Ford Otosan: Active Chassis Control

- RapidPro and MicroAutoBox at Ford Otosan
- Ford Transit Connect with active chassis control
- Industry-university cooperation

A Ford Transit Connect equipped with continuous damping control (CDC) dampers and a double pinion active steering system is being used by Ford Otosan (Turkey) for research on active chassis control. The dSPACE system (MicroAutoBox and RapidPro) is used for implementing the active chassis controller. The research vehicle has a semi-active suspension controller that works in coordination with the steering controller for improved ride and handling characteristics. The dSPACE system allows easy modification of the control algorithms being tested.

Semi-Active Suspensions

Passive suspensions require a compromise between the requirements ride comfort and handling performance. Active suspensions allow the best of both worlds at a relatively high cost. Semi-active suspensions are the intermediate, lower cost solution. Semi-active CDC dampers were used to improve ride comfort without compromising the handling performance of the Ford Transit Connect research vehicle. Skyhook, groundhook and hybrid CDC control algorithms were tested using the MicroAutoBox and RapidPro system for implementation and rapid controller prototyping (RCP). Testing was conducted at the Ford Otosan grounds, on a four-poster and on a test road with different levels of surface irregularities.

▲ *The Ford Transit Connect with semi-active suspension controller is being tested on a four-poster.*

Active Steering

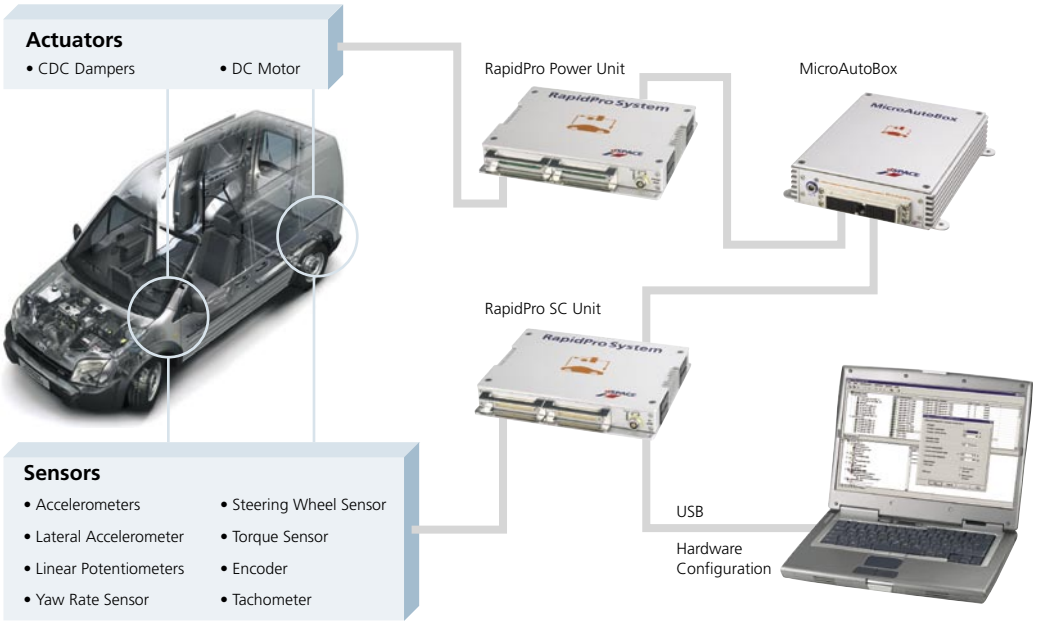
A double pinion active steering system was designed and installed on the same research vehicle. The active steering actuator was first used to implement electric power steering. This steering either mimics the original hydraulic steering behavior of the Ford Transit Connect or works as a programmable, compliant steering system. The driver can program the steering wheel stiffness dynamically and schedule changes according to velocity. The steering wheel is soft during low speed and parking maneuvers. It stiffens as velocity increases. The use of the active steering system in testing a yaw stability controller is in progress.

"This was the first dSPACE system that we used in a research vehicle in our division. We were satisfied with its performance and have begun using dSPACE MicroAutoBox and RapidPro systems in other research vehicle control applications."

Asst. Mng. Mustafa Sinal, Ford Otosan

Active Chassis Control and Instrumentation

In active chassis control, the semi-active suspension and active steering controllers work in cooperation. The CDC dampers are adjusted to reduce undesired body motion transients during handling maneuvers and when the yaw stability controller is active. Each suspension has two accelerometers and a linear potentiometer. The active steering system has one moment sensor, one tachometer, one encoder, one steering wheel angle sensor and a yaw rate sensor. It also reads



The dSPACE MicroAutoBox and RapidPro combination is used for controlling both the semi-active suspension system and the active steering system.

vehicle speed. PWM drivers are needed for driving the CDC dampers and the active steering electric motor. The RapidPro and MicroAutoBox combination with its software programmable signal levels, large variety of I/O choices and rapid controller programming feature have facilitated research vehicle implementation.

Hardware-in-the-Loop Tests

The research vehicle described above has been built as part of a joint research effort by Ford Otosan and the European Union Framework Programme 6 funded center of excellence on Automotive Control and Mechatronics Research (Autocom) at Istanbul Technical University. Instrumentation of the research vehicle including the dSPACE systems, control algorithm development and implementation are carried out by the teams provided by Ford Otosan and the Autocom center. An active steering hardware-in-the-loop (HIL) test system at the Autocom center is used for steering controller designs before the test vehicle implementation phase. This HIL test system has the same hardware as the research vehicle. A quarter car semi-active suspension control HIL test setup is being built at the Autocom center for developing the CDC controllers before research vehicle testing.

"We had been successfully using different dSPACE products including the MicroAutoBox in our labs. So when Ford Otosan asked us to work on this research project, we recommended the MicroAutoBox and RapidPro combination. The RapidPro system proved to be a very useful tool."
Prof. Levent Güvenç, Istanbul Technical University

"The RapidPro system supplies power to all our sensors, provides the required large number of analog sensor inputs and allows us to adjust analog input levels by software."
Assist. Prof. Bilin Aksun Güvenç, Istanbul Technical University

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