

Dongfeng Automates Manual Transmission

➤ **Innovative powertrain project at Dongfeng in China**

➤ **Development of a 12-speed automated mechanical transmission (AMT)**

➤ **Production code for automatic shift control with TargetLink**

Vehicles with automated mechanical transmission (AMT) combine the comfort features of an automatic transmission with the cost advantages of a manual gearbox. Using a commercial truck with a 12-speed manual transmission as a basis, Dongfeng developed a new AMT system including a control unit for automatic gear shifting. The production code generator TargetLink was used to generate the control software and helped to reduce the development time.

The Dongfeng company (the Chinese name means east wind) is one of the five largest Chinese car manufacturers and the leading manufacturer of Chinese commercial motor vehicles. A research team at Dongfeng developed a new Automated Mechanical Transmission (AMT) based on the EQ4195 truck with a 12-speed manual transmission. The system consists of a 12-speed mechanical gearbox and an automatic shift control system (ASCS). The ASCS includes several sensors and actuators, and a transmission control unit (TCU). The actuators are powered by air supply. The TCU takes input signals such as velocity, brake pedal position, gas pedal position, and engine speed into account to control the actuators. The input signals are

delivered by directly connected sensors or derived from the vehicle CAN.

Features of the Dongfeng AMT System

- Obvious reduction of fuel consumption and emission
- Comfort improvement due to automated shift
- No clutch pedal
- Selectable modes: economy, power, mountain
- Failure detection and the clutch & transmission protection by the system software
- Cost, weight and packaging optimized design
- Different driving styles possible

Tools and Development Cycle

The function model developed with Simulink® was first tested in the truck with a dSPACE MicroAutoBox.

“By implementing the automatic shift control system, we succeeded in considerably reducing fuel consumption and improving powertrain efficiency.”

Hongfei Ni, Dongfeng

The developed functions were already optimized and adapted to the mechatronic system during the prototyping phase. To implement the model on the TCU equipped with a Freescale MC9S12DT128B microcontroller, fixed-point object code had to be generated. The automatic scaling features of TargetLink were of great help in fine-tuning the fixed-point code. Automatic scaling was a huge time saver as it took away the tedious and error-prone task of manually scaling each variable and each operation in the software. The precision of the scaled code was easily judged by comparing model-in-the-loop



▲ The automatic shift control system was developed for the EQ4195 truck from Dongfeng.

(MIL) with software-in-the-loop (SIL) simulations; errors like overflows were detected that way. The final object code was generated using the CodeWarrior compiler and merged with custom code.

Advantages of Production Code Generation with TargetLink

When the production code generator TargetLink is used, the definition of the module function is clearer, and implementing and validating the arithmetics is more convenient and takes less time. The model data is completely managed in TargetLink. In addition, the A2L file which is

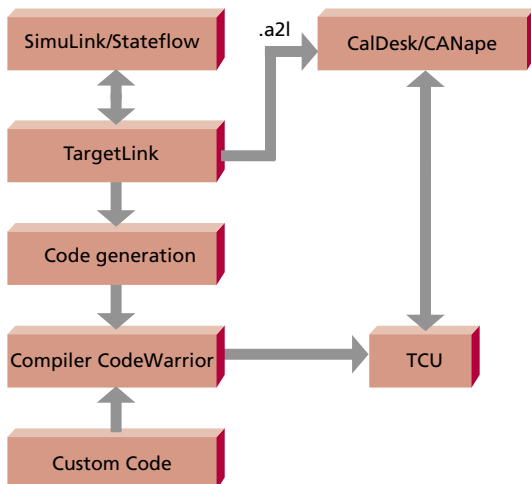
“TargetLink greatly improved the efficiency and quality of the control software for our automated mechanical transmission.”

Hongfei Ni, Dongfeng

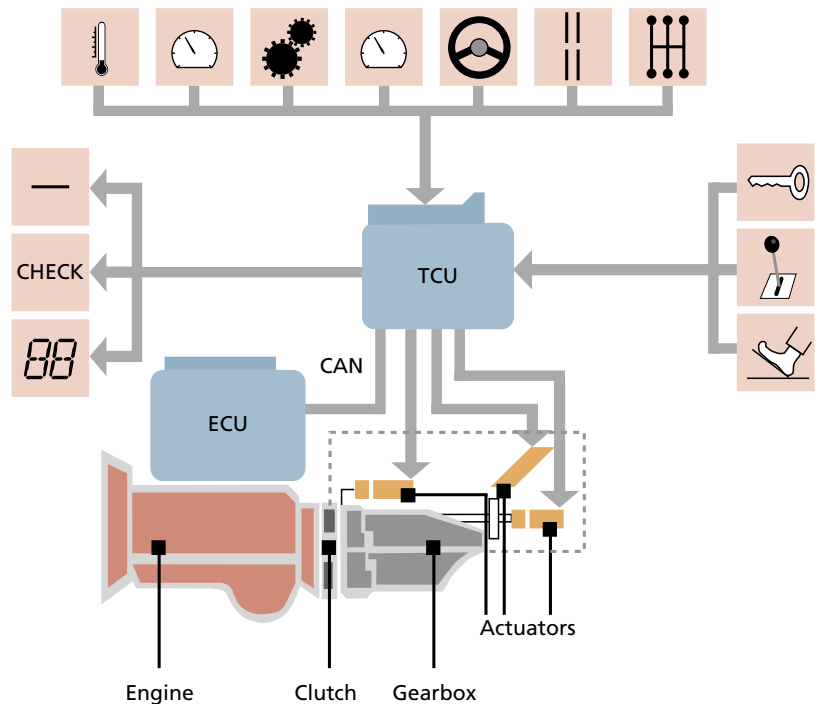
required by the calibration software also can be generated with TargetLink. Overall, the efficiency and quality of development can be greatly improved.

Verification and Validation of Controller Functions

The TCU was then tested in a hardware-in-the-loop test environment based on dSPACE Simulator. Before, too much time and work would be required for the TCU test with manual methods. We would have to do validation tests on actual vehicles. Now, some tests which cannot be finished in a normal environment can be done by using the simulator. Moreover, with the automated test runs, test can be performed more systematically, resulting in greater test efficiency.



▲ The AMT control system development cycle.



▲ The components and signals of ASCS.

Results

By implementing this automatic shift control system, the Dongfeng research team has succeeded in considerably reducing fuel consumption and improving powertrain efficiency. For example, the driver has much less work to do than with the predecessor systems.

The tool chain supplied by dSPACE, with its largely automated procedures, makes the process to a large extent seamless and ensures very good reproducibility. This considerably reduced the time used to develop the TCU and also increased the quality of the code that was produced, and greatly facilitates the development and implementation of control systems.

Outlook

The system is currently undergoing second-cycle development. Meanwhile, improvements are also being made to the development process. A real-time operating system (such as OSEK), well supported by special blocks in TargetLink, is used in the new development, and multi-rate implementation will be realized by using TargetLinks multi-rate features.

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