Tread & Sidewall Measurement in Tires

By

Ramanathan Varadharajan
Sr. Engineer, Measurement & Automation
Data Science Automation Inc.
USA

And

Gregory C. Cala, Ph.D.
Vice President, Operations
Data Science Automation
USA

Category
Automotive

Products Used
LabVIEW version 6.0.2
PCI-7334 Motion controller card
Compumotor EAC Drive
Compumotor Encoders
UMI-7764 Universal motion interface
SCB-68 Digital I/O connector block
SH68-C68-S Cable
Laser sensors
Flex Motion 5.1

The challenge
A high-throughput tire testing system that acquires more accurate tread and sidewall measurements (every 0.2 mm) and offers more flexible analysis options was desired. The system also required alignment of X and Y sensors using Zero alignment mechanical Zig.

The solution
Data Science Automation replaced an obsolete machine with a custom NI LabVIEW, NI Motion and laser DAQ integrated solution. Tire shape/profile data is collected significantly faster, displayed in real-time and saved in a file which can be easily interpreted by any software application. The application was developed with LabVIEW 6.0.2, NI PCI-7334 motion control board and Compumotor EAC drive to handle X-Y motion of tread and sidewall laser sensors and acquire analog data from the sensors using the analog inputs available in PCI-7334 motion control board.

The Problem Expressed
A leading truck tire manufacturer evaluates tire quality by measuring the inflation growth and shape at different pressure levels. Position data were collected, with a 1987-vintage tire shape machine, along the tire tread and sidewalls at various inflated pressures on both recently manufactured and old tires for lifecycle performance comparisons. The obsolete, low-throughput machine experienced frequent crashes that resulted in high maintenance costs. Customer approached DSA to develop a control system that meets the following requirements.

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com

- a low-cost, fully documented solution incorporating current technologies and off-the-shelf components
- a system that can acquire both X and Y data simultaneously to increase tire testing throughput.
- An automatic system to align the X and Y sensors by interfacing with the existing laser control board.
- Acquire data every 0.2 mm across both the tread and sidewall of the tires in a coordinated mechanism.
- Display test results while data is being acquired and log data to a file that can be interpreted easily by third party software.

The Solution Offered

DSA developed an operator interface where an operator can enter the tire attributes (shown in Figure-1) so that information can be stored in the data file giving the ability to analyze and compare test results at a later date. Also control buttons were provided to jog the X and Y stepper motors housing laser sensors.

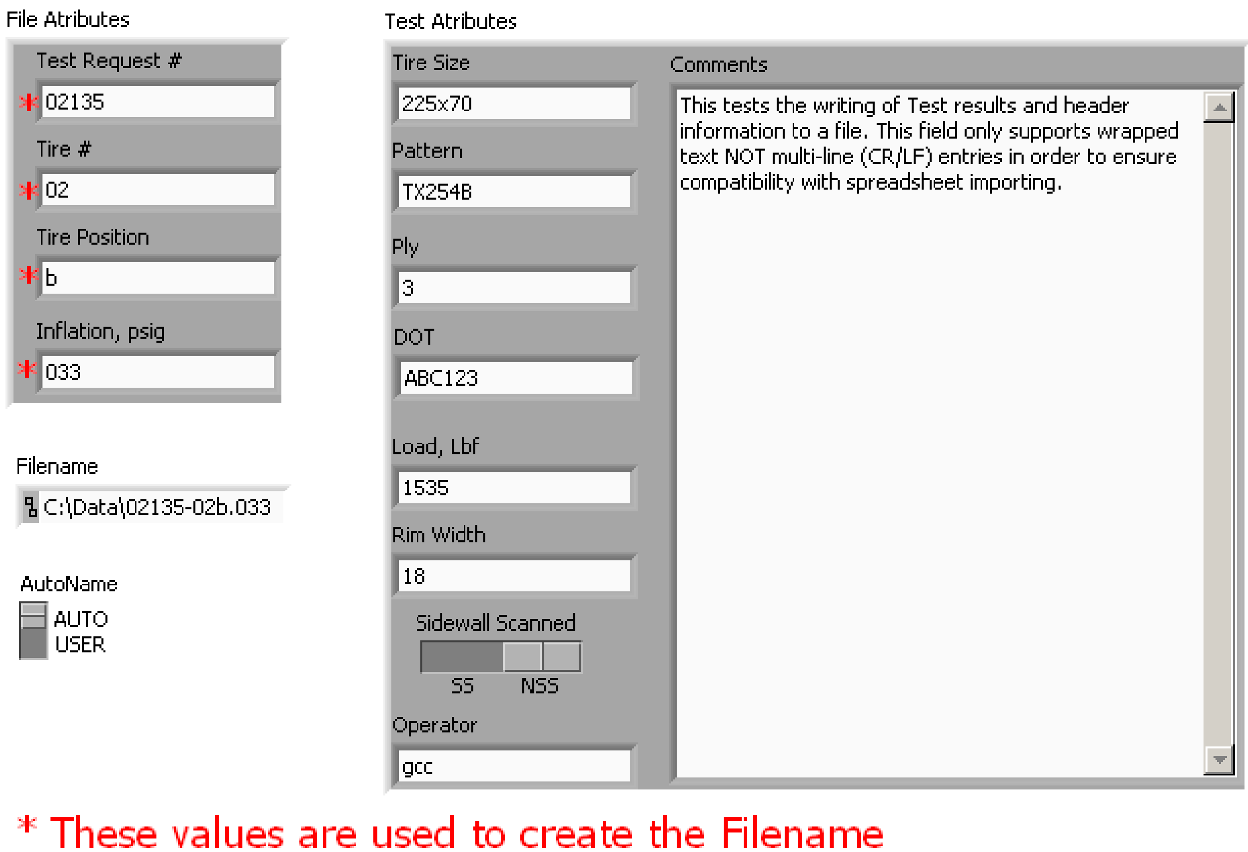

Figure 1: Tire attributes

During the start of the testing process, code was developed to automatically start the zero alignment process (using precise control and X and Y stepper motors). The feedback signal for successful alignment is taken from the existing laser control board. Code was written to coordinate the motion control of the X and Y stepper motors and sensing of the digital feedback signal. The location of the X and Y stepper motors are saved internally in the software so that test can be started from the same location every time without repetitively performing the alignment process.

After zero alignment is verified, analog data is captured every 0.2 mm of the sidewall and tread. This required coordination of the X and Y sensors, which is implemented using the native functions that are available in FlexMotion products and NI PCI 7334 motion control board. Availability of four analog inputs in the motion control board simplified the integration process. As data is being acquired, data was displayed in an X Y chart as shown in Figure-2. The test is stopped based on the forward limit switch positions of the X and Y sensors and data is saved to a tab delimited text file and the test results can be viewed in a list box as shown in Figure-3.

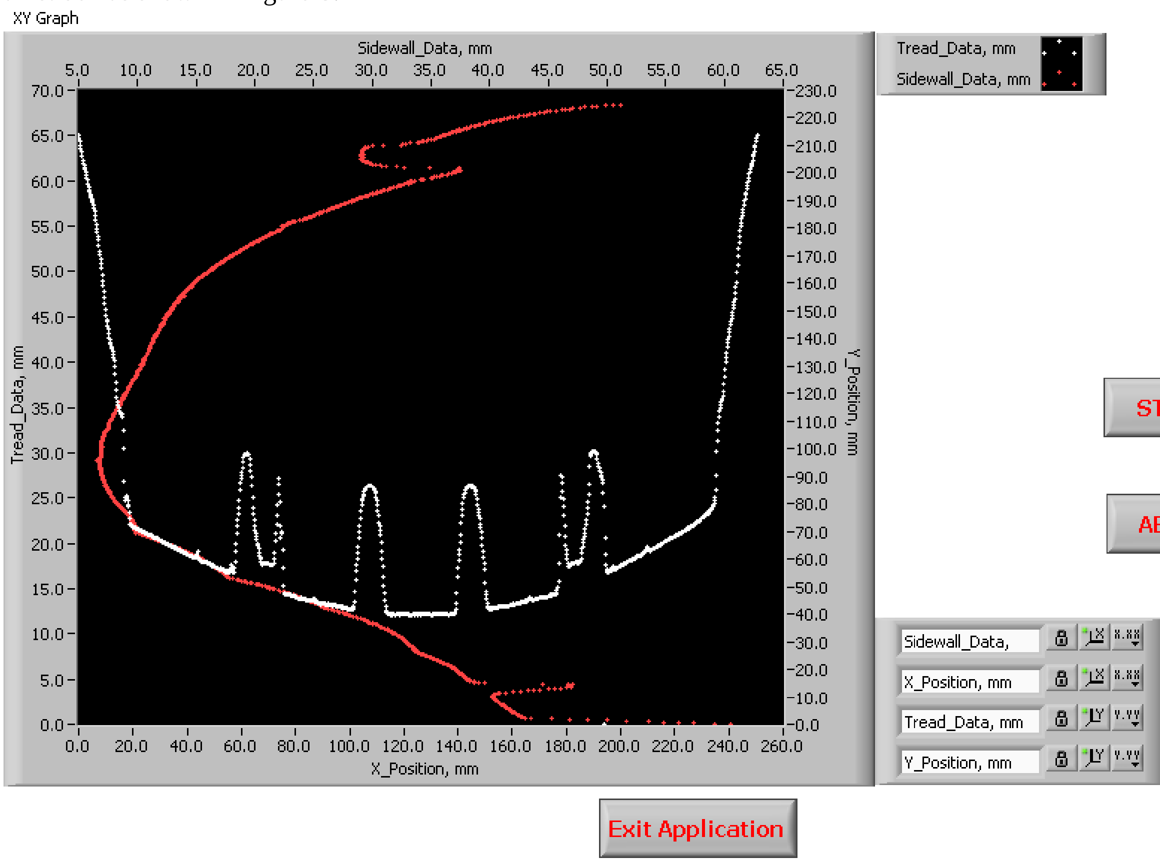

Figure-2 Tread and sidewall data

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com

File Path C:\My Documents\Bridgestone-Firestone\Data\2002_1014-143222_TestData.xls

DataTable

X_Position, mm	Tread Data, mm	Y_Position, mm	Sidewall Data, mm
Header_Lines	11		
Date	2002_1002		
Time	13:45:03		
Operator	gcc		
Tire_size	225x70		
Pattern	TX43		
Pressure_Psig	32		
Load_lbf	1000		
Software_Version	0.1		
Comment	This tests the writin		
X_Position_mm	Tread_Laser_mm	Y_Position_mm	Sidewall_Laser_mm
0	0	0	0
0.2	0	0.2	0
0.4	0	0.4	0
0.6	0	0.6	0
0.8	0	0.8	0
1	0	1	0
1.2	0	1.2	0

Header Information

Figure-3 Data in list box

The application software was created in LabVIEW 6.0.2 using NI FlexMotion version 5.1 (shown in Figures 4 and 5) and each component of the system was integrated and tested with the main application software. The challenge is to write an optimized code which can complete the test quicker and also acquire data every 0.2mm on the fly without compromising accuracy. The application was developed using an event structure to poll the user the interface control actions if their values are changed and queued state machine architecture. The user interface provided the flexibility to manually operate the individual devices and helped in troubleshooting during the commissioning process.

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com

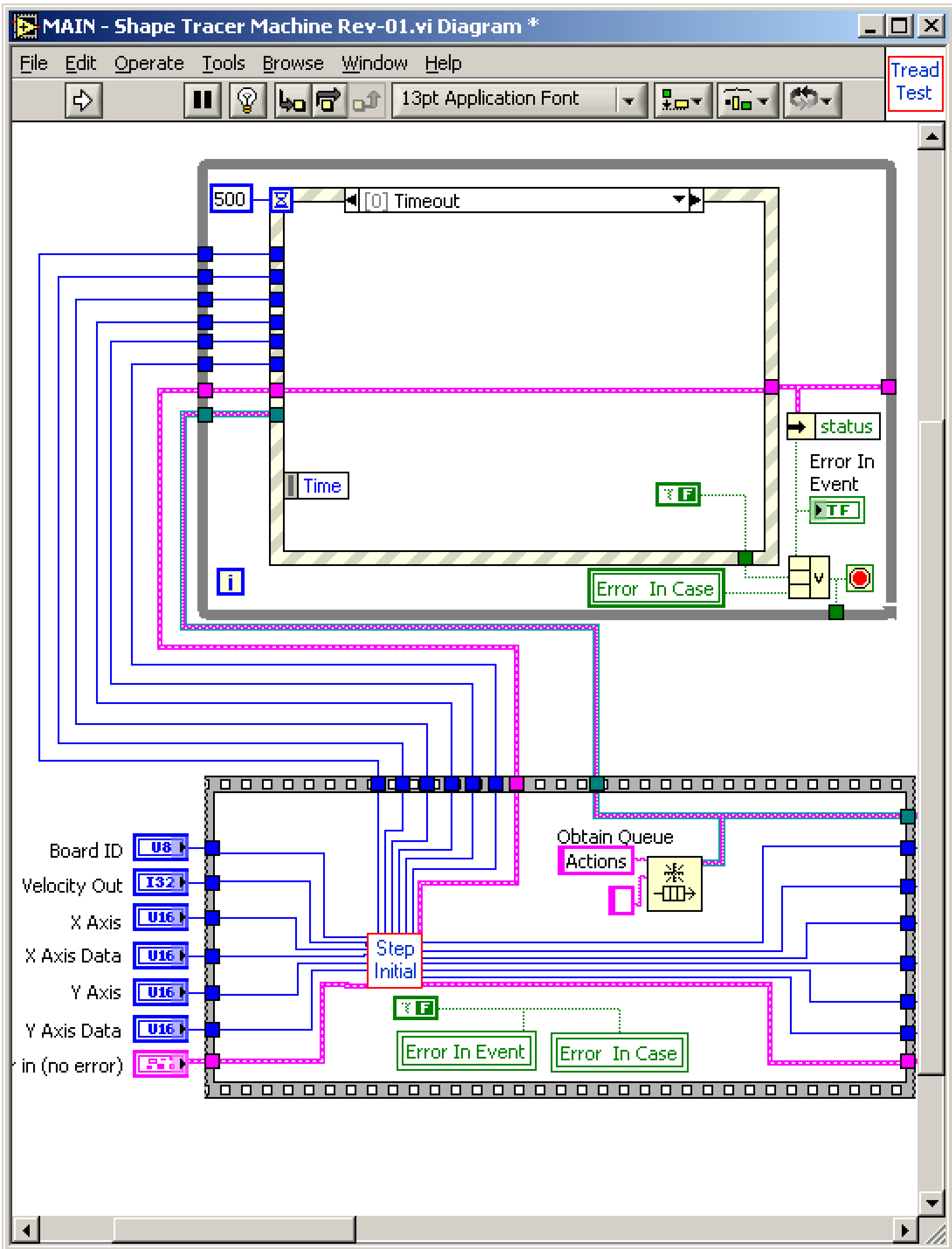

Figure-4 Event Structure

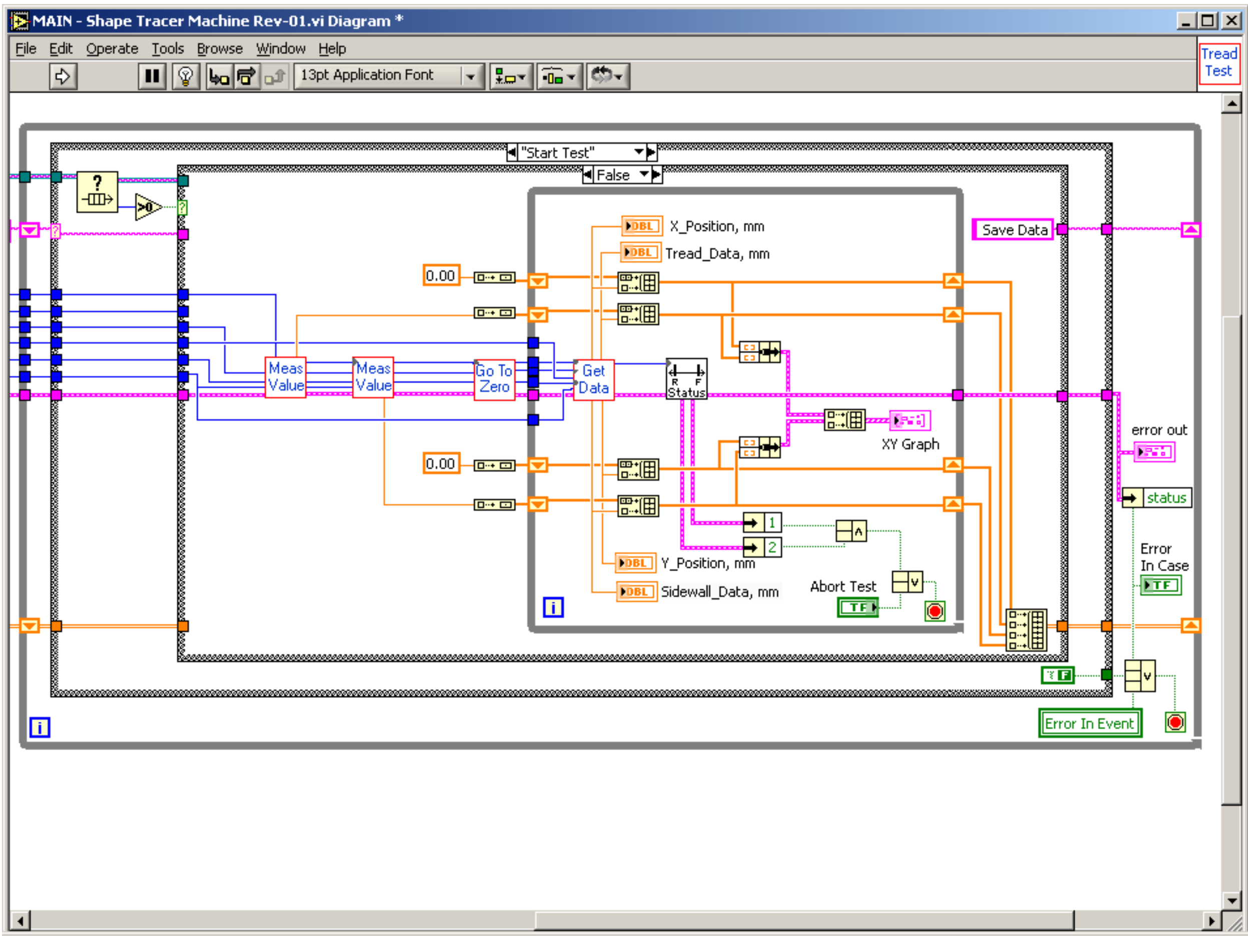

Figure-5 Queue State Machine Architecture

The Reward Attained

This effort produced a fully integrated and fully automated testing system capable of acquiring more accurate data and also provides them the flexibility to analyze test results efficiently. Also, the new system utilized commercial off the shelf (COTS) technology for a significant cost reduction and reduced maintenance cost and downtime liabilities.

