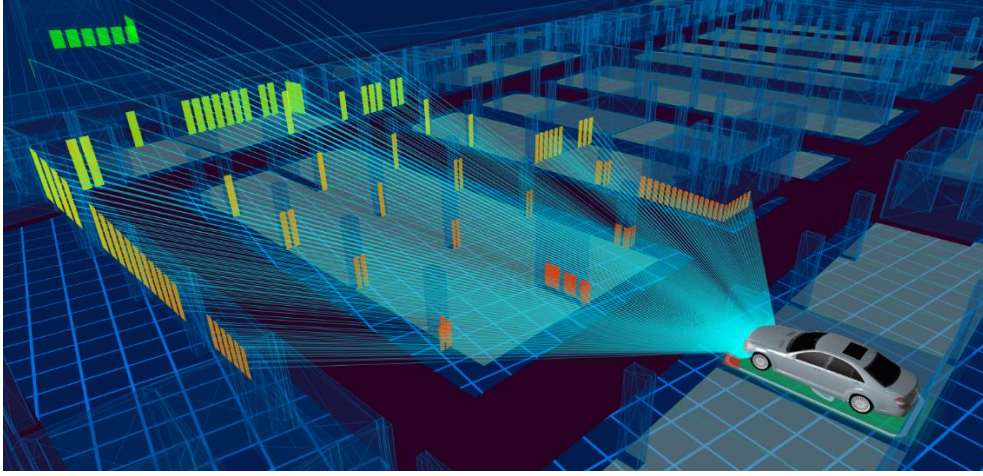
Daimler Center for
Automotive Information Technology Innovations

PHABMACS

your lightweight vehicle simulation tool for prototyping cooperative Advanced Driver Assistance Systems



About

As an alternative to commercial vehicle simulators, PHABMACS is designed to be a lightweight, easy to modify tool to prototype cooperative driver assistance systems. Developers can use the simulated vehicle in PHABMACS first, before going into real test vehicles. For this purpose, interfaces for sensors and actuators of the simulated vehicle models are provided to the prototype system. Additional to radar and lidar sensors, especially communication between vehicles and infrastructure is provided, to address cooperativeness. Application code and additional sensor models can either be created in JAVA™ and deployed to the PHABMACS framework or interfaced from MATLAB/Simulink®. In combination with our CAN-Bus hardware interface, PHABMACS can be hooked up with in vehicle controller setup and replace real world vehicles for testing.

At a glance

PHABMACS is a physically realistic vehicle simulation tool that is used to prototype cooperative Advanced Driver Assistance Systems. In this context PHABMACS simulates a virtual environment including vehicle dynamics, sensors, road infrastructure and communication elements.

Part of the VSimRTI Suite

The integration with VSimRTI enables coupling PHABMACS with other simulation tools of different domains, such as network simulators for V2X/4G communication, specific sensor simulation models, or application modelling tools. For example, simulating V2X communication using the single hop communication models of PHABMACS, is restricted to map simple metrics like delay and packet loss. If a complex communication scenario is needed, e.g. Omnet or NS3 can be coupled. Combined with traffic simulation tools like SUMO, the PHABMACS simulation can be embedded in large scenarios of communicating vehicles.

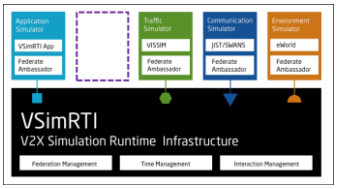


Figure 1: VSimRTI Integration

VSimRTI Integration

PHABMACS is shipped with an integration with VSimRTI. This enables coupling with other simulation tools, e.g. with network simulators for V2X simulation between vehicles, 4G connection to backend systems or sensor and application modelling tools.

Scope

Fitting the scope of prototyping cooperative Advanced Driver Assistance Systems, PHABMACS addresses two conflicting requirements. (1) Driver assistance systems need to be aware of the driving dynamics. For that purpose, the simulation needs to map physics as realistic as possible, which results in high computational effort per vehicle. (2) Cooperativeness requires as many vehicles as possible being part of the simulation. For PHABMACS, we optimized the computational effort by mapping physics realistically, when vehicle parameters are below the limits of driving dynamics, which is sufficient for its scope. Regarding the maximum number of vehicles in the simulation and its level of detail, PHABMACS closes the gap between traffic simulators and high detail vehicle simulations like FEM, K&C, or MKS.

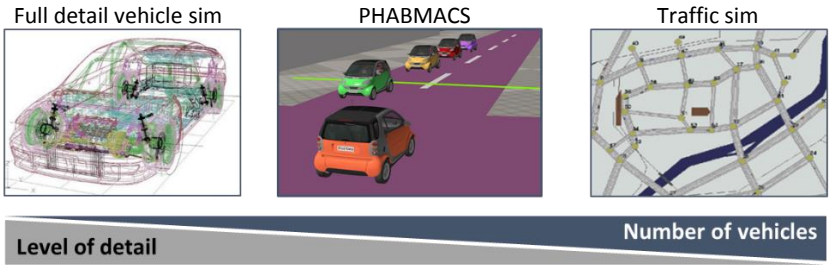


Figure 2: Trade of in simulation between level of detail and number of vehicles

Vehicle Model

The applications to be prototyped can access the simulated vehicles in PHABMACS by controlling their actuators (throttle, brake, steering) and read their sensors. The input on throttle and brake are transformed by the power train (and brake) to move the vehicle model. The powertrain include separate modelling of the engine, the torque converter (and clutch alternatively), the transmission and the wheels. The interaction of the vehicle and other objects of its environment is based on rigid body dynamics.

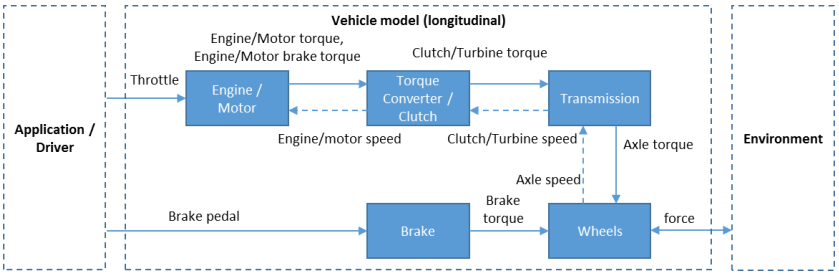


Figure 3: Model of the longitudinal dynamics

Easy to use

PHABMACS is a standalone software, written in JAVA™. The simulation can be run/created/designed by users with basic JAVA™ experience. This includes scenario and environment definition as well as modification of the vehicle models. Modifications of the simulator itself, e.g. to develop new sensors and visualization themes, requires intermediate JAVA™ experience. Integration of ADAS to be prototyped can be done in JAVA™, within the PHABMACS framework, or by using external tools like MATLAB/Simulink®.

Calibration Method to Match Real World Vehicles

In order to enhance the precision of the simulation, the vehicle dynamics models can be calibrated to match specific real world vehicles and validated against them. For this purpose, PHABMACS comes with a dedicated method that requires capturing experimental data from a real vehicle driving six different maneuvers. This experimental data is then split, aligned, averaged and compared to the simulated data by checking differents metrics, e.g. the 95% confidence interval.

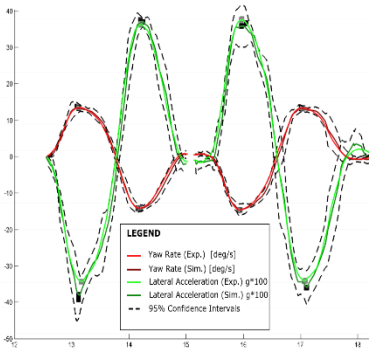


Figure 4: Double lane change to compare lateral dynamics

Environment / Infrastructure

The environment in PHABMACS allows for creation of arbitrary scenarios. Conveniently, such scenarios can be automatically generated from OpenDRIVE® and Open Street Map (OSM) map material using the street grid, buildings and some natural elements like trees, grass, and water. Additional infrastructural elements like construction sites can be added. The standard visualization theme has a puristic, yet appealing rendering style. Customized themes can be implemented easily.

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