BC Research Institute for Children's & Women's Health benefits from NI solution applied to fluorescence imaging and high accuracy timing.

By Laurent Mingo, P.Eng.
Project Leader & Systems Development.
Blue System Integration Ltd.

The Challenge:
Integrating timing, vision, DAQ, and third party hardware in a single system. Maintaining flexibility and expandability for future development.

The Solution:

- Using LabVIEW's capability to integrate NI and third-party hardware.
- Taking advantage of multi-cards' timing and synchronization with Real Time System Integration bus (RTSI).

Objective

Every year in British Columbia about 600 babies are born with congenital heart disease. Of that number, about 200 will require open-heart surgery.

Because congenital heart disease can cause gross malformation of the heart, corrective surgery can be very complex and require the baby's heart to be stopped with the baby on heart bypass for long periods. The mortality rate for this type of surgery is up to three times greater than for adult heart bypass surgery. Working with pediatric cardiac surgeons and

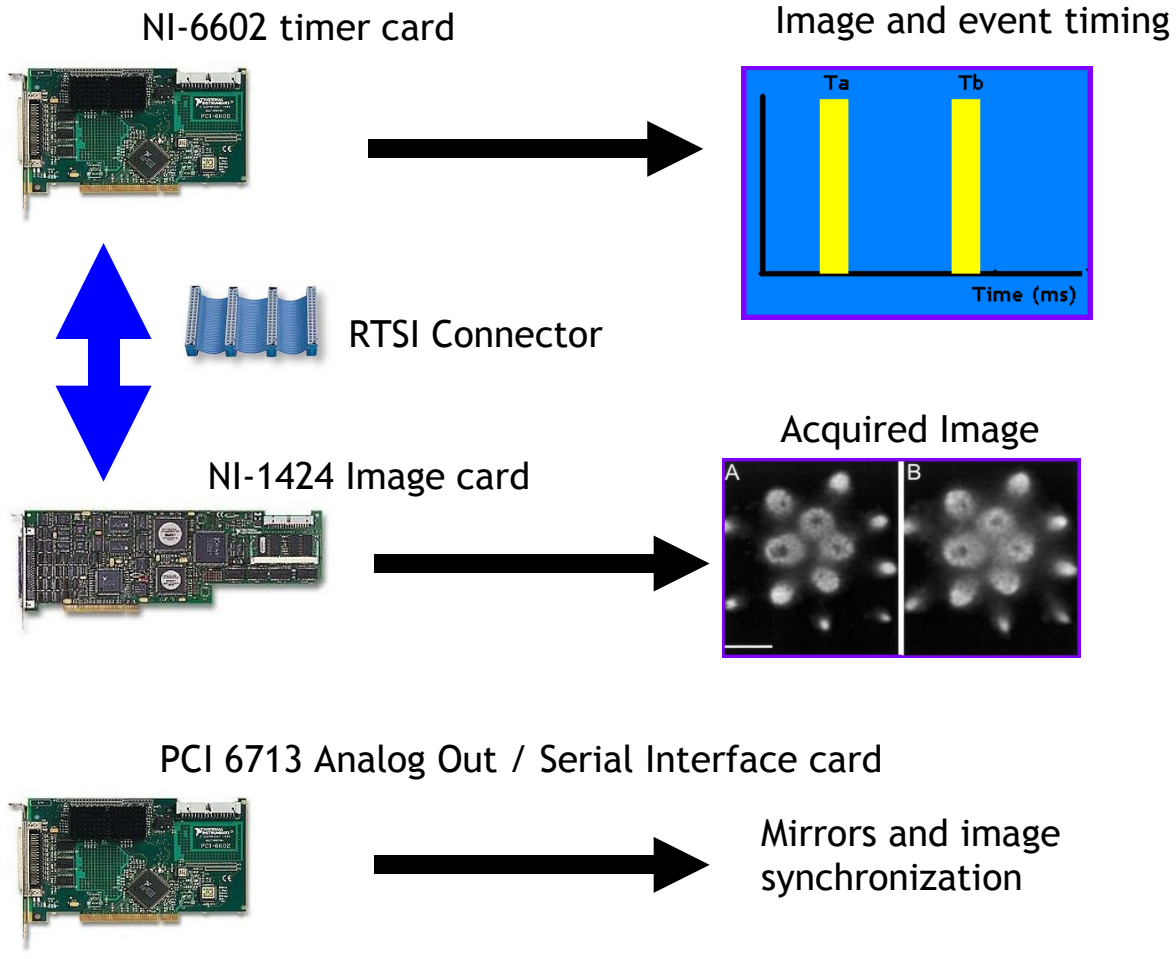

Fig. 1. System integration components.

cardiologists, Dr. Glen Tibbits, Director of Cardiovascular Sciences at BC Research Institute for Women's and Children's Health (BCRICWH), is dedicated to reducing the risks of open-heart surgery for these vulnerable babies.
[*See BC Research Institute for Women's and Children's Health web site at www.bcricwh.bc.ca*]

Cardiovascular Research

Dr. Tibbits' research group is working on understanding how proteins, which regulate the heart's intake and removal of calcium, function in a developing heart compared to adult heart. Calcium is the ion responsible for triggering contraction of the heart. During bypass surgery calcium levels rise, and if sustained, can cause cardiac malfunction and cell death. To determine which factors control calcium level in the heart, several different approaches are used. The first and most integrative approach makes use of isolated single cardiac cells in which shortening is assessed by video microscopy, the calcium ion transient determined by fluorescence microscopy and the underlying membrane currents assessed by patch clamping. Accurate timing of a controlled injection of calcium ions onto a heart cell, with the calcium's effect on heart cell as measured by fluorescence imaging signals, is essential to characterize the cell properties induced by the calcium injection.

System Integration

The initial experimental setup for the fluorescence signal measurements is well described by Wier and Al. and is used as starting point to expand the system with advanced timing capabilities. To satisfy the timing

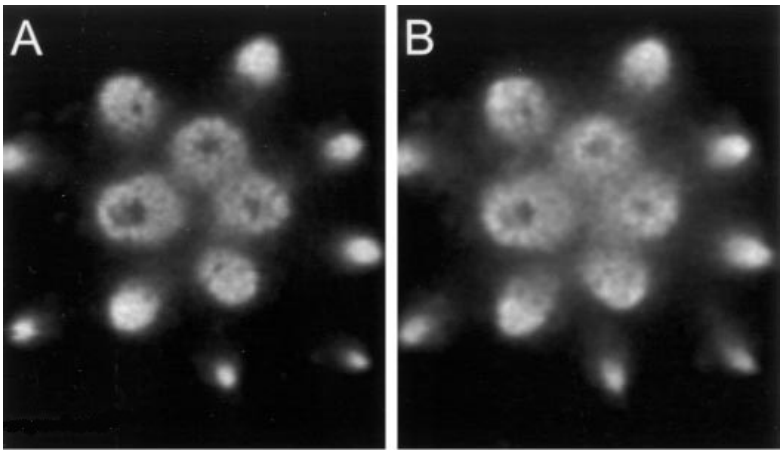

Fig. 2. Example of fluorescence image (Wier and Al.).

of requirements, the injection of calcium is controlled with a TTL pulse that also triggers timing operation on a NI counter board. The first occurrence of this recurring pulse triggers the time measurement of the fluorescence imaging acquisition system. By taking advantage of RTSI for hardware-based timing and triggering in a multi-card system, the timing card receives a hardware pulse from the IMAQ vision card every time an image has been acquired. This hardware trigger is software configurable. In addition to both the calcium injection signal, and the image acquired signal, a third TTL pulse is sent to the counter card. It is used in the same way as the calcium TTL signal, except that it represents a miscellaneous event that must also be timed. By taking advantage of the counter card trigger capability, all three timing measurements (calcium injection, image acquisition and the miscellaneous event) are made with respect to a common time reference. The relative timing of these pulses can then be derived well within the 1 ms required accuracy.

The software, developed in LabVIEW, allows full control of the NI hardware used in the application (Fig. 1.) as well as third-party serial devices for controls the laser, filters, optical shutter, and scanning device.

Conclusion

This application describes integration of several hardware components into a single system. Each hardware component is devoted to a specific task: image acquisition, timing, analog output and serial interface, and still they can be incorporated into a single system thanks to the level of integration of NI hardware and LabVIEW software. As a result, the system commissioned for BCRICWH was developed at a reasonable cost and still retains great flexibility for future system expansion.

For more information, please contact Laurent Mingo at Blue System Integration Ltd.
laurent.m@bluesystem.ca
www.bluesystem.ca

Acknowledgments:
Photo credit: National Instruments. Project initiated with Advanced Measurements Inc.
Reference:
Wier WG**,** Balke W, Michael JA, Mauban JRH. A custom confocal and two-photon digital laser-scanning microscope. In: *An. J Physiol Heart Circ Physiol. 278:H2150-H2156,2000.*