DATA SCIENCE AUTOMATION

Celera Genomics Uses LabVIEW in Human Genome Sequencing

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Biotechnology and Medical Device Edition

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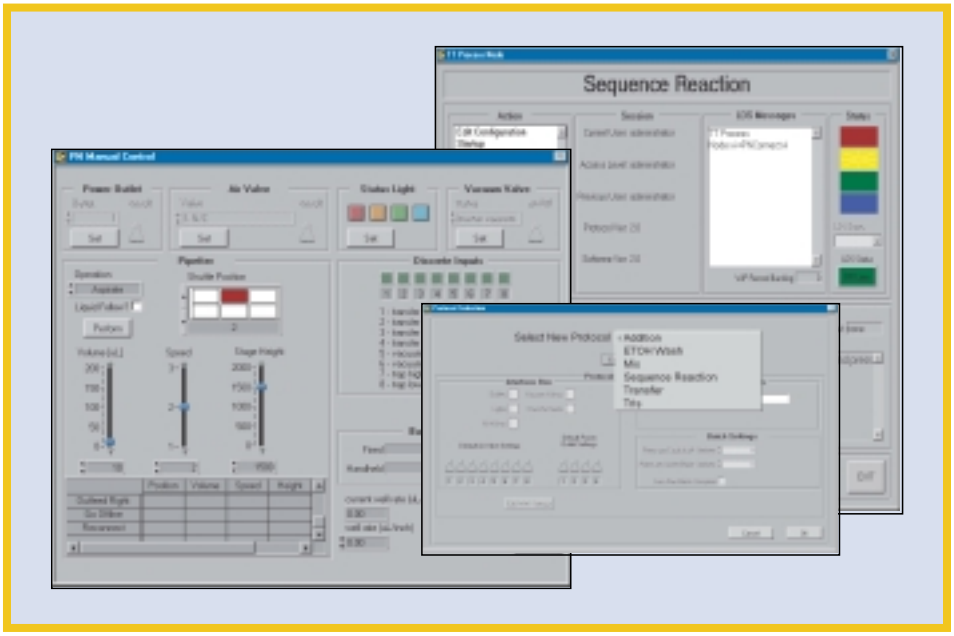
Celera Genomics Uses LabVIEW™ in Human Genome Sequencing

Data Science Automation in conjunction with Applied Biosystems assisted Celera Genomics, one of the leading sources of genomic information, with its goal to sequence the entire human genome and other organisms. Celera Genomics accomplished sequencing by automating pipetting robots using National Instruments LabVIEW. The pipetting robots transfer samples and dispense reagents while processing initial E. coli clones, generating resultant templates, and performing sequence chemistry in preparation for final base calling. Pipetting tasks involve various loading and unloading steps, as well as ensuring correct volumes are aspirated and dispensed from appropriate sources. Each pipetting task needs to process a large number of plates.



National Instruments LabVIEW screens display manual processing of plates through pipetting robots.

Developing an Automated Pipetting System

Manual processing of these plates through the pipetting robots, despite the programmable sequences built into the robots, is very costly in terms of time and labor. To speed up the process, Celera Genomics decided to automate the pipetting system using NI LabVIEW as the development tool. With LabVIEW, Data Science Automation and Applied Biosystems engineers quickly developed a relatively large-scale application. Using the multithreading and various synchronization tools of LabVIEW, the application can handle complex simultaneous tasks, while the SQL toolkit can seamlessly integrate with the databases. In addition, we designed the application to add motion and vision functionalities if necessary. With LabVIEW vision and motion compatibility, we can extend this application easily.

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Achieving Successful Results with LabVIEW

The automated pipetting system developed by Celera Genomics ensures the consistency of sequencing chemistry, reduces human error, and lowers the production time and cost of development. In addition, the login process further lowers the wasted plates and samples by making sure that only the authorized and properly trained operators can perform pipetting tasks. The plate information is now verified against the Celera laboratory database for type and process sequence verifications, which reduces accidental processing of incorrect plates and prevents another source of costly waste. We can also track sample and reagent volumes for more efficient use of reagents. For expensive reagents, tracking reduces wasted volumes and results in tremendous cost savings.

Currently, Celera Genomics uses the pipetting control system on most of their production pipetting systems. In addition, we are constantly improving the system as the role of pipetting robots expands and as Celera R&D and production efforts diversify.■

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Improving Test Throughput on a Monitored Run-In System for Medical Oxygen Concentrators

by David J. Boyd, Senior Test Engineer, Respironics

The Challenge: **Developing a new software application for monitoring performance of multiple oxygen concentrators throughout factory run-in test and improving operator efficiency, test coverage, unit performance data archiving and overall throughput, while preserving the hardware of an existing custom system.**

The Solution: **Using National Instruments LabVIEW to ensure timely development of the application and control diverse hardware components using custom serial protocols. With ActiveX capability we integrated text-to-speech for a user interface. G's inherent parallelism made coordination of multiple test processes with test equipment resources easy.**

A wireless barcode scanner and battery-operated belt receiver allows an operator to move anywhere along the test line, adding, removing, and checking on UUTs.

Introduction

Medical oxygen concentrators are used to provide oxygen therapy for patients with chronic obstructive pulmonary disease (COPD) and other respiratory conditions as an economical alternative to compressed or liquefied O2 systems. Concentrators work on the principle of differential adsorption rates for nitrogen and oxygen when pressurized air is passed over a suitable zeolite or molecular sieve. The primary components of Respironics' Millennium concentrator include an air compressor, a dual-chambered canister containing the sieve medium, an accumulating tank, check and solenoid valves, filtering and noise abating components, drive electronics, an outlet pressure regulator, and an integrated metering valve and flowmeter. We produced models for domestic and international use and optionally include an internal circuit for monitoring outlet oxygen purity.

System Details

We designed and programmed the custom I/O module to be compatible with devices communicating via the Optomux serial protocol – a popular, relatively low-speed interface developed by the OPTO 22 Corporation. It provides eight channels of analog input, two channels of analog output, 8 bits of digital input, 8 bits of digital output, and a few miscellaneous timer/counter inputs. The serial interface is a two-wire RS-485 permanently coded for 19.2 Kbaud, and each module maintains a serial device address in nonvolatile storage. We mounted thirty modules, sharing one NI-485 port on the PC mounted in the overhead wiring and hose troughs, and provided the diagnostic interface to the concentrators.

We also mounted six modules, sharing the other NI-485 port, on the shelves within the test rack to control the valves, mass flow controllers, and pressure transducers. Each shelf contains a one-of-five valve manifold followed by an MKS mass flow controller. Additional valves on each shelf can occlude the selected UUT output into a pressure transducer or route one shelf's output to the Siemens analyzer. When not selected for measurement, UUT outputs are vented to atmosphere. The module on the topmost shelf also converts the output of an ambient temperature/ humidity probe mounted outside the rack.

Enhancements from LabVIEW

In the spring of 2000, we were assigned the task of developing a LabVIEW-based test application to replace the original software for the fall Georgia plant relocation. LabVIEW made it easy to implement a queued state machine software design to schedule the test esources, increasing test cycles to three per hour per UUT and ensuring continuous monitoring of UUT status. Using functions from the SQL Toolkit, we logged all test data to an Access database kept on a server, which engineering, quality assurance, and manufacturing personnel can querry in real time. LabVIEW helped uncover a longstanding bug in the I/O module's protocol code and implemented a workaround. We used the Siemens analyzer protocol in LabVIEW, increasing O_2 measurement accuracy and permitting inclusion of analyzer status.

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Using Motion Control in Drug Discovery

Molecular Devices, a leading developer of high-performance, bio-analytical measurement systems, creates technologies that help with drug discovery. We use motion control products from National Instruments in a system that uses luminance to help determine new drug compounds.

How the CLIPR System Works

The CLIPR system from Molecular Devices is an ultra-sensitive, high-throughput screening system for testing individual drug compounds that are carefully placed in tiny, individual, specialized wells. The system, which contains 1,536 of these wells housed in special microplates, tests cell-based and SPA assays.

Overall, the system integrates a high-sensitivity CCD camera, a telecentric lens, a high-precision positioning mechanism, and a computer system to control the instrument and record data.

The overall goal of the system is to find drug "hits" using luminescence, or light, to check how certain drug compounds react. Based on the compound reactions, we can determine if the compounds will make good new drugs candidates.

We start the process by taking a core group of compounds, then recombining them into new chemical combinations such as receptors or proteins. To give an idea of how many combinations scientists need to discover a new drug, it takes an average of testing 10,000 compound combinations to get one "hit" or positive reaction. For a full-fledged drug candidate, scientists test another 1,000,000 combinations. Because of this need to test a large number of combinations, having a system that can quickly and accurately test provides a key advantage in drug discovery.

Molecular Devices and Motion Control

The CLIPR screening system uses motion control products that consist of a controller, four motors, and two 2-axis driver boards to precisely position each high-density well plate. The complete motion control system is housed in one box to ensure top accuracy and sensitivity. Along with controlling the position of the plate, motion control products also help precisely position the camera focus.

Combining the highest accuracy with precision movement is a key to new drug discovery worldwide. Using an ultra-sensitive screening system with precision motion control, Molecular Devices strives to find new pharmaceutical solutions.■

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Improving Test Throughput on a Monitored Run-In System for Medical Oxygen Concentrators

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We enhanced the user interface by creating a process that discontinued the need for an operator to return to the PC to interact with the test system when adding, removing, or checking status on UUTs. To do this, the PCs soundcard output to a low-power assisted-listening transmitter added to the system. With the wireless barcode scanner and the battery-operated belt receiver, the operator can now move anywhere along the test line, adding, removing, and checking on UUTs. With this approach, the test system to actively direct the operator, by voice prompts, to remove UUTs when they complete run-in or fail a test cycle. When a passing UUT is removed, the application prepares a certificate with summary results and prints it at a final QC station where the UUT is serialized before packing. Failing UUTs generate a detailed test report at a repair station printer.

LabVIEW is an excellent development tool for rapidly creating a test application, meeting performance goals, coordinating multiple test processes, providing high-quality data presentation and archiving, and supporting user interface techniques.

Manufacturing began using barcode in-process IDs, and an Intermec wireless barcode scanner was added to the system. To provide response to the operator, we used the ActiveX client capabilities in LabVIEW to call Microsoft Speech API text-to-speech methods and fed

Conclusions

LabVIEW was an excellent development tool for rapidly creating a test application – meeting all performance goals, coordinating multiple test processes, providing high-quality data presentation and archiving, and supporting novel user interface techniques. The application runs round the clock with no reliability problems. Manufacturing now has a tool that supports high-volume production while ensuring consistent high quality.■

For more information, contact David Boyd, Respironics, tel (770) 429-2809, fax (707) 423-2302, e-mail david.boyd@respironics.com

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Building a Test System for Medical Stents

by Dave Weisberg, Principal,
Cal-Bay Systems, Inc.

The Challenge: Automating a high-volume production test for a medical device manufacturer that analyzes properties of a medical stent (a device that is placed in an artery to support the arterial walls) and increases existing test throughput by a factor of ten.

The Solution: Building an automated test system that tests 30 stents simultaneously by simulating the action of the medical device as it is inserted into the body, and measuring its expansion properties.

Introduction

Medical research and development is expanding rapidly and devices inserted into the body to assist or sustain are becoming more widely used. In the case of an aneurysm, the walls of an artery become weakened and are susceptible to breakage. A device that supports the walls of the artery in the area of the aneurysm could prove to be invaluable. But how would one get such a device into an artery (some arteries are the diameter of a silver dollar) without disturbing the sensitive area and possibly causing a premature rupture?

A device called a stent is used to prop open and support an artery that is weakened by an aneurysm. A stent is a spring that starts out very small, compressed and super-cooled, and is inserted into an artery at a convenient location (usually the inner thigh). The stent is then routed through the artery and deployed at the point of the aneurysm at which time it expands to its desired diameter and supports the walls of the artery. It is necessary to ensure that the stents expand at the proper rate and to the proper size within extremely rigid specifications. A mistake could be life threatening.

The System

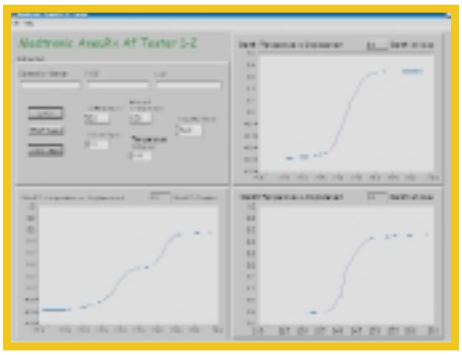
Cal-Bay Systems designed, developed, and implemented a fully automated test system, based on National Instruments PXI/SCXI hardware, for measuring and comparing the rate of expansion and the maximum expanded diameter of medical stents through a range of temperatures. This system replaced an older test system and provided a 10x increase in number of stents that are tested at one time.

Using National Instruments LabVIEW and PXI/SCXI data acquisition hardware, Cal-Bay designed a state of the art production test system. We designed the system to test the expansion of 30 stents at one time, using linear variable displacement transducers (LVDTs) to determine the diameter of the stents as they are heated from a supercooled state to normal body temperature.

A PC running a LabVIEW application collects the data and graphs expansion versus temperature in real time for each stent under test. You can select up to three stents to view at one time. At the end of the test (when the test bath reaches body temperature), we performed analysis on the displacement curve to determine if the stents meet the desired specification. A report is generated for each test.

The software also controls the temperature of the test bath and a pneumatic valve that lowers the LVDT sensors onto the stents under test.

With the new test system, we can now test 30 stents at once, where only three stents were being tested simultaneously with the old system.



LabVIEW Main Screen for Test System

FDA Validation

The software for this test fixture required FDA validation, and using LabVIEW, we wrote an application to test every input and every output of the system. We provided complete documentation of calculations, expected results and actual results to the FDA.

Conclusion

Because of the success and popularity of medical stents in aiding aneurysm patients, and recent FDA approval, production of stents has skyrocketed. The automated test system developed by Cal-Bay Systems allows 30 stents to be tested at one time (an increase of 10x), and there are currently five production test systems in use.■

For more information, contact Dave Weisberg, Cal-Bay Systems, Inc., tel (415) 258-9400 ext. 15, e-mail dweisberg@CalBay.com.

Visit **ni.com/zone** *for information on LVDT measurements.*

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