Stretching the Limits of LabVIEW
(Measuring Polymer Strength using LabVIEW)

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Category:
Prototype/Test

Products Used:
NI LabVIEW 8.2.1
NI GPIB Card
NI M Series DAQ Device

The Challenge:
Develop a software application to produce load bearing stress onto a plastic polymer while reading multiple signals to determine the overall material strength.

The Solution:
Leveraging modular LabVIEW-based software architecture, Data Science Automation (DSA) has created a system utilizing National Instruments acquisition and communication boards to monitor and control signals containing loads, electrical stresses, temperatures and birefringence data.

Abstract:
A polymer manufacturer was at the mercy of an outside testing facility to determine the strength characteristics of new polymer compounds. Using this contractor test facility meant long and costly delays between the development and manufacturing of high quality plastic polymers. To replace the outside test facility, the effort would have to incorporate stress bearing motion while acquiring and analyzing loads, temperatures, electrical conductivity and birefringence data in a manner in which small quantities of polymers could be tested periodically during development.

Overview
The majority of consumers do not consider the complex, iterative processes involved in the development of the plastic materials that are found in so many modern products. But some of the public are keenly aware of the life saving strength characteristics of advanced polymers when they hear about the protective gear used by the military, construction workers and first responders. In order to expedite product development and grow market share, management understood the return on investment to be gained by eliminating the dependence of their product development pipeline on an external contractor test facility for polymer physical testing.

Test Configuration
To configure a test run the test engineer would have interact with a simple and intuitive user interface (Figure 1) for entering such values as:

- stretching movement mode,
- hold time,
- stretch speed,
- electrical current settings (for picoammeter),
- expected load cell values (for load cell selection)
- test identifiers (operator, material, etc.).

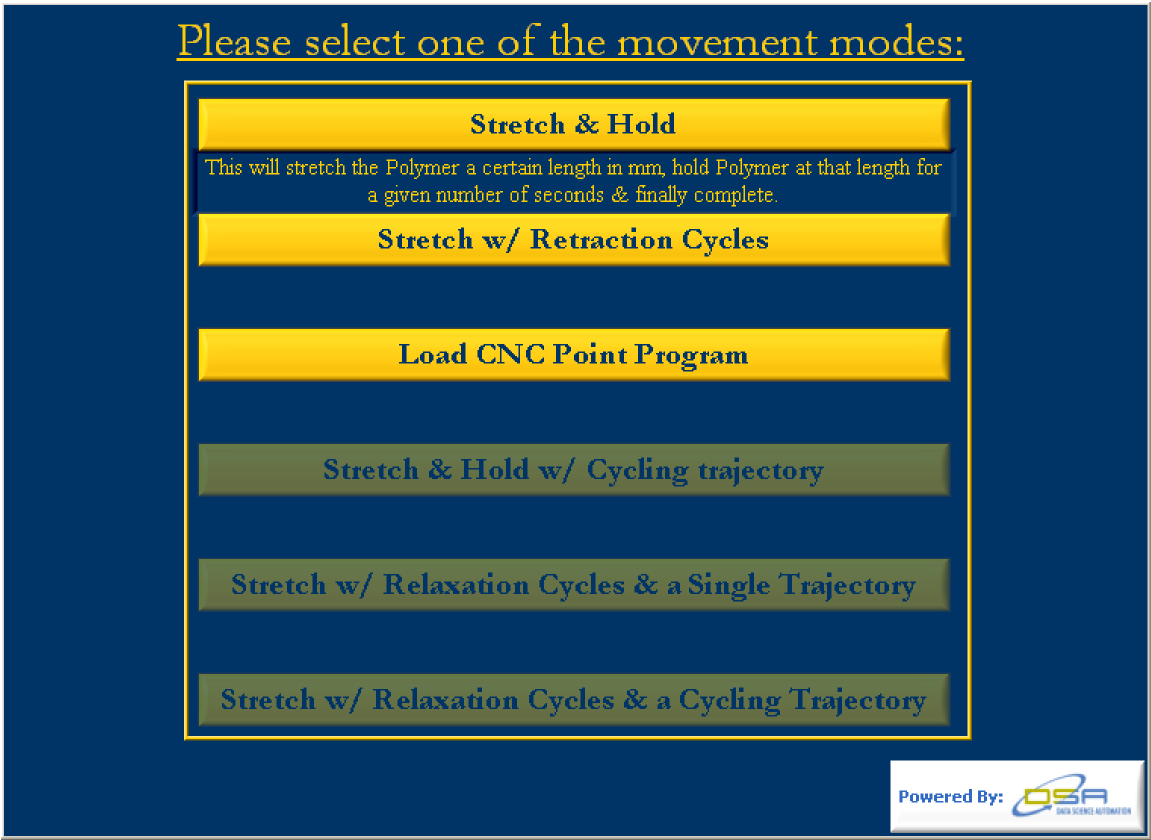

Figure 1 – Mouse Clicks Allow the User to Efficiently Select the Current Stretching Parameters.

This user interface would prompt the engineer with individual questions in a manner that only acceptable values would be permitted minimizing the risk prematurely destroying a test specimen before the desired test data was acquired.

Once the test was configured, the system would then allow the engineer to preview data to validate all signals and instrumentation was functioning. Also at this time the system would determine the acquisition rate and all offsets for the birefringence readings.

Temperature and Motion Control

Because of the influence of temperature on the polymer’s physical properties, the temperature was controlled as part of the test preparation. The operator would manually adjust an external control knob while reading real-time temperature values on the user interface. To read the temperature, the system integrated thermocouples which were read using the M-Series data acquisition device card. The motion for stretching the polymer material was controlled using LabVIEW’s ability to easily communicate with vendor supplied DLLs (dynamic link libraries). The stretching motion was determined by the configured accelerations, decelerations, and velocities along with travel distance. These were transferred to the motion controller using both vendor supplied and custom DLL function calls.

Nuts and Bolts

The mechanical design of the project utilized a previously procured brushless servo motor used to stretch the polymer material in a uniform linear motion. By stretching the material, vertical tensile force will be applied to the material. Load cell signals were measured by using an NI M-Series data acquisition device. As the material weakened in due the vertical force, the electrical conductance of the polymer would change slightly. To measure this change, the system integrated a GPIB Pico-ammeter. Most of the polymer material being tested would initially stretch and eventually break if destructive forces were applied.

Analysis and Data Storage

After the completion of a successful test, all raw data would be analyzed automatically with the birefringence data displayed on spectrometer graphs (Figure 2). Once the analysis was completed, the analysis results would be placed in a folder hierarchy. This hierarchy would allow the user to productively display multiple products tested or a particular product's test cycles. The computational algorithms for determining stress capabilities were proprietary but flexibility was provided to permit easy adjustment of algorithm parameters for validation. To permit parametric analysis with a variety of algorithm parameters the raw data was stored along with the analyzed data. To ensure quality assurance the system had to have the ability to reprocess all data collected, meaning the system had to save test information (during testing) along with the raw data so that all computed data could, in the future, either be reprocessed or validated via an outside source.

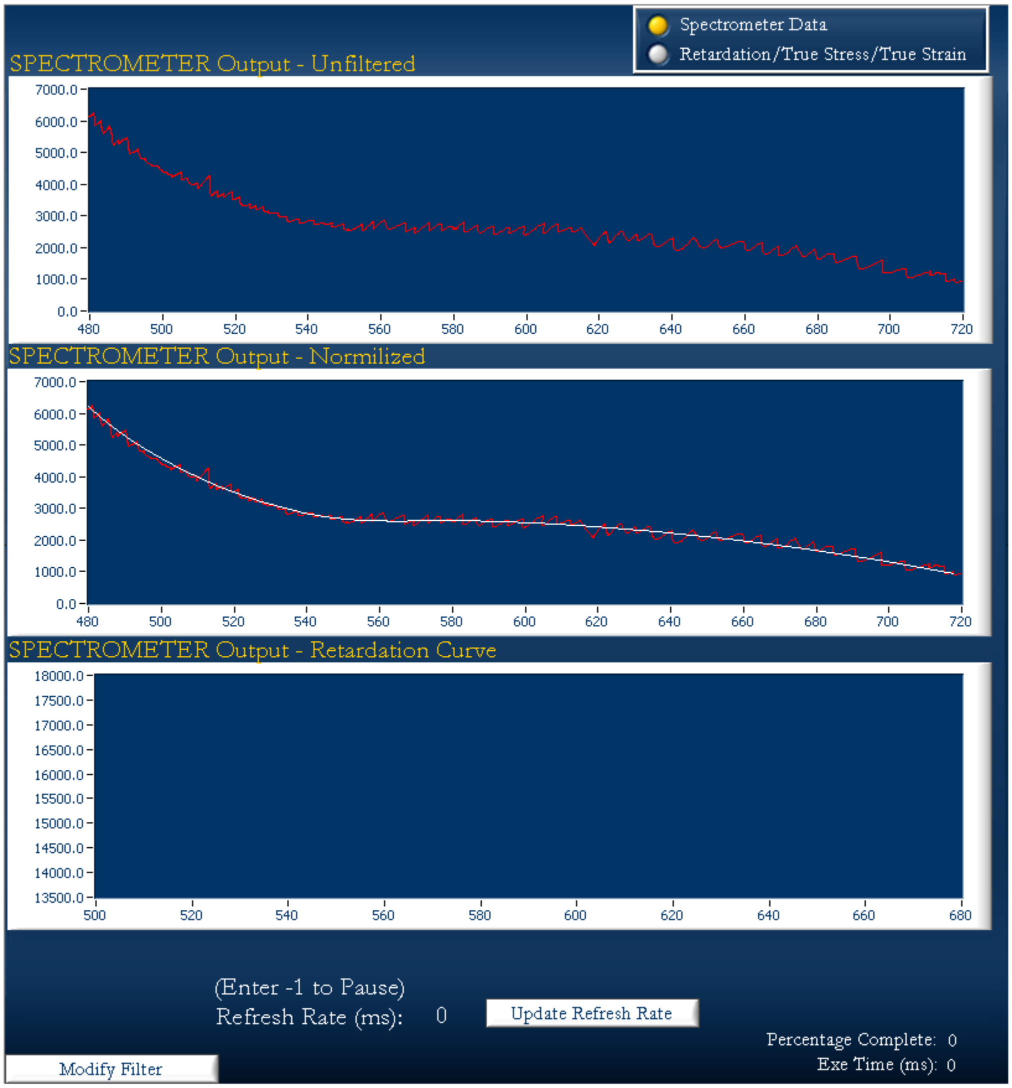

Figure 2 - Analytical Display for Representing the Current Berefringence Calculations

The Bottom Line

To remove the unnecessary, costly, and time consuming outside polymer tensile strength testing an integrated hardware and software system was created by Data Science Automation using National Instruments LabVIEW software and data acquisition cards. By using National Instruments products, Data Science Automation was able to create the solution in a timely fashion. And by creating the system using a modular software design, the customer had the flexibility to change and modify with relative ease any analytical algorithms to accommodate the needs of ever-changing polymer material. This solution successfully gave the client independence while providing a convenient, reliable, and repeatable in house solution.