Control of yaw dynamics in the presence of input time delay with rear axle steering system

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Commercial vehicles which have to transport tons of freight usually fitted with multi-axle groups to distribute their load among the axles. In order to address the problem of manoeuvrability with multiply axes self-steered or actively steered rear axle systems are used on these sorts of trucks. RAS systems have the advantages that the lateral dynamics of the vehicle can be influenced independently from the front steering system. Thus using RAS systems in the vehicles, the performance of active safety systems such as Advanced Emergency Braking System (AEBS) and Electronic Stability Systems (ESP) can be enhanced. These systems help to extend the domain of safety operation of vehicles in more extreme driving situations such as high-speed manoeuvring and mu split braking by the usage of differential braking methods [1].

This paper deals with the lateral yaw control of a truck with the help of RAS system. A 6x2 tag axle steered vehicle is considered as basis for the investigation. The layout of the system is depicted in Figure 1. To simulate the vehicle lateral dynamics a nonlinear planar two track model is used. The model parameters have been identified with the help of dynamic vehicle tests.

The rear axle steering mechanism is driven by a hydraulic actuator and the internal dynamics of the actuator sub-system limits the intervention speed of the control input and this causes time

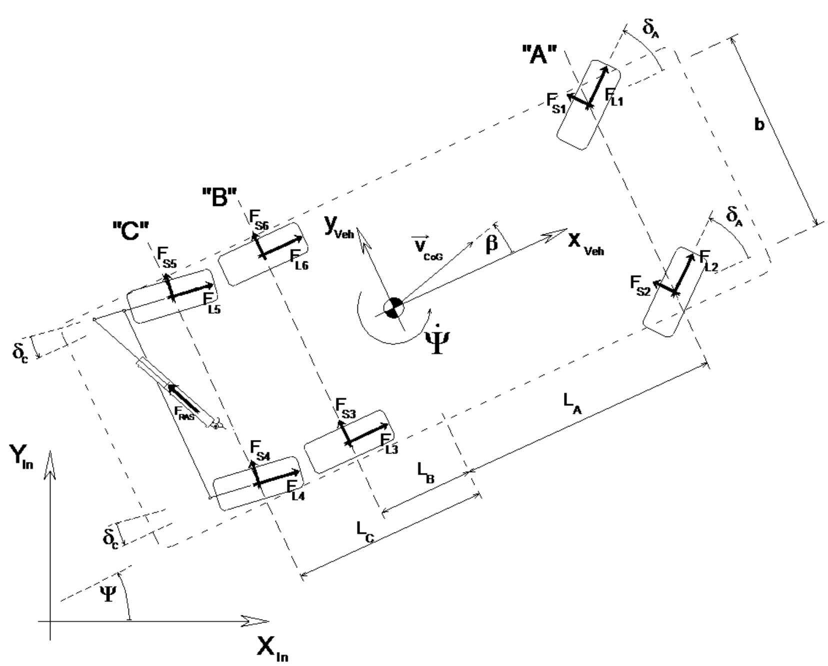

Figure 1: 6x2 vehicle with RAS

delay in the high level yaw control loop. This time delay cannot be neglected when increasing the dynamic performances is aimed at. Therefore the yaw control is analysed subjected to input time delay.

The effect of time delay is analysed with the help of a further simplified linear single track rear steered bicycle model combined with proportional feedback control. With this simplified model the stability and control performance can be analysed analytically. Basis of this kind of analysis method can also be found in [2]. The result of the stability analysis will be checked against real measurement to reveal the confidence interval of the analysis made with the simplified model and control.

In a former paper [3] a Sliding Mode Control synthesis was carried out for controlling the yaw dynamics. This control algorithm will also be tested with the before mentioned input time delay to see how the SMC can tolerate time delay together varying vehicle parameters such as different load conditions, and cornering stiffness resulted from real driving situations. We can expect that this analysis and tests will help to define the necessary actuator dynamics and high level control scheme which ensure the desired stability of the vehicle high speed motion and enhance the efficiency of active safety system.

Keywords: Rear Axle Steering; stability; input time delay; yaw control

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