Robotic Control for Reactor Verification

by
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Category:
Design Validation

Products Used:
PCI-6035E Multifunction data acquisition card
DAQCard-DIO-24 Digital data acquisition card
PCI-1411 Image acquisition card
Measurement Studio 6.0 (LabWindows/CVI)
NI-DAQ 6.9
NI-IMAQ 2.5
IMAQ Vision for Measurement Studio 6.0
NI_ReadWriteAVI.dll (available on the NI Developer Zone)

The challenge: The development of a robust, Windows-based operation tool to control multiple robots used in generator testing and diagnostics. The motion of each robot had to be controlled, and each robot generated several analog, digital, and video outputs that needed to be monitored, logged, and presented by the system.

The solution: The development of a scaleable, reliable application using LabWindows/CVI to control robotic movement via third-party driver interaction, to acquire data using National Instruments (NI) data and image acquisition products, and to process and present data using built-in LabWindows/CVI functionality as well as supplemental NI vision and NI audio-video interleave (AVI) software.

The Problem Expressed
Siemens-Westinghouse Power Corporation, a division of Siemens Energy and Automation, Inc., performs diagnostic testing and in-depth reporting on high-output generators for their customers. Due to the high-voltage environment in which they work, Siemens-Westinghouse engineers had developed a number of robotic “carriages” used to crawl along the inside of generators performing various structural and electrical tests and collecting the resulting data (figure 1). Each carriage’s motion was controlled manually via an external joystick and all data collection, analysis, and presentation was performed using several different DOS programs installed on a PC taken to the job site.

As time progressed, however, the needed functionality of each robotic carriage began to increase, as did the number and necessary quality of the information gathered and the reports produced. In addition, operation of the carriages was cumbersome due to the existence of several control and processing programs in the DOS format as well as the necessity for manual motion control. As a result, Siemens-Westinghouse contracted Data Science Automation (DSA) to assist them in developing a single C-based application that was capable of operating several types of carriages, automating the multi-axial motion of the each carriage, collecting, processing, and retaining the various types of data output by the carriages (analog, digital, and video), and compiling numerous customized reports in a professional-looking format. In addition, Siemens-Westinghouse desired a Windows-based format incorporating standardized, intuitive operator interfaces to minimize the time required to train new operators.

The Solution Offered

National Instruments' LabWindows/CVI (a component of Measurement Studio 6.0) was an easy choice for an optimum software development tool due to its C-based development environment and its excellent support and integration with NI's reliable and efficient data and image acquisition components. With LabWindows/CVI and NI hardware, DSA was able to quickly and efficiently implement a distributed executable furnishing a solution to all of Siemens-Westinghouse's requirements.

Using the multitude of built-in LabWindows/CVI user interface, formatting, and input/output libraries, DSA was able to design and construct an comprehensive application structure that allowed for the selection of a variety of carriage types, and then offered the user an assortment of configuration, operation, and data manipulation and presentation menu options corresponding to the user's carriage selection. The application structure also provided the capability of creating new configurations, saving or loading existing ones, and attaching saved configurations to specific job or personnel sessions, allowing for maximum flexibility, reliability, and repeatability in carriage setup and configuration (figure 2).

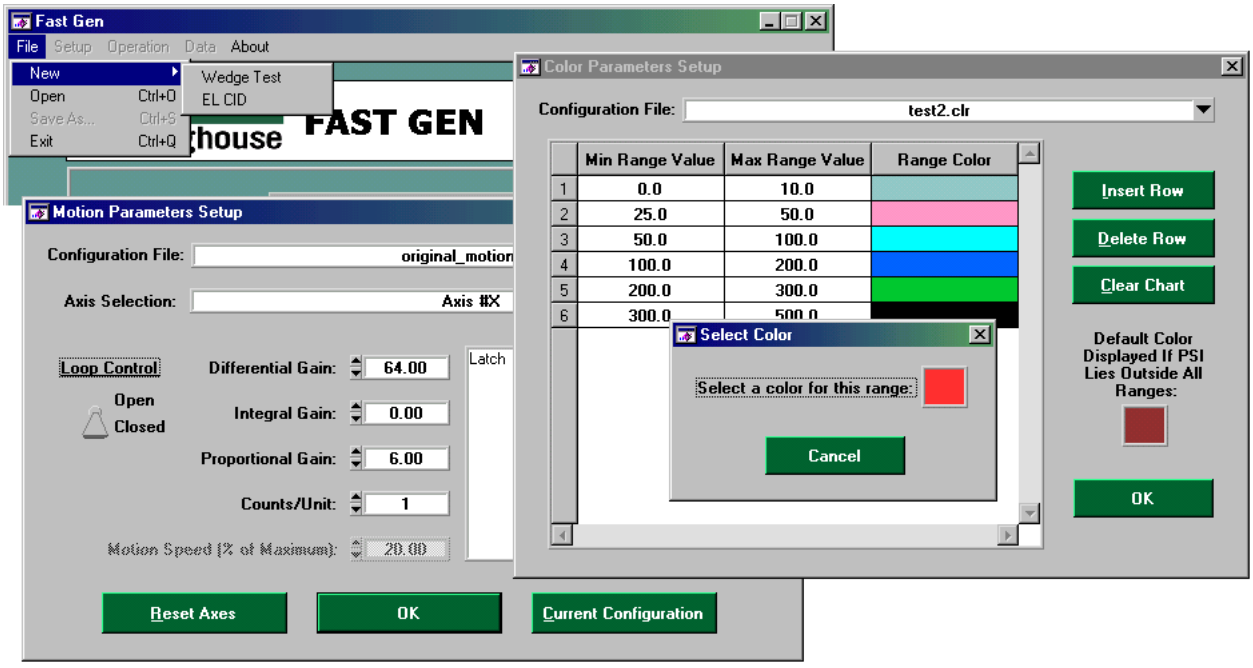

Figure 1: Multiple carriage selection and configuration

Multi-axial motion control for the automation of the carriages was achieved using two Galil DMC-1000 motion controller boards (providing control of up to eight axes) and the corresponding Galil C-based driver, to which the LabWindows/CVI environment provided easy connectivity. Once the appropriate library (.lib) file and header (.h) files were referenced in the project, Galil driver functions were made available and two-way communication between the application and the motion controllers took place flawlessly.

To perform the acquisition of test and status data returned by the carriages, the NI PCI-6035E multifunction data acquisition board was used to acquire analog I/O, while the NI DAQCard-DIO-24 digital acquisition board was used for digital I/O. Using the capable NI-DAQ 6.9 driver (referenced easily from LabWindows/CVI), both analog and digital data were acquired and logged with greater precision, accuracy, and efficiency than that afforded earlier with the DOS-based system. To control data acquisition, the application provided both simple diagnostic tools to communicate directly to data acquisition cards (as well as the motion controller) as well as more complex carriage test execution tools enabling comprehensive, fully automated execution of carriage tests (figure 3).

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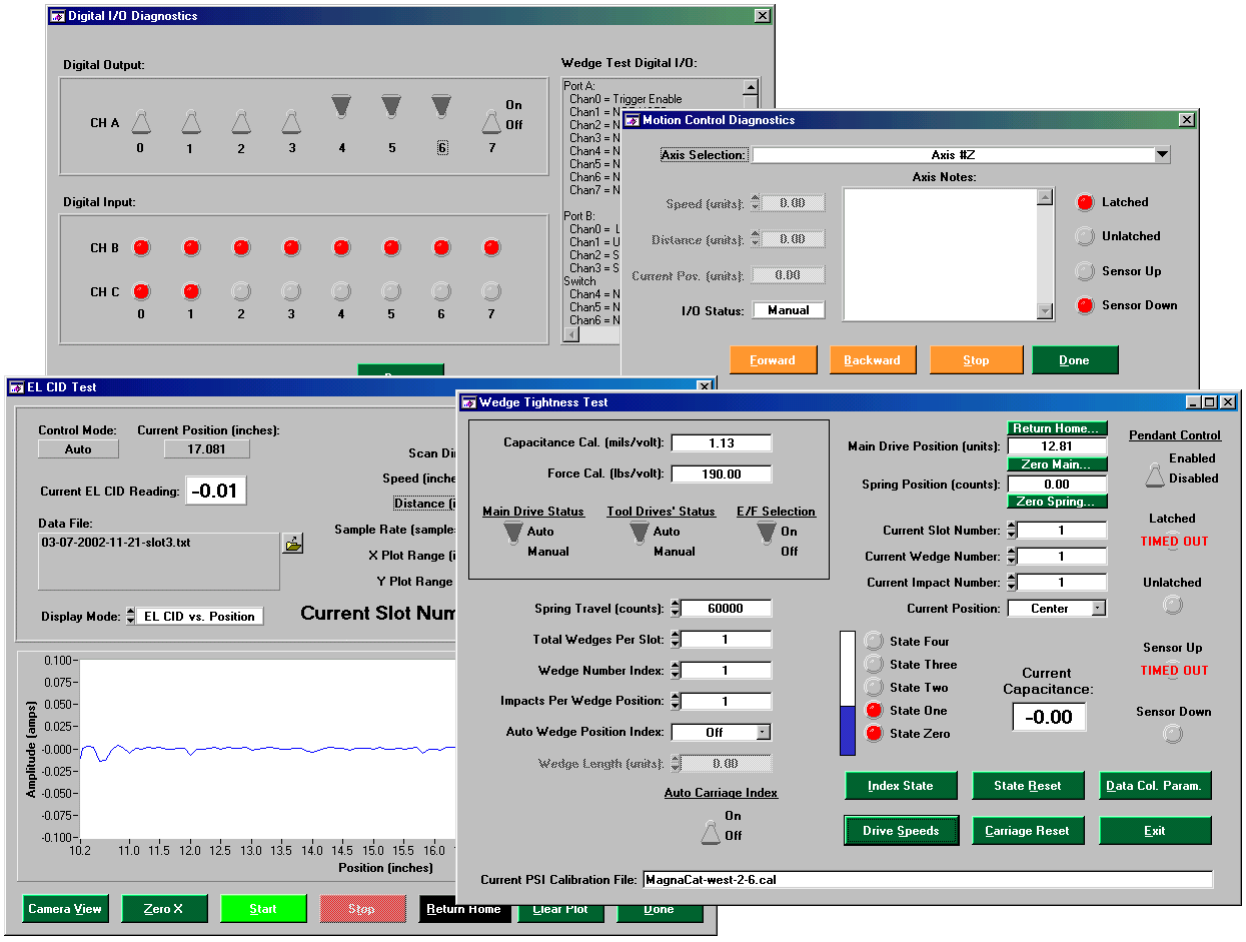

Figure 2: Diagnostic and test execution tools

In addition to handling analog and digital output, the application software was also required to acquire video output returned by the carriages, allowing the saving of snapshots (.jpg files) and movies (.avi files) during carriage operation. To satisfy these requirements, a National Instruments PCI-1411 color image acquisition board was used with the NI-IMAQ 2.5 image acquisition driver to acquire the images, while the IMAQ Vision for Measurement Studio 6.0 toolset was used to control image manipulation, presentation, and the saving of snapshots (figure 4). The IMAQ Vision toolset did not provide a tool for the saving of movies; however, a quick search on the NI Developer Zone yielded a free NI_ReadWriteAVI.dll that provided this functionality. Furthermore, examples were located on the website that made implementing the functions in the .dll swift and simple.

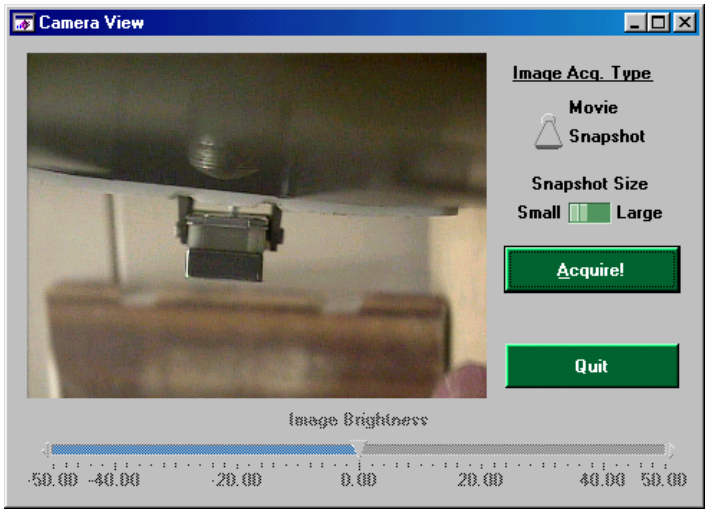

Figure 3: Image acquisition

Finally, a multitude of professional-appearing, comprehensive reports was created for recalling, analyzing, and printing previously acquired data. These reporting options employed a host of built-in data presentation tools available in LabWindows/CVI, including multiple-plot graphs, charts, and tables (figure 5).

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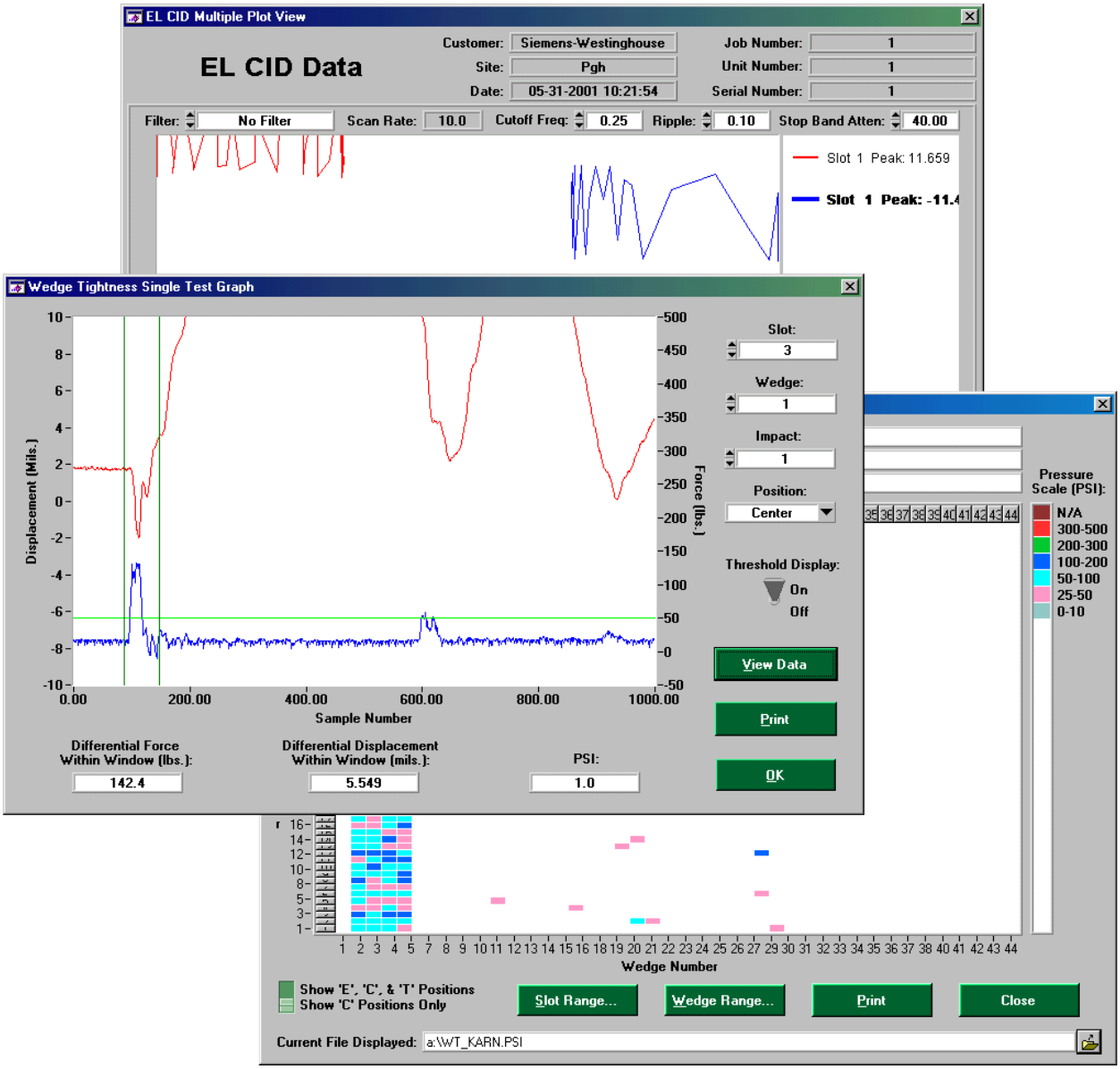

Figure 4: Report generation

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The Reward Attained

Upon completion of the project, Siemens-Westinghouse had replaced their previous outdated, multi-program carriage control architecture with a single, standardized, distributed application providing much more functionality and control, better results through superior hardware and software and expanded reporting options, and reduced cost in training and operation due to automation. Through National Instruments products and Data Science Automation's engineering expertise, Siemens-Westinghouse was able to harness the power of the PC to gain a market advantage, producing a better product at less cost.

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