USER STORY

MagneShock Develops Semi-Active Suspension Control System with xPC Target

Soon, drivers will be able to adjust the comfort of their ride by pushing a button—whether they're driving a luxury car, a truck, or a sport utility vehicle. Enabling this compelling feature is semi-active suspension, a technology that adjusts the vehicle's suspension system based on real-time vehicle dynamics and driver feedback.

To help with the development of this system, MagneShock used MathWorks tools for Model-Based Design to develop a real-time shock damping control system for a commercial truck that, with parameter tuning, can accommodate customer changes and even different vehicle types.

"The model we developed using MathWorks tools for Model-Based Design will be applicable to everything we do from now on," explains Michael Craft, mechatronics engineer at MagneShock. "Now, we can deliver suspension systems that our customers need quickly."

THE CHALLENGE

Engineers at MagneShock set out to design a control system that could be used to evaluate standard suspension systems as well as provide real-time active damping control with magnetorheological (MR) dampers. The control system would also need to be flexible enough to allow for different I/O hardware, multiple sensors, and various vehicle types.

Because the system needed to support live driver feedback, MagneShock would require rapid prototyping capabilities for real-time parameter tuning of up to 32 channels of data.

"We get a wide range of feedback from different customers depending on the preference

Tuning parameters of a military vehicle's semi-active suspension system with a wireless laptop.

and age of the driver, and our systems need to account for these preferences," explains Craft.

To accelerate development and analysis, they would also need an integrated software environment with proven automatic code generation and analysis capabilities.

THE SOLUTION

MagneShock used MathWorks tools for Model-Based Design to develop a real-time semi-active suspension system for commercial trucks, military vehicles, and luxury automobiles.

Engineers began by building a Simulink® model of the vehicle dynamics. Initial "stock" vehicle setups were primarily based on customer data of spring and damping rates and vehicle mass properties. Simulations of the vehicle dynamics were then performed and validated with onroad vehicle testing, suspension component testing, and shaker rig testing for the stock and MR-equipped vehicles.

MagneShock used MATLAB® to analyze and plot the vehicle dynamics by correlating simulated vehicle data with dynamic road test data. Based on their engineering analysis, they made changes to the damping control.

THE CHALLENGE

To develop a semi-active suspension control system that could be adapted to multiple vehicle types

THE SOLUTION

Use MathWorks tools for Model-Based Design to design a rapid prototype of the controller, tune parameters in real time, and acquire and log data for analysis

THE RESULTS

- Deployable test code
- $100,000 in savings
- Reduction in development time

> *xPC Target gives us the speed, the capacity, and the flexibility we need by enabling us to use a variety of different data acquisition cards and target PCs. There's no way we could have gotten that from any other software package.*
>
> Michael Craft, MagneShock

They used Simulink, Real-Time Workshop®, and xPC Target to develop a rapid prototype of a controller, tune parameters, and acquire and log data for later analysis with MATLAB. The rapid prototype control algorithms are run on a target PC/104 computer connected to the vehicle. The computer logs up to 32 channels of input data, which is used for real-time suspension control and vehicle dynamics analysis to determine the control algorithm best suited to deliver the desired ride.

"We take driver feedback, make adjustments, and get immediate results all in real time," says Craft. "Also, we analyze the data quickly to determine our acceleration and dynamics. Based on this data and driver feedback, we then make changes."

After completing the baseline testing and simulation of a vehicle suspension system, MagneShock installed shocks on the vehicle and conducted real-time parameter tuning with xPC Target. Using xPC Target Embedded Option, they provided their customer with a stand-alone version of the prototype system for extended trial testing.

"We can make an immediate change by asking the customer, 'Is this too stiff?' and adjust the stiffness within the algorithm running in real time," says Craft. "For the commercial truck market, we've designed different settings of the dynamics into the controller, so the driver can switch from sport to comfort to off mode."

The semi-active suspension systems for the commercial truck and the military vehicle are in long-term testing with their respective customers. Production systems will be available in late 2005.

THE RESULTS

- **Deployable test code.** "xPC Target Embedded Option has been very helpful for our longer-term vehicle test trials," reports Craft. "We simply run the application code stand-alone in our PC/104 target setup, and lend the vehicle to our client."
- **$100,000 in savings.** "We have a hydraulic dynamometer for testing shock absorbers. By controlling the power supply with xPC Target, we were able to modify our dynamometer to run with a different hydraulic cylinder and servo valves," explains Craft. "This allowed us to avoid purchasing another system, which would have cost us at least $100,000 more."
- **Reduction in development time.** "We could not have completed this project within the time frame without MathWorks tools," says Craft. "We would have had to program our control system and purchase another data acquisition system that would not have enough channels or be fast enough. It would have taken months to make changes that we can now make instantly."

For more information on MagneShock, visit **www.magneshock.com**

PRODUCTS USED

- MATLAB
- Simulink
- Real-Time Workshop
- xPC Target
- xPC Target Embedded Option

APPLICATION AREAS

- Automatic code generation
- Data analysis
- Model-Based Design
- Rapid prototyping
- Simulation

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