

Audi: Dynamic and Safe

➤ **dSPACE Prototyper for Audi Dynamic Steering**

➤ **In-vehicle function tests using MicroAutoBox and AutoBox**

➤ **Production code generation with TargetLink**

Audi Dynamic Steering is now close to production. This is a new superimposed steering system that will provide both more responsive vehicle behavior and increased safety. All the function prototyping for developing the system was done using MATLAB®/Simulink® and dSPACE Prototyper. TargetLink is used for automatic production code generation.

Audi Dynamic Steering

Audi Dynamic Steering, our new steering system based on a planetary gear developed by ZF Lenksysteme GmbH, allows an additional steering angle to be set via an actuating motor. The angle is computed according to the driver's steering angle and vehicle dynamics variables. For example, the steering ratio can be adjusted according to speed. The new steering system also offers drivers agility functions and extra stabilization functions in critical situations, greatly boosting both dynamics and safety. However, the new system required considerable changes in the development process. Previous steering systems had been developed more or less as stand-alone systems, but the new functions necessitated networking with other vehicle dynamics control systems such as ESP (Electronic Stability Program).

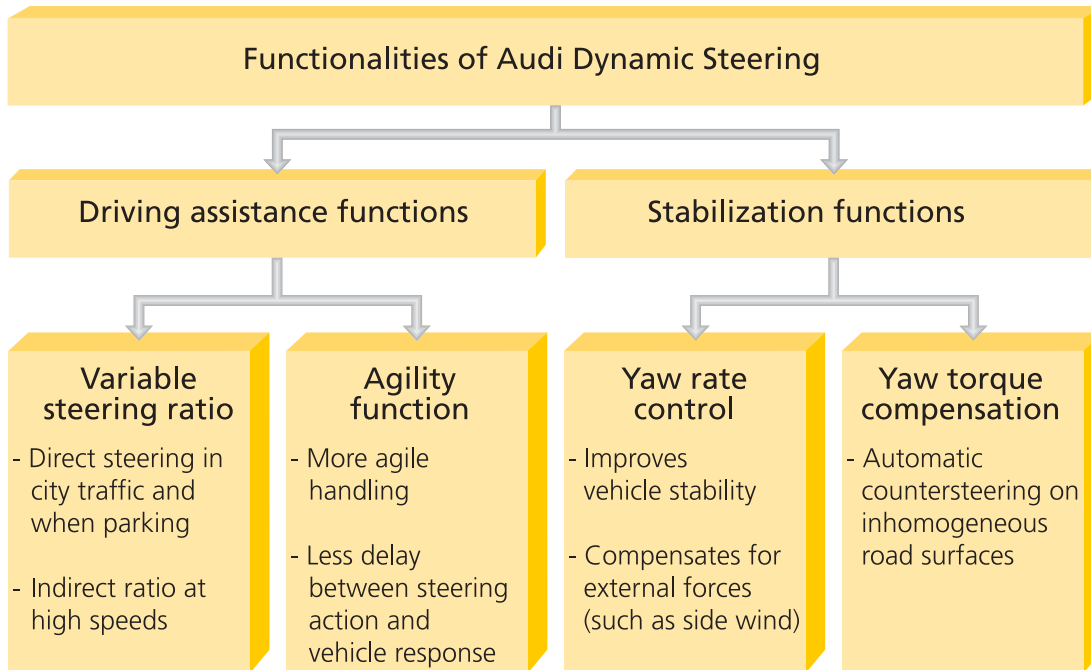
New Functions with dSPACE Prototyper

Implementing the new Audi Dynamic Steering system involved work in all fields of development, from plausibility checks on input signals, to the monitoring of driving states and the design of vehicle models, right through to control design. The functions for Audi Dynamic Steering were designed in MATLAB/Simulink, tested by software-in-the-loop simulation and finally tested and optimized in the vehicle using dSPACE Prototyper. Two vehicles were equipped with an AutoBox and one with a MicroAutoBox for this purpose.

Because the actuator was not yet available, to begin with the dSPACE hardware was used for measuring analog signals (such as those from the measurement steering wheel) and bus signals (CAN signals, yaw rate, lateral acceleration, gear position). This data was



▲ Audi Dynamic Steering in a hardware package.



▲ *Functional scope of Audi Dynamic Steering. The functions of the steering system allow sporty driving while at the same time providing greater safety in critical situations.*

used for initial parameterization of the vehicle models. Once the actuators and sensors had been installed in the vehicle, the controlled system was measured and the vehicle models adjusted accordingly. The basic functions supplied by ZF Lenksysteme GmbH were integrated into the Audi models as S-functions. All newly developed functions are always tested in a Simulink simulation first, and then thoroughly tested and refined in the vehicle using dSPACE Prototyper. To standardize software development at Audi, in-house style guides were used, for example, covering the naming of functions.

Automatic Production Code Generation Speeds Things Up

Automatic production code generation using TargetLink plays an essential role in meeting deadlines and fulfilling the software consistency required for Audi Dynamic Steering. To optimize the time, quality and cost factors, great importance was – and is – placed on a seamless tool chain throughout all development steps, from the initial design to production level, with MATLAB/Simulink providing the reference standard. For example, a seamless transition is guaranteed from function prototyping to automatic production code generation.

Looking Beyond the Steering Wheel

Audi Dynamic Steering is a taste of things to come. Future developments will focus more on integrated function design across several vehicle components, and not so much on functions for individual components. Steer-by-wire will mean an even greater degree of network integration, and unlike Audi Dynamic Steering it will have no mechanical backup system. The processes within the development workflow will also change, as an increasing number of suppliers offer intelligent actuators and sensors for shipment along with the basic functions. Audi itself will continue to develop high-level functionalities that give it the competitive edge.

*Dipl.-Ing. Wolfgang Dick
Mechatronics Development and Testing
Chassis Coordination
Audi AG
Germany*

*Dipl.-Ing. Michael Holle
Chassis Section
Institut für Kraftfahrwesen Aachen
Germany*