Future Vehicle Stability Control Systems for Motorcycles with Focus on Accident Prevention

Abstract

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Vehicle Stability Control systems (VSC) for four-wheeled vehicles like the electronic stability program (ESP) helped to decrease the number of traffic deaths in Germany to an all-time low over the last ten years. However, the number of people killed in powered two-wheeler accidents has been almost constant over the same period of time. Vehicle Stability Control systems for powered two-wheelers (especially motorcycles) so far include only anti-lock brakes and traction control systems, both systems are not designed to work in cornering. Further stability control systems are not known up to now.

The objective of this paper is to assess the technical possibilities for future Vehicle Stability Control systems and the amount of accidents that could be prevented by those systems. From an accident analysis, all accidents not avoidable by today's VSC Systems have been analyzed. Only accidents while cornering without braking have been determined as potentially avoidable by future technical systems (braked accidents have been counted as preventable by improved today's systems). The accidents can be caused by insufficient friction (e.g. slippery road surface, sand, oil or to high curve speed). About 4 to 8 percent of all motorcycle accidents are of this type.

The data source for accident descriptions were interviews of motorcycle experts who were able to describe their own accidents and detailed accident descriptions from an accident database. The accident types have been investigated with driving experiments and computer simulation. With a vehicle model different ways to influence the critical driving situations could be analyzed and evaluated. Experiments and simulations showed an instable roll and side-slip angular acceleration of the motorcycle during critical driving situations. The sideslip rate proved to be a robust criterion for recognizing whether a driving situation is critical. The roll movement of the vehicle cannot be influenced with reasonable means, because neither the lateral tire forces can be increased nor stabilizing gyros can be used since the necessary angular momentum is to large for a feasible package. The vehicle sideslip rate can be influenced by braking the front or the rear wheel, thus generating a yaw moment to avoid the dangerous high-side type accidents when friction changes back from low to high.

The motorcycle accidents influenced by this system are only a small portion of the mentioned accidents, so as a result of this study, the potential for future vehicle dynamic control systems that help prevent non-braking cornering accidents is estimated quite low.