Physiological Testing
- ***LabVIEW®***
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IMAQ and LabVIEW Automate the Study of Eye Motion

by Philippe SAUVAN-MAGNET, Graftek Imaging, Inc.

The Challenge: Automating the monitoring of human eye motion to aid physicians in researching internal ear diseases.
The Solution: Developing a flexible PC-based image processing system using IMAQ and DAQ boards, IMAQ Vision software, and LabVIEW.

Introduction

Graftek France, a National Instruments Alliance Program member, was retained by CCA Biodigital, a company specializing in medical research equipment for otolaryngologists (ear, nose and throat doctors), to develop a new generation of nystagmography research systems. Nystagmus is a particular motion of the eyes occurring in specific situations, such as watching the landscape race by while riding in a train.

In these situations, a low-speed motion (when the eyes are focused on an object) is followed by a high-speed motion (to locate the next object).

The new system was required to simulate this condition for the eyes with moving objects, such as a 6-foot-long horizontal LED bar, a light ball projecting a light beam on the wall, or a rotating chair. The patient can see the simulation equipment through a 45 degree semitransparent mirror, while the patient's eyes are being illuminated by infrared lights and monitored by two cameras. Both the infrared lights and the cameras are mounted on open goggles.

An important benefit of using LabVIEW for such applications is the ability to integrate image acquisition and processing with data acquisition and control functions, such as controlling the LED bar with the PCI-DIO-96 board.

An Inexpensive Solution

The goal was to create an innovative solution without using expensive onboard DSP chips and to achieve an expected system life of 10 years. In the past, dedicated image processing boards incorporating DSP chips have been used. Because two such boards are required to track the two eyes simultaneously, a system is quite expensive. Plus, DSP programming is time-consuming and not at all flexible. A much less expensive virtual instrumentation solution is available thanks to IMAQ and the power of today's Pentium processors; image processing boards with onboard DSP chips are no longer necessary.

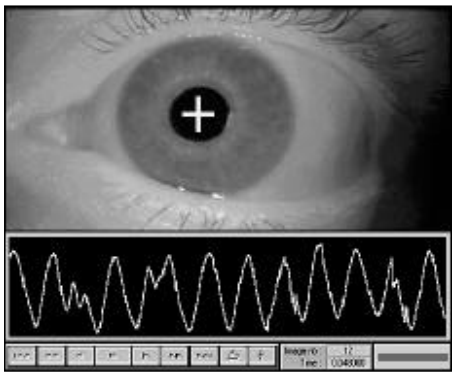
The Image Processing System

Our system consists of a Pentium computer running Windows 95, equipped with LabVIEW, IMAQ Vision, two IMAQ PCI-1408 image acquisition boards, and one PCI-DIO-96 digital I/O board. The two cameras monitoring the patient's eye movements provide two video signals that are routed to the two IMAQ boards.

We chose IMAQ boards and IMAQ Vision software because we believe that the new PCI technology, combined with the fast Pentium engine, offer enough power to avoid using DSP chips. An important benefit of using LabVIEW for such applications is the ability to integrate image acquisition and processing with data acquisition and control functions, such as controlling the LED bar with the PCI-DIO-96 board.

Using the LabVIEW graphical user interface (GUI), we created an easy-to-use operator interface for setting the parameters of the application, which are critical. They must be easy to adjust by a doctor concerned with the patient rather than the computer. Calibration, which includes configuring the board to adapt to the patient's eye lighting, differs from one patient to another.

We also interfaced the application to a database for recording the results in the patient's records. The LabVIEW data analysis library offered numerous possibilities for calculating the different coefficients (speed, acceleration, position, and so on) necessary for the diagnosis. The entire development of the application, including clinical tests, took five man-months compared with the man-years of development invested in DSP-based solutions.



LabVIEW and IMAQ vision track human eye movement.

The finished product can acquire 100 images/s and process it on the fly. We did this by using a special feature of the interlaced video, where each image is composed of two fields acquired with a 20 ms separation. We acquire 50 fields/s for each eye and the software must process 100 images/s with a resolution of 768 by 256 for each field. Using the LabVIEW CIN toolkit, we developed an optimized LabVIEW vitrual instrument (VI) that performs the eye tracking by software – a real-time 100 image/s processing algorithm.

Conclusion

Using LabVIEW and IMAQ products, we were able to develop a research system in a very short time. By developing a LabVIEW and IMAQ system based on PC-based virtual instrumentation technology, instead of DSP technology, we reduced cost significantly.

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