Industry: Automotive Test System
Products Used: LabVIEW™ • DAQ • SCXI™

Developing a Dual-Dynamometer Road Load Simulator for Heavy-Duty Tracked Vehicles

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The Challenge: Updating a dual-dynamometer system for repeatable, reliable testing of heavy-duty tracked vehicles, such as bulldozers or armored military vehicles like tanks.

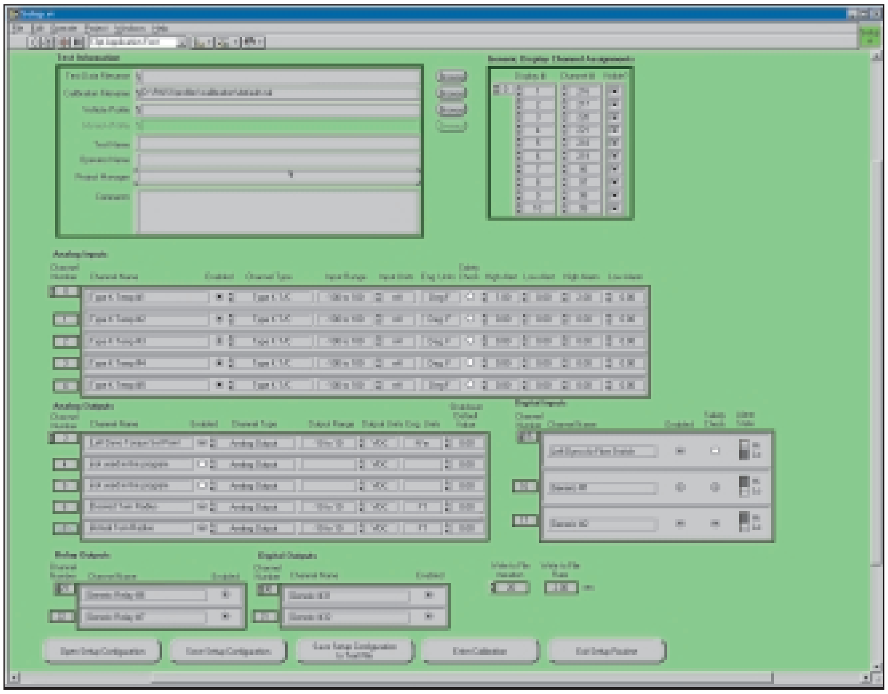
The Solution: Developing a PC-based acquisition and control system using an SCXI and DAQ system controlled by LabVIEW.

Introduction

A client contracted with Southwest Research Institute (SwRI) to install and upgrade a 1980s vintage high-power dynamic vehicle test system that duplicates the road loads encountered by tracked vehicles, including turning resistance. The testing of tracked vehicles has long needed improvement because most test facilities are capable of testing only individual components such as the power pack that is, engine, transmission, and final drive. Road testing of a vehicle yields unrepeatable results because of factors such as inconsistent weather conditions and different drivers. It had become increasingly important to test the durability and performance of an entire vehicle under controlled conditions.

The efficient use of SCXI modules made it possible to use only one DAQ board and thus to build an extremely cost-effective high-channel-count data acquisition system.

The dynamics of tracked vehicles are very different from that of wheeled vehicles. Tracked vehicles experience the same road loads as other vehicles, but also undergo "scrubbing" – the frictional force encountered by the tracks as the vehicle performs a turn. During a turn, the tracks slide across the ground as they roll to propel the vehicle forward. Much research has been done to create equations that predict the amount of torque required to overcome scrubbing, based vehicle geometry and ground conditions.



Setup Screen

The Hardware

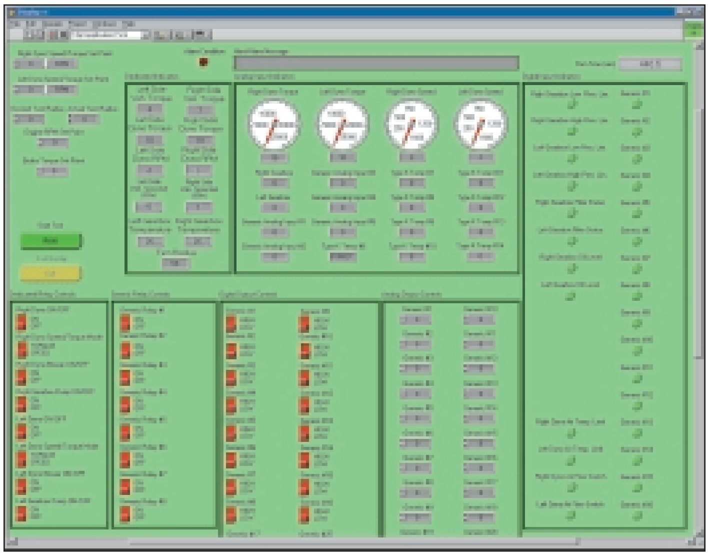
The test system we upgraded included two 1250 hp DC dynamometers (dynos). It simulates road load by measuring the speed and turning radius of the test vehicle. We chose a LabVIEW-based data acquisition system for upgrading the system. We configured 370 channels of data acquisition to monitor and control the dynos, as well as monitor the vehicle under test and measure its performance. Thanks to the multiplexing capabilities of SCXI, the acquisition was done with one multifunction board installed in an industrial PC (350 MHz Pentium II) running Windows NT 4.0. The PCI-MIO-16XE-10 digitized all the signals between two SCXI-1001 12-slot chassis, both fully loaded.

Quantity	Module
3	SCXI-1102
3	SCXI-1102B
4	SCXI-1120
2	SCXI-1126
7	SCXI-1124
3	SCXI-1161
1	SCXI-1162
1	SCXI-1163

Using SCXI, we achieved a channel count of 370 in a relatively simple setup. The associated SCXI terminal blocks gave us ready access for wiring as well as for troubleshooting with a handheld meter. Although the company is not likely to use all of the channels, they wanted a lot of options for configuring different test setups. We provided:

- 48 Type K thermocouple inputs
- 48 Type J thermocouple inputs
- 96 analog inputs
- 32 isolated analog inputs
- 16 frequency inputs
- 42 analog outputs
- 24 SPDT relay outputs
- 32 digital inputs
- 32 digital outputs

Although some channels are dedicated to fixed hardware in the test setup (control of dynos and accessories), the user can custom configure most channels from the set-up



Display Virtual Instrument

screen, including renaming channels and providing scale factors. Input channels provide error checking for low/high alarm and alert threshold values, and output channels provide for specification of a default value. Upon crossing an alarm threshold on an input, all outputs revert to the specified default values.

Fixed analog input channel sensors include left/right dyno torque, left/right dyno speed, and gearbox temperatures. Fixed digital inputs include oil pressure limit switches, filter differential pressure limit switches, oil level switches, oil temperature limit switches, dyno air temperature limit switches, and dyno air flow switches.

The client will likely use the generic input channels to monitor various vehicle temperatures, pressures, fluid levels, and speeds, as well as environmental conditions such as humidity, barometric pressure, and temperature.

The Software

SwRI chose LabVIEW because of its sophisticated graphical user interface, its simple integration with NI hardware, and its rapid development environment. With LabVIEW, we had the functionality to meet the complex requirements of the test system in a time-efficient manner without having to resort to more complicated text-based programming languages.

We took advantage of the extensive indicator-attribute features of LabVIEW to customize the graphical user interface. With the large potential channel count for this application, it is impossible to fit all of the channels on the screen simultaneously; moreover, many of the channels do not need to be seen on screen. By using the attribute node feature of the front panel indicators, the operator can define which channels he or she would like to monitor on screen, as well as where they should be placed. We used array clusters in the set-up program as a scrollable form from, which the operator can define channel names and features. We use global variables to store all system constants and to pass data from one subroutine to another.

The program also contained a calibration routine so the technician could monitor and adjust each signal on a channel-by-channel basis and then store the calibration parameters to a file. We used buffered acquisition to read all of the defined input channels at 100 Hz. The main program loops operated at 10 Hz, and performed 10-point averaging of the data to help eliminate any noise. The program saved data to a file every two seconds. In addition, it maintained a circular buffer of the most recent 400 10Hz data points. In the event of an alarm, this data in the buffer could help determine what went wrong.

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Summary

Development of the system went smoothly. Thanks to the efficient use of SCXI modules, we used only one DAQ board and built an extremely cost-effective high-channel-count data acquisition system. Our system exercises the multifunctionality of the PCI-MIO-16XE-10 board, using analog input and digital I/O channels. Using LabVIEW with these NI hardware products offered easy software development and system integration. Our client is looking forward to using the system to test a new prototype test vehicle. ■

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