Motion Control System to Characterize Neuro-Otologic Response of Humans

By

Richard M. Brueggman, President and CEO

Ryan W. Vallieu, Engineer, Operations

Data Science Automation
USA

Category
Biotechnology/Life Sciences

NI Products Used
LabVIEW 7.1
DAQmx
NI-Motion
NI-PCI-7342 2-Axis Stepper/Servo Controller
NI-UMI-7764 Universal Motion Interface
NI-PCI-6229 Multifunction DAQ
NI SCB-68 Shielded I/O Connector Block

The Challenge
Develop a motion control and high speed position feedback module to be used as the basis of a 2-Axis Neuro Otologic test system to allow researchers and physicians to better understand and diagnose neurological and otological disorders.

The Solution

The PCI-7342 2-Axis Stepper/Servo Controller was selected to provide Step and Direction commands to the drives. This was easily accomplished by choosing to utilize the 7342 in Open Loop Stepper mode. The Yaskawa drives incorporated a feature to close the position loop internally making it unnecessary to operate the PCI-7342 in closed loop operation. A Universal Motion Interface, UMI-7764, was used to connect the PCI-7342 to the drives (Figure 1) and counters on a PCI-6229 were used to accurately track the position of the two axes.

Abstract
The complex interactions between the human body's neurological and otological systems are disrupted by disorders and sometimes simply by unusual body motion. A Neuro Otologic test system is used to test a patient's inner ear response to motion by tracking eye response after the body has been moved to various positions or subjected to cyclic motion. The patient's response to these motions can indicate specific disorders are present. A motion control and position tracking system was developed for use as a tool for researchers and physicians.

Introduction

The motion interface needed to be able to handle two classes of motion, either step motion, or cyclic motion on the Tilt axis. These two classes of motion served as the bases of a sequence of positions or protocol. The target positions were transformed into motion commands that the PCI-7342 Stepper Controller card would to convert to Step and Direction output for the Yaskawa drives. In prior iterations of this system the client had been converting analog signals with external filters to feed the Step and Direction inputs to the Yaskawa drives. They required a more flexible and scalable way of providing the necessary signals to the custom drives.

The client also had the need for high speed position feedback and display to allow the operator to track the position of each of the axes in the system. Although the PCI-734 controller is capable of high speed position capture, it is single valued software timed and required a reset operation which introduced a performance impact that was unacceptable for this particular application. In order to avoid the adverse performance impact resulting from the resetting of the high speed position capture feature of the PCI-7340 controller a PCI-6229 counter card was added to the system

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com

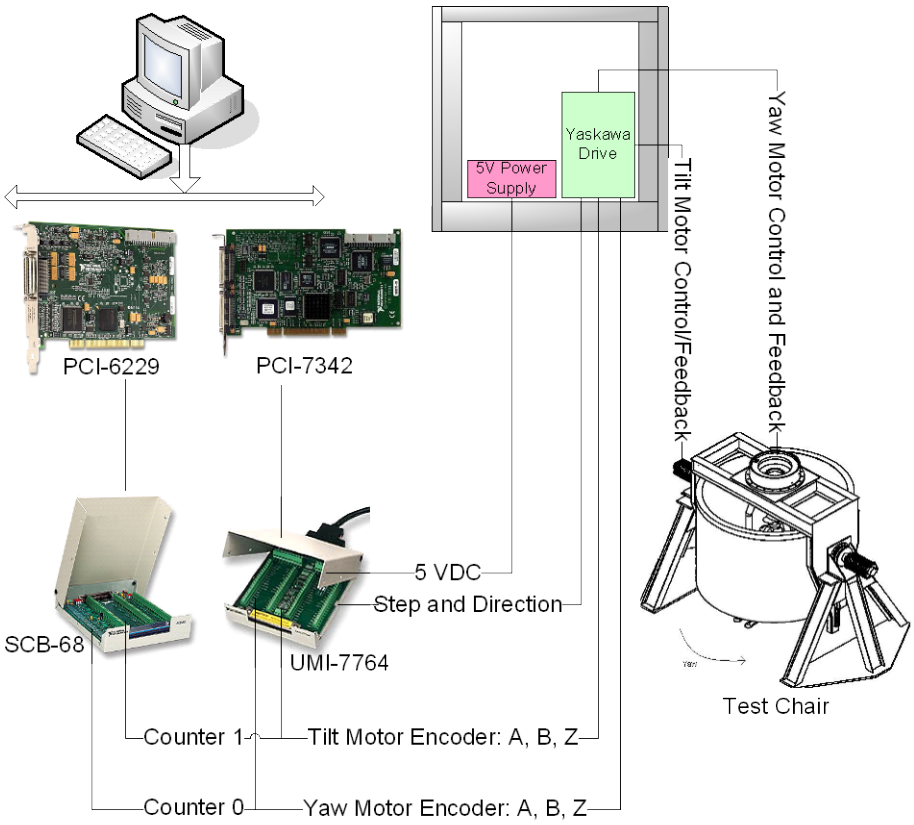

Figure 1. Neuro-Otologic Test System

The application requires the tracking of the angular position of the chair in both axes during the test. This information needed to be shown on the user interface enabling the test technician to monitor the motion on the screen. In order to avoid the performance impact associated with resetting of the position register a PCI-6229 Multifunction DAQ board was selected to allow high speed buffered encoder position acquisition. The encoder signal returned from the Yaskawa drives was fed into the UMI-7764 and also sorted into the 80MHz 32-bit counter/timer inputs on the PCI-6229.

DAQmx simplified the creation of two Counter Input Angular Encoder channels, one for the Yaw Axis and one for the Tilt Axis. These DAQmx channels track the encoder inputs into the PCI-6229 and decode the encoder

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com

position as angular outputs. The Z Index input from the encoder resets the angular encoder channel output to zero degrees.

Motion can be controlled by the technician using one of two available protocols. The first motion protocol consists of moving the test subject in a sequence of single axis motion steps. The second motion protocol consists of moving the test subject in a cyclic pattern on the tilt axis. For this cyclic motion protocol, the motion ramps in amplitude from a stationary position.

For the protocol utilizing single axis motion steps, a control input into the motion action engine was developed. The general multi-step test protocols typically consist of 6-11 individual motion steps. Each step can be described by six motion parameters (Figure 2):

- Axis of motion
- Maximum Velocity, Deg/Sec
- Acceleration, Deg/Sec^2
- Deceleration, Deg/Sec^2
- Target Angle, Degrees
- Motion Direction, Clockwise or Counterclockwise

These parameters are converted into the units required by the NI-Motion Virtual Instruments, such as “Load Velocity in RPM.flx”. The power and flexibility of the NI-Motion Virtual Instruments made passing the motion parameters to the Yaskawa drives very simple and efficient.

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com

The tilt axis cyclic motion protocol utilizes the “Absolute Contouring” buffered waveform motion capability of the PCI-7342 card. In Absolute Contouring mode the controller smoothly splines through the motion described by the

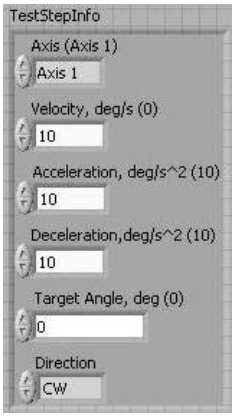

Figure 2. Motion Control Parameters

target waveform. The operator creates a motion profile using a previously developed cyclic motion protocol editor. The output of this protocol editor is a waveform that describes the tilt axis motion in target degrees versus time. The waveform target angles are converted from degrees to motor steps and then loaded into a buffer on the motion card. The motion is then initiated on the tilt axis using the buffered position information.

Summary

This application greatly simplifies the client’s hardware set up, removing the need for external filters to convert analog motion commands to step and direction information required by their drives. It also allows the use of the NI-Motion suite of VI’s, simplifying the motion control operation. The use of the PCI-6229 80 MHz 32-bit counter channels along with DAQmx allows the operator to precisely track the motion. The use of the PCI-6229 also overcomes the sample rate limitation of the high speed position read function of the PCI-7342 Motion Controller.

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com