Improving Retinal Disease Treatment with LabVIEW FPGA and Intelligent DAQ

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Industry:
Life Science

Product:
Data Acquisition, LabVIEW FPGA

The Challenge:
Developing a highly accurate system capable of using patterns to automate the delivery of laser pulses used to treat retinal diseases.

The Solution:
Using NI LabVIEW FPGA and intelligent data acquisition (DAQ) hardware to deploy a controller for the innovative PASCAL (pattern scan laser) photocoagulator.

Traditional methods of pan-retinal laser photocoagulation to treat retinal diseases caused by diabetes have changed little in the past 35 years. Laser photocoagulation involves the controlled destruction of the peripheral retina using targeted laser pulses. While this type of treatment has proven effective at reducing the chances of vision loss by as much as 50 percent, it can be very tedious to both patients and doctors. Ophthalmologists can deliver only one burn at a time, and treatment can require as many as 2,000 burns. A full course of treatment typically requires two to four sessions, each lasting 12 to 15 minutes.

The PASCAL system from OptiMedica uses NI LabVIEW FPGA and the NI PCI-7833R to improve pan-retinal laser photocoagulation treatment.

At OptiMedica, we specialize in designing medical devices that help ophthalmologists improve the way retinal disease is treated. We designed the PASCAL photocoagulator to be a fully integrated pattern scanning laser system that provides significantly improved performance for the physician administering the treatment, as well as an enhanced therapeutic experience for the patient.

We are experienced users of National Instruments LabVIEW at OptiMedica, and we decided to use LabVIEW FPGA and an R Series intelligent DAQ device instead of a custom hardware solution for the PASCAL photocoagulator. A single National Instruments PCI-7833R intelligent DAQ device controls the entire system. The hardware determinism of the NI PCI-7833R allows for faster retinal scanning, significantly reducing the number of office visits for the patient. With a single graphical development platform, we were able to design and prototype the machine quickly and efficiently using customizable off-the-shelf PXI hardware and successfully demonstrate the system to potential investors. Given how well the prototype met our requirements, we knew that the LabVIEW graphical system design platform would give us a smooth migration path to deploy the final system on PCI intelligent DAQ hardware.

Using an FPGA in this application provides the reliability of a hardware solution, which does not require

the same level of code reviews as processor-based systems when obtaining FDA approval. The decision to use programmable silicon as opposed to a fixed ASIC chip also reduced our development time by 30 percent. Another benefit is the ability to add functionality in the future and easily expand or customize the system when needed.

The PASCAL photocoagulator takes full advantage of the precise timing and triggering achievable with R Series intelligent DAQ hardware. With conventional methods of retinal laser photocoagulation, the physician uses a mechanical joystick and foot pedal to deliver single 100-millisecond laser pulses to abnormal blood vessels of the peripheral retina. We discovered that automatically delivering multiple, shorter pulses rather than a series of manually placed lesions allows for greater precision and safety. Furthermore, the PASCAL system greatly reduces the risk of inadvertent application of the treatment to the fovea, which can result in localized vision loss; physicians using conventional methods of photocoagulation must manually attempt to avoid this critical region of central vision.

By programming in LabVIEW FPGA, we were able to vary the timing and power of each pulse to optimize for speed and precision while still protecting the fovea by creating patterns with integrated foveal exclusion zones. By reducing the laser pulse time from 100 milliseconds to just 10 milliseconds, and then automating multiple spots with each depression of the foot pedal, the PASCAL system significantly reduces the overall procedure time, as well as the amount of discomfort felt by the patient.

From the main control panel, an LCD display with a touch screen control is used to select from predetermined pattern types and administer up to 25 spots at a time. All the equipment is very similar to conventional, single-shot photocoagulation, with a mechanical joystick and foot pedal, so physician training is minimal. Once the pattern is selected, a separate red beam is used for aiming and visualization of the placement before delivery. The touch screen interface is also used for selecting various parameters, such as aim beam intensity, treatment laser power, exposure time, system status, and shut down. Because each pulse size and pattern is predictable, PASCAL photocoagulation is a more precise way to evenly distribute patterned spots, which also increases the reproducibility of results for each treatment.

Photocoagulation is a proven procedure that has been manually administered for many years to improve the lives of patients suffering from diabetic retinopathy. Using LabVIEW FPGA technology, we were able to automate this proven procedure with speed and reliability. The PASCAL photocoagulator successfully reduces treatment duration as well as patient discomfort. It also can reduce the number of treatment sessions, thereby reducing costs to both doctors and patients and making it very popular among lead users.

To watch a video demonstration of this application from NIWeek 2006, click here.

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