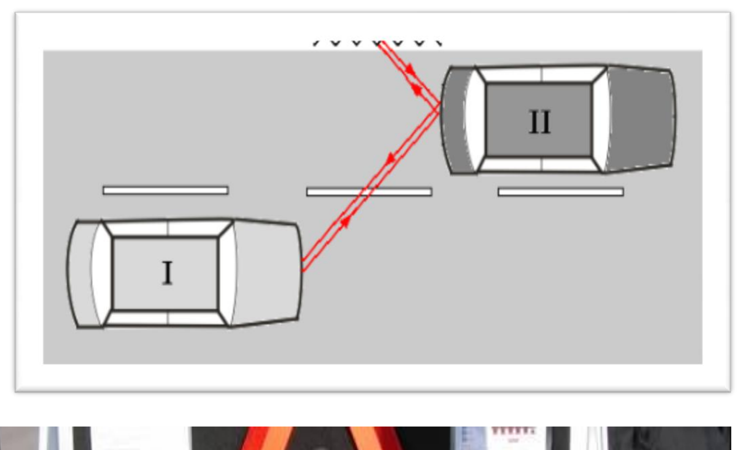












The trajectory generation is based on idealized model of the plant. This is represented by kinematic relations marked in Figure. This idealized model of longitudinal movement is independent of specific properties of the vehicle such as e.g. the time behavior of the engine or of the brakes. This approach gives a possibilities for developing system for trajectory generation only once and may then be applied to different vehicles. The tracking controller then has to be adapted to each vehicle with respect to certain dynamics.