

NI Tools Assist In Biomedical R&D Breakthrough

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Category:

Biomedical

Products Used:

LabVIEW version 6.0.2
PCI-7344 Motion controller card
NuDrive 2SX-411 2-axis motor drive
UMI-7764 Universal motion interface
SCB-68 Digital I/O connector block
SHC68-C68-S Cable
SH68-C68-S Cable
MCA-7724 Motion Axis Router
68M-50F Bulkhead cable adapter
FlexMotion 5.1
NI-DAQ 6.9

The challenge: The development of a high-throughput liquid handling system that applies sample solutions to twenty microscope slides at a rate of one slide per second.

The solution: The development of a flexible, PC-based slide coating system using a National Instruments (NI) PCI-7344 motion control board and an NI NuDrive 2SX-411 motor drive to handle X-Y motion as well as system digital and analog output, NI-VISA drivers to interact with third-party serial equipment, and LabVIEW 6.0.2 to create reliable, intuitive, and modular control software.

The Problem Expressed

Proteomics technology now plays a vital part in biomedical diagnosis and therapy, a role forecast to grow significantly in coming years. But despite a flurry of development, a major need remains: a rapid and low-cost means of measuring the activity of enzymes. These are the proteins on which most drugs are designed to act and the clinical markers of much disease. Morewood Molecular Sciences Inc. is developing a novel means of assaying enzyme activity, improving on the speed and cost of existing methods by orders of magnitude.

At the heart of Morewood's breakthrough technology is a unique and cost-effective liquid handling system that applies sample solutions to microscope slides. To prototype this liquid handling system, Morewood approached Data Science Automation to develop a fully automated and integrated solution meeting the following requirements:

- a low-cost, fully documented solution incorporating current technologies and off-the-shelf components
- a system throughput of up to twenty slides at a rate of one slide per second
- serial control of a third-party pump controller controlling multiple syringe pumps

- control of a third-party spray nozzle and a third-party gas flow control valve via analog output
- control of multiple multi-port valves and a fan via digital output
- coordinated control of the motion of an X-Y stage
- professional-looking, intuitive sequence editing and execution software allowing an operator to create, save, and run a variety of different sequences, as well as monitor their execution time and log their results

The basic operation of the system defined by Morewood included withdrawing an operator-specified solution into a syringe pump (pump and valve control), directing the flow of solution to a spray nozzle (valve control), engaging the nozzle (nozzle control), engaging gas flow (gas flow valve control), and then moving the slides to be coated in a zigzag pattern underneath the nozzle (motion control). The type, rate, and volume of the solution used, as well as the order of events was to be defined in a sequence created or loaded by the operator.

The Solution Offered

A schematic of the solution offered by DSA is shown below in figure 1:

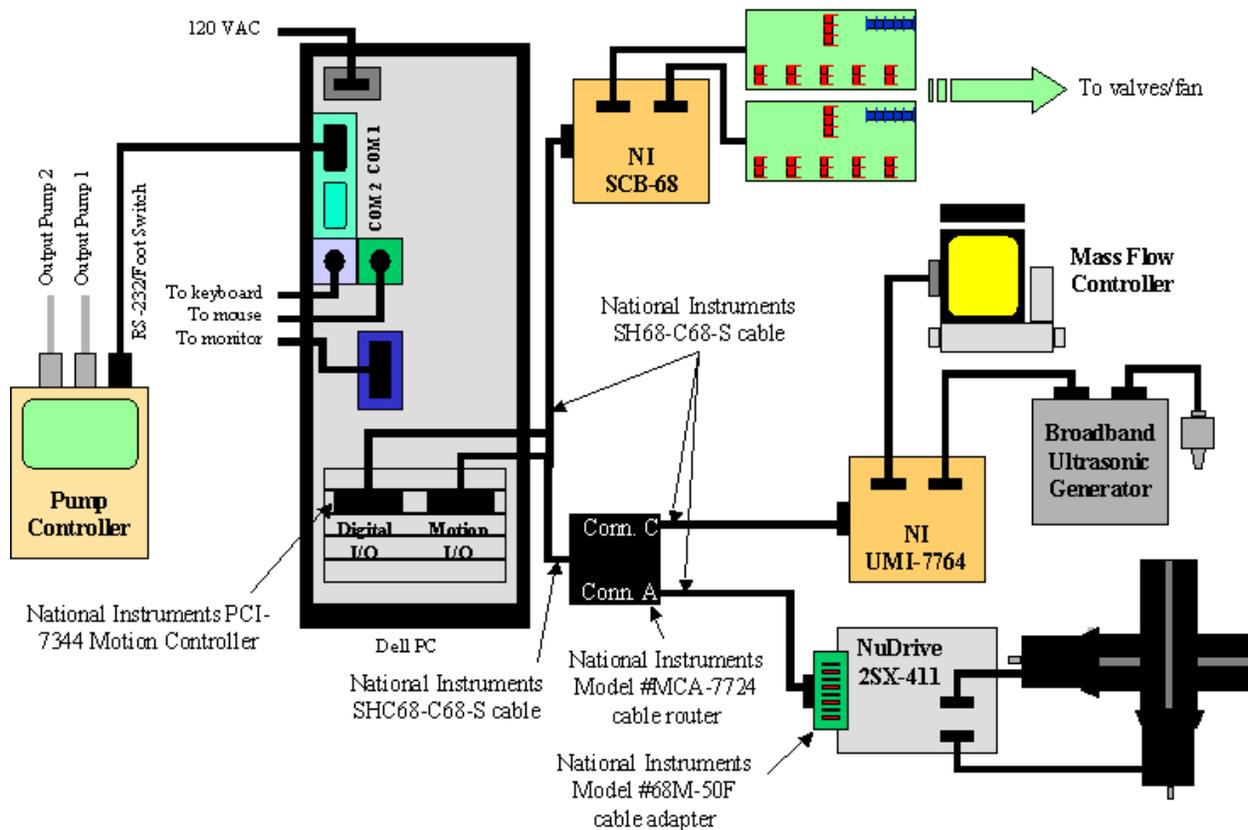


Figure 1: Solution schematic

Controlled motion of the X-Y stages was accomplished quickly and easily using NI’s well-integrated motion tools. The NI PCI-7344 motion controller was selected and easily configured and tested using NI Measurement and Automation Explorer (MAX) version 2.1. Due to the large motors used on the project, a high-power motor drive was necessary, and NI answered the call with the NuDrive 2SX-411 two-axis motor drive and the 68M-50F bulkhead cable adapter for easy connectivity. Motion configuration and execution VI’s were then created in LabVIEW using NI FlexMotion version 5.1.

The PCI-7344 motion controller card also included analog and digital outputs, which were used to control the spray nozzle, the gas flow valve, the multi-port solenoid valves, and the fan. Wiring the inputs to each of these components was facilitated by NI's SCB-68 digital I/O connector block and the UMI-7764 motion interface, and the MCA-7724 motion axis router allowed for the simultaneous connection of the NuDrive and the UMI-7764 to the single PCI-7344 motion I/O port. As was the case previously, the FlexMotion software made access of each analog and digital output a simple and reliable operation, reducing overall development time and cost.

Serial control of the pump controller was achieved using NI MAX to configure the COM1 port of the PC, and then using NI-VISA drivers and resource names to quickly and easily implement a LabVIEW driver capable of executing the full command set of the instrument.

Finally, each component of the system was integrated and brought together under a master control application built in LabVIEW 6.0.2, incorporating professional, intuitive user interfaces to allow direct operator control of each component in the system, as well as the ability to load, save, and edit sequences defining the nature and order of the process to be run (figure 2). Comprehensive application documentation was also provided (figure 3), as well as basic LabVIEW training for Morewood's key members (via Certified NI LabVIEW Basics I and II classes offered at DSA), which combined to allow Morewood to explore the functionality of their code easily and to modify it if needed.

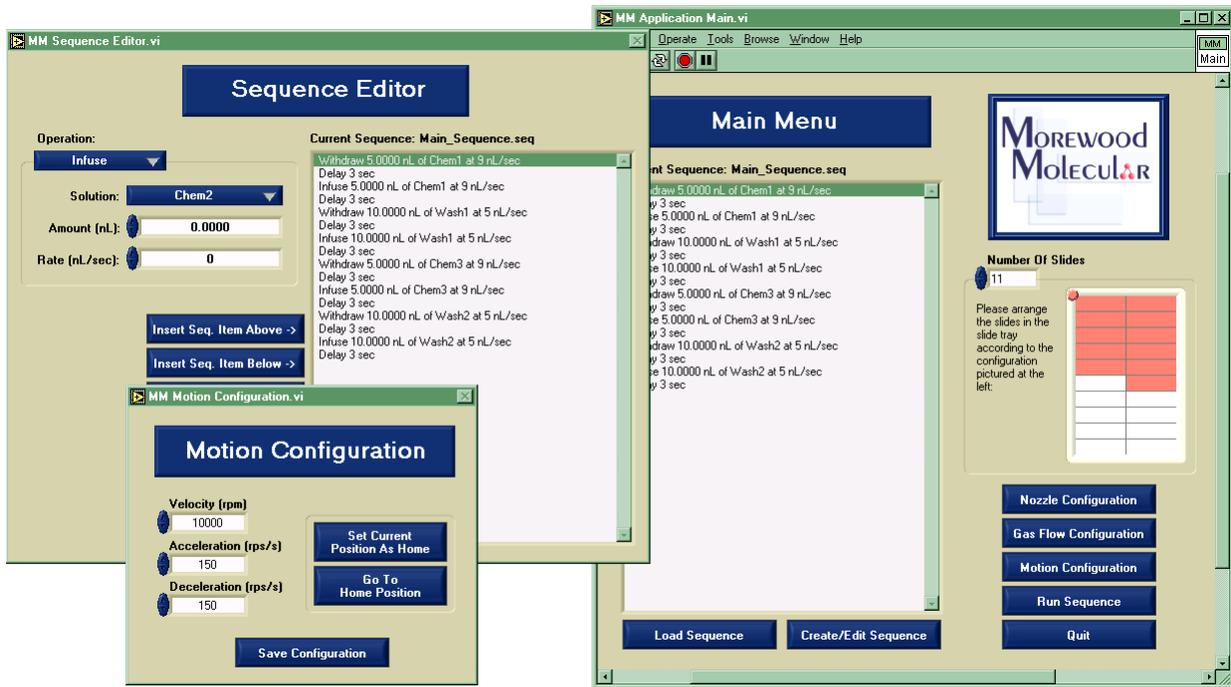


Figure 2: Application interfaces

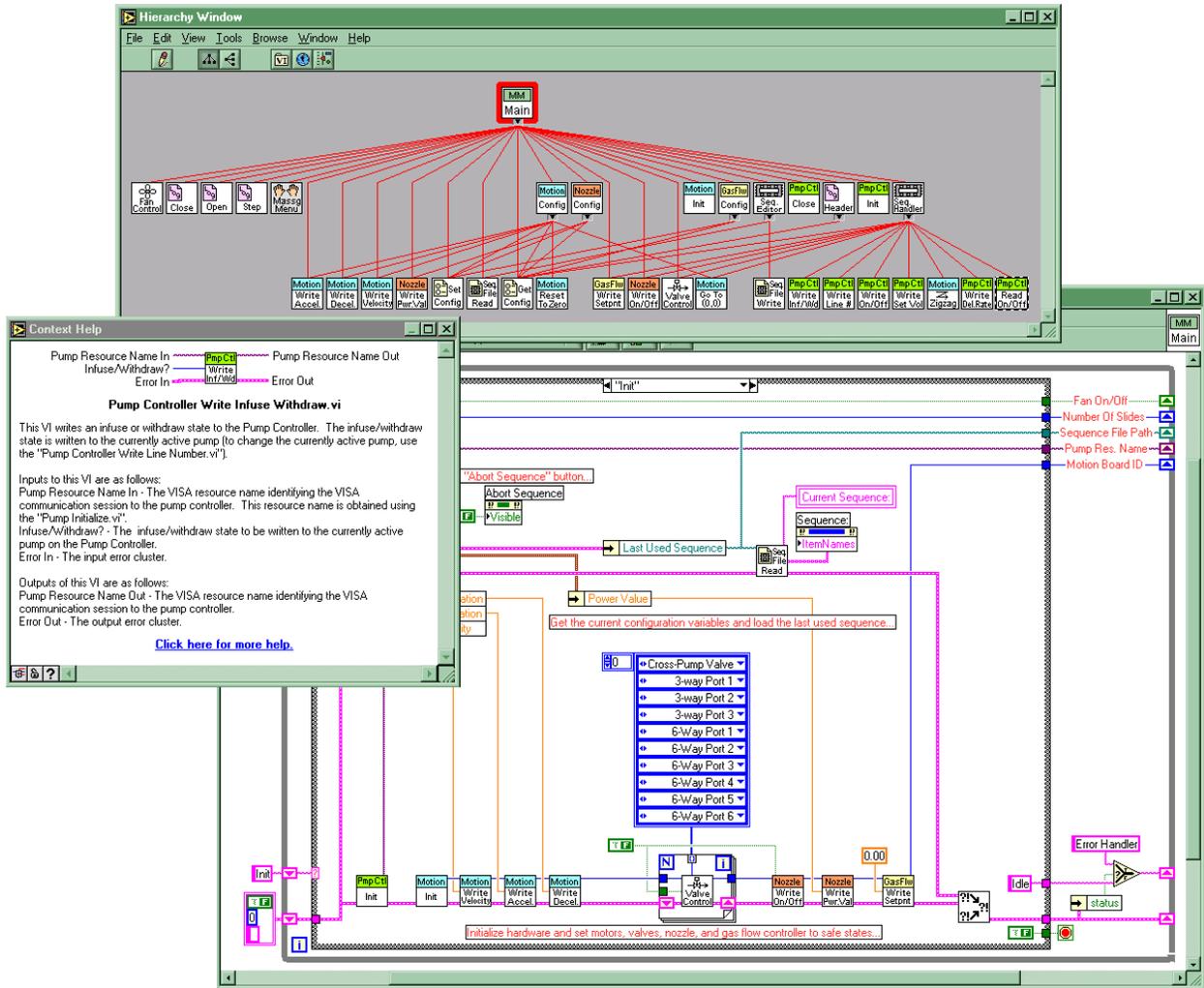


Figure 3: Application documentation

The Reward Attained

Upon completion of the project (figure 4), Morewood Molecular had a fully integrated, fully automated liquid handling solution capable of greater throughput than that specified. In addition, their solution harnessed the power of the PC as well as the cost efficiency of off-the-shelf components. Through the marriage of Data Science Automation’s engineering expertise and NI’s well-integrated, well-supported hardware and software tools, Morewood Molecular was able to realize current, scalable technology to match their novel microfluidics method.

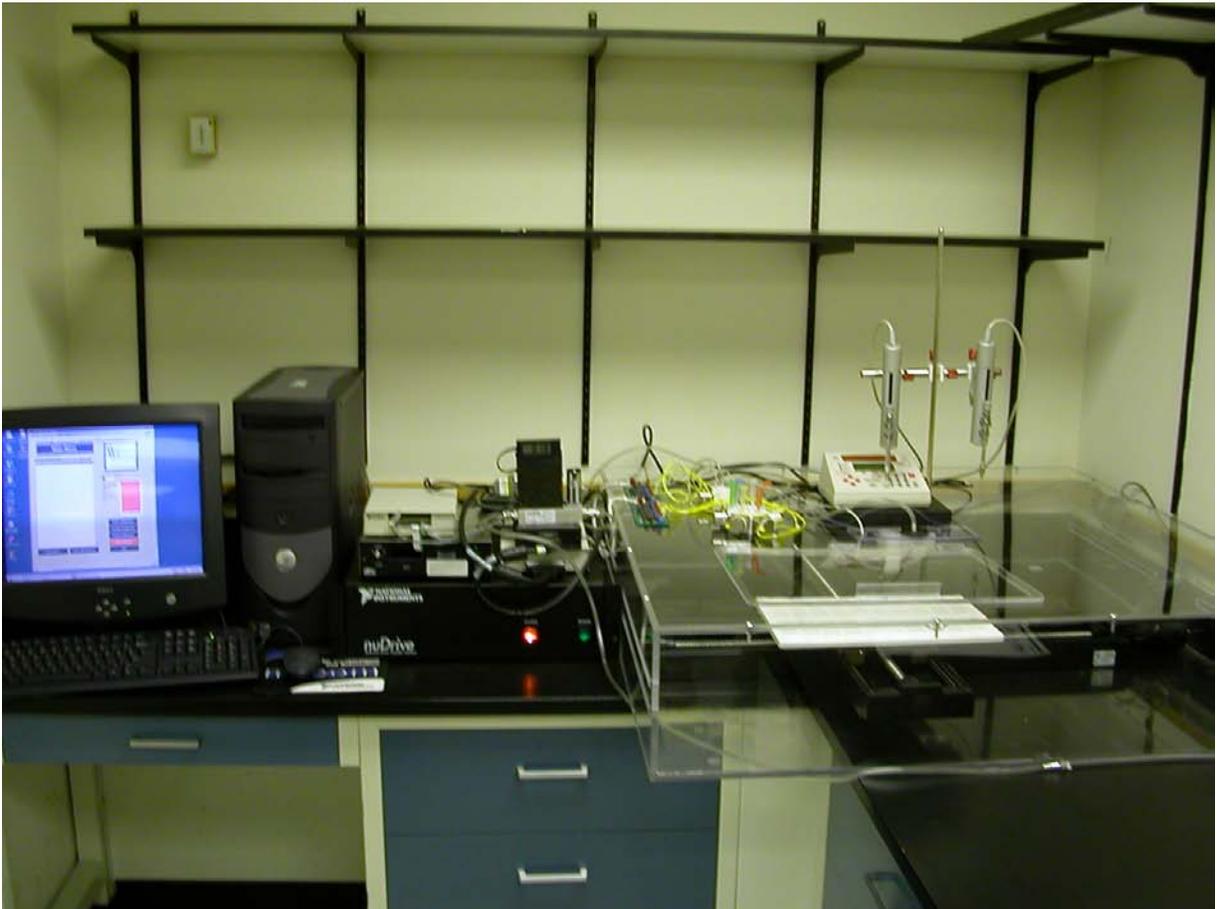


Figure 4: Complete system