In this work, a new method is developed to estimate the unknown inputs of heavy vehicles. These inputs represent road profile which is very interesting since it is used to estimate the vertical forces acting on the wheels. We reconstruct these unknown inputs by using higher order sliding mode observer. First, we estimate speeds and accelerations of heavy vehicle in finite time. Validation process is done using an instrumented heavy vehicle and measured road profile by LPA instrument.

Many researches on vehicle-road interaction are performed without taking into account the response of the road profile. Recently, the responses of the road profile to dynamics vehicle forces have been investigated. However, these inputs are not well known and there are some difficulties to have them in real time. Then, it’s not easy to estimate the vertical forces on board. A variety of sensors and instruments can be used for measuring these inputs (LPA, inertial method, profilometers…). However, the sensors are expensive and the measurements are not done on board.

In this work, we propose a new method to evaluate the road profile inputs based on higher order sliding mode observers which are considered as inputs of the developed heavy vehicle model. First, these inputs are measured by LPA instrument (Longitudinal Profile Analyzer), APL in French, developed at Roads and Bridges Central Laboratory (LCPC in French) and applied to the heavy vehicle model. Then a third order sliding mode observer is developed to estimate these unknown inputs. This estimation allows us to reconstruct the vertical forces which are very important to calculate road damage or to evaluate the risk of rollover of the heavy vehicle using the Load Transfer Ratio.

In a validation procedure, we compare the LPA measures with simulation results coming from a developed estimator. We compare also the states and vertical forces estimations with those given by an instrumented tractor of Renault Trucks rolling on Valbonne site (near Lyon in France). Different rolling scenarios are done to show the robustness of the proposed approach. The details of this instrumentation are given in this paper.