Using Modelica models for Driver-in-the-loop simulators

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Driver-in-the-loop simulators are increasingly used in Motorsport and Automotive companies to enable engineers and drivers to experience a new vehicle design in a realistic environment before it is built. The use of simulators enables drivers to test a new vehicle and/or control system without having to build a prototype and to carry out those tests in complete safety and in repeatable conditions.

As vehicle systems increase in complexity, the successful integration of all these systems becomes even more critical to achieve a correctly functioning package. The control of the powertrain systems coupled to the chassis model, for example, will define a large part of the driving experience. These systems must be designed to work in harmony and deliver the required driving experience.

The use of simulators enables engineers to test a new vehicle and/or control system without having to build a prototype. It also enables the tests to be carried out in complete safety and in 100% repeatable conditions.

Using Modelica as the development language for the vehicle model within these systems enables rapid model development and the fast evaluation of vehicle concepts. This enables more vehicle concepts to be tested before committing to a prototype build. The reduction in prototype builds translates into a cost reduction in the development stages of the vehicle and a broader range of solutions through model swapping and parameterisation changes can be explored within the same amount of time.

This paper presents an example of a Sports Saloon car with full multi-body double wishbone suspension chassis model coupled to a manual transmission 4-cylinder turbocharged direct injection gasoline powertrain. The vehicle model is created using the VDLMotorsports [1] and Engines [2] Libraries. Some of the key aspects of these libraries that enable them to achieve real-time simulation are described in the paper. For the suspension mechanism, the key is the development of highly optimised models that eliminate the nonlinear systems of equations found when modelling a double wishbone suspension. We also discuss other issues such as the tyre contact model.

The whole vehicle model is then exported as C-code and integrated into a driving simulator. The generic architecture of a driving simulator is introduced and a more detailed description of a test system is included. In this test system the model is running at 800Hz which is governed by rFactor Pro running at 400Hz and the need for the model to run at a multiple of this base frequency.

References

[1] http://www.claytex.com/products/claytex-libraries/#vdlmotorsports-library

[2] Dempsey M. Picarelli A. Investigating the MultiBody Dynamics of the Complete Powertrain System. Como, Italy: Proceedings 7th Modelica Conference, 2009.