VIRTUAL SENSING OF WHEEL CENTER LOADS FOR DURABILITY APPLICATIONS

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This work provides the means to generate time-domain information related to the six Wheel Center Loads (WCLs), i.e. the loads acting at the center of the vehicle wheel due to the interaction with the road, without directly measuring them. So-called virtual sensors for WCLs are instead generated by combining information from other commonly available sensors with a system simulation model.

When designing a new vehicle, the knowledge of WCLs is indeed needed as an input quantity to assess durability performances. In the current practice OEMs perform direct measurements of these loads during so-called Road Load Data Acquisition (RLDA) testing campaigns in which a prototype vehicle is heavily instrumented and then driven on proving grounds or public roads. The instrumentation includes so-called Wheel Force Transducers (WFTs) which directly measure WCLs, but which turn out to be expensive, intrusive and time-consuming to install. Therefore it would be appealing to find an alternative way of measuring WCLs which does not make use of such measurement devices.

During RLDA up to hundreds of other sensor channels including strain gauges, accelerometers and displacement sensors are acquired along with WFTs channels. On the other hand, virtual prototypes, i.e. system simulation models, are more and more used to assess the vehicle performances already before the first real prototype is built and tested. Therefore an appealing alternative is to re-use the readily available system simulation models in combination with these other sensors, in order to virtually measure the WCLs. This would imply a cost reduction and hence a tangible increase of the overall process efficiency.

A state estimation framework is developed in this work to perform the information fusion between the available measurements and a flexible multibody model of the vehicle suspension system. Such type of system simulation model is needed to accurately reconstruct the time domain signal for all six WCLs. In addition, this also allows to virtually measure the full strain field on the suspension flexible components.

The methodology is validated on a real suspension test-rig based on a McPherson suspension which is excited by an hydraulic shaker capable of reproducing operational road loads. The results show that all six WCLs as well as the full strain field can be accurately reconstructed, given that a system simulation model with adequate level of accuracy is used.