USER STORY

Automotive Systems Laboratory Tests Crash Sensors Using MATLAB® and the Data Acquisition Toolbox

THE CHALLENGE

To sample crash test data fast enough to enable accurate testing of a magnetic sensor

THE SOLUTION

Use MATLAB and the Data Acquisition Toolbox to develop an onboard crash test system and analyze the resulting data

THE RESULTS

- 30-40% reduction in test and analysis time
- Data acquisition program built and refined in just two hours
- Versatile, built-in mathematical functions for complete data analysis

In a crash, the vehicle's internal sensors must determine within a split second whether to deploy the airbag. Virtually all automotive manufacturers use accelerometer-based sensors to detect crashes. They have found, however, that these sensors do not always respond accurately because they are limited to collecting data at the speed of sound in metal and detecting disturbances at single points.

Automotive Systems Laboratory-Takata is helping leading automotive manufacturers diminate inadvertent airbag deployment by replacing the accelerometer with a magnetic sensor, which responds to disturbances much faster than the speed of sound in metal and detects disturbances at multiple points.

"With MATLAB and the Data Acquisition Toolbox, we developed an algorithm that enables the sensor to more accurately assess and respond to the severity of a crash," says William Merrick, sensor development engineer at Automotive Systems Laboratory-Takata. "This is a major improvement to our previous onboard crash test system."

THE CHALLENGE

Automotive Systems Laboratory set out to ensure vehicle safety by developing and testing a more reliable crash sensor.

Accelerometers measure the vibrations that travel through the chassis when a car gets hit. "The problem is, accelerometers are single-point sensors, so the surface within the vehicle where they are mounted becomes the most sensitive," explains Merrick. "If the sensor is mounted on the floor of the car and a stone hits the underside, this may appear to the sensor like a huge crash signal, which can confuse the algorithm and in some cases cause inadvertent airbag deployment."

The Automotive Systems Laboratory crash test unit.

Researchers at Automotive Systems Laboratory replaced the accelerometer with a magnetic coil that is mounted near or around the hinge of the car door. "We generate a magnetic field in certain parts of the car and receive it with the sensor," Merrick explains. "In a car crash, the metal in the car door is stressed and deformed, causing the generated magnetic field to become distorted. The sensor emits a signal proportional to the distortion, and that signal can trigger the airbag."

Testing the new magnetic technology proved challenging for the team. The existing onboard crash test systems could not sample data fast enough for the magnetic sensors.

To characterize the new sensor's behavior, the engineers needed to collect data to measure its response to various classes of car crashes at varying degrees of severity.

THE SOLUTION

To collect the data, they created an onboard test system built with MATLAB and the Data Acquisition Toolbox. The hardware components of the test system consisted of a laptop computer with a PCMCIA data acquisition card. The engineers placed the laptop in a

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>
> William Merrick, Automotive Systems Laboratory-Takata

foam-lined briefcase and strapped it down within a vehicle equipped with the sensor. They then conducted many industry- and governmental-standard crash scenarios.

During the crash, the onboard test system received a signal from a contact switch outside the car to trigger the acquisition. Using the Data Acquisition Toolbox, the system then recorded several channels of data at high speed including the output of the new magnetic sensors. The output of traditional accelerometer sensors were also recorded for reference. The high-level acquisition functions in the Data Acquisition Toolbox simplified the programming task, enabling Merrick to write and refine the program in approximately two hours. The entire acquisition routine consisted of a few lines of MATLAB code with calls to functions in the Data Acquisition Toolbox.

Merrick then brought the acquired data back to the lab to analyze the sensor output using MATLAB and the Signal Processing Toolbox. The numerous analysis functions available in the MATLAB environment made it easy to examine the acquired signals for frequency content and recurring waveform trends.

Once Merrick understood how the sensor behaved in car crashes, he and his team developed an algorithm in MATLAB that controlled airbag deployment. They validated the algorithm, and then programmed it in C and implemented it on a microprocessor that can be integrated into the vehicle's electronics.

Automotive Systems Laboratory expects the magnetic sensor to go into production by 2006/2007.

THE RESULTS

- **30–40% reduction in test and analysis time.** "MATLAB and the Data Acquisition Toolbox saved me at least 30-40% of time because I didn't have to deal with separate tools for measurement and analysis," Merrick says.
- **Data acquisition program built and refined in just two hours.** "Without the simplicity of the high-level MATLAB data acquisition functions, we would have had to purchase an expensive data acquisition system or spend many hours programming with a lower-level language," says Merrick. "With MATLAB and the Data Acquisition Toolbox, I wrote and refined the program in approximately two hours."
- **Versatile, built-in math functions for complete data analysis.** "MATLAB is very versatile and offers lots of built-in physical functions and filter development tools that we used to analyze data," Merrick says. "I don't know of another product that can do all that."

To learn more about Automotive Systems Laboratory-Takata, visit
www.takata.com

APPLICATION AREAS

- Automotive
- Test and measurement
- Algorithm development
- Data analysis

PRODUCTS USED

- MATLAB
- Data Acquisition Toolbox
- Signal Processing Toolbox

www.mathworks.com

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