Development and Experimental Evaluation of a Tractor Roll-Over Stability Model

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**Abstract.** The roll-over stability is one of the main issues that affects agricultural tractors/machinery, and earth-moving machines operating in hilly or mountainous environments. Indeed, on average, there are more than 100 fatal accidents every year in Italy due to tractor roll-overs. In the best cases, when operators are not or only minimally injured, they cause considerable damage to the vehicles as well as the loss of income from missed work [1]. Therefore, creating stability models to study the behavior of existing vehicles operating in hazardous conditions results very important, especially if they are designed to work in flat surfaces. These models can then be integrated into the vehicles control systems in order to warning the operator when instability is approaching, or to implement automatic countermeasures to prevent it [2]. In this work the model for determining the stability of a generic agricultural vehicle is presented. It is developed in Matlab environment and it is based on the determination of the forces discharged to the ground by the wheels/tracks. Different vehicle configurations can be considered such as conventional tractor, tractor with isodiametric wheels, tracked tractor, vehicles with rigid or articulated chassis, presence or not of implements, etc. Moreover, a multitude of slope conditions can be studied, evaluating for example the most common lateral roll-over, or the motion of leaving a crop row and entering in the next one. The model has been validated through a series of experimental tests on real machines, considering some reference case studies. For this scope, a rig for testing the stability of vehicles available at the Agro-Forestry Innovation LABoratory (AFILAB) of the Free University of Bolzano has been exploited. It consists in a rotating platform able to move a machine positioned on it (up to a weight of 10 tons) according to two rotational degrees of freedom: (1) support plane inclination, (2) support plane rotation around an axis normal to its surface. Moreover, the support plane can change its conformation and simulate uneven terrains with presence of bumps or potholes. A series of load cells, integrated into the support plane, measure then in real-time the forces discharged to the ground by each wheel/track.

**References**

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