

Remote Control of a Robot Using LabVIEW and the World Wide Web

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Introduction

This paper describes a prototype system to control a robot via the World Wide Web. The user is able to move the robot and view the results through a video camera. National Instruments' LabVIEW software is used to program the system.

There are two major goals of this project. The first is to replace DOS based robot controllers with modern motion control hardware and software. Not only does this eliminate the difficulty of finding computers that are capable of communicating with the controllers, but the system is flexible enough to give students experience with many levels of motion control. Students may only use the top level of the application and program the robot in a "teach pendant" mode, or they may read encoders and energize the motors step by step.

The second goal is to allow monitoring and control of the robot over the Internet. This may be used for students in a distance education environment, but is also attractive for K-12 demonstrations. LabVIEW 6i makes Web interface easy, using the DataSocket software (included in LabVIEW) to pass controls and information between the Web application and server.

Hardware Description

The motion control card is a National Instruments 7344 Motion Controller. It has encoder inputs and control outputs for four axis using stepper or servo motors and four ports of digital I/O. In this project configuration the digital outputs are used to control the motor. Pulse width modulation is used to change the speed of motion. The motion control and digital I/O are on separate connectors, so two cables and connector blocks are needed. (See Figure 1.)

Driver circuits for the motors have been designed and built in-house so the robot can be controlled from a variety of sources, including micro controllers and programable logic controllers. The driver circuits (one for each axis) converts TTL level signals to +/- 12V, high current signals necessary for the servo motors. The driver circuits also provide connectivity to the encoder and hard home signals. Circuitry on the robot prevents motion past the end of travel switches, and these signals are not available on the cables coming from the robot.

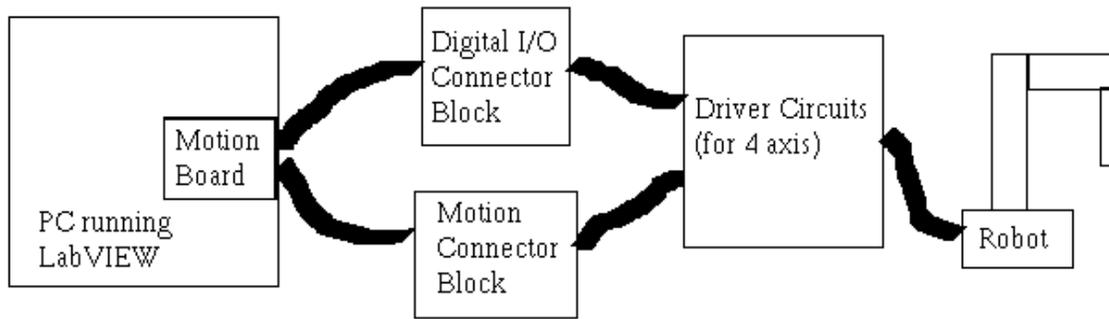


Figure 1: Hardware Block Diagram

The robot used in this system is a four axis plus gripper Selective Compliance Assembly Robot Arm (SCARA). (See Figure 2.) The shoulder and elbow operate in the x-y plane. The wrist has z movement, as well as theta. The gripper can open or close. Each of these five motors are servo motors with quadrature encoders and hard home indicators.

Software Description

The motion controller hardware comes with software to monitor quadrature encoders, home axis, pulse width modulation for speed control, and other high-level controls. This system uses LabVIEW graphical programming language.

In most applications, the motion control board uses a polarized analog output to drive the motor forward or reverse. But the driver circuit used for this project requires two different digital inputs: one TTL input indicates forward and a separate input is used for reverse. Because this system cannot fully utilize the motion control capabilities of our control board, the motion VI's have been written from scratch. Development has been kept extremely modular to accommodate possible future changes in system hardware. For instance, a counter-timer board could be used to read the encoders and generate PWM signals, or another motor driver circuit (that can accept analog inputs) may replace the current version.



Figure 2: SCARA Robot

Figure 3 shows the front panel for a simple one axis control. The axis is selected (A, B, etc.) and the target position, represented in percent of full motion, is set. As the motion is taking place, the position information is read from the quadrature encoders and displayed. This VI is the

basis for the rest of the robot control system. Used as a sub-routine, it is called to control all the axis simultaneously.

Web Control

DataSocket Server, created by National Instrument using ComponentWorks, allows data to be passed between applications running on different machines. The server software runs on the local machine to facilitate the data transfer. Figure 4 shows a low level LabVIEW VI Diagram for a write operation to the DataSocket server. The remote computer runs a similar VI to read the data. If both the read and write VI's point to the same URL, data will be exchanged. The same procedure is used to send control data from the remote site to the robot. Using LabVIEW 6i, much of this low level control is transparent to the programmer and user. Communication can take place over an intranet or the Internet - the software does not change.

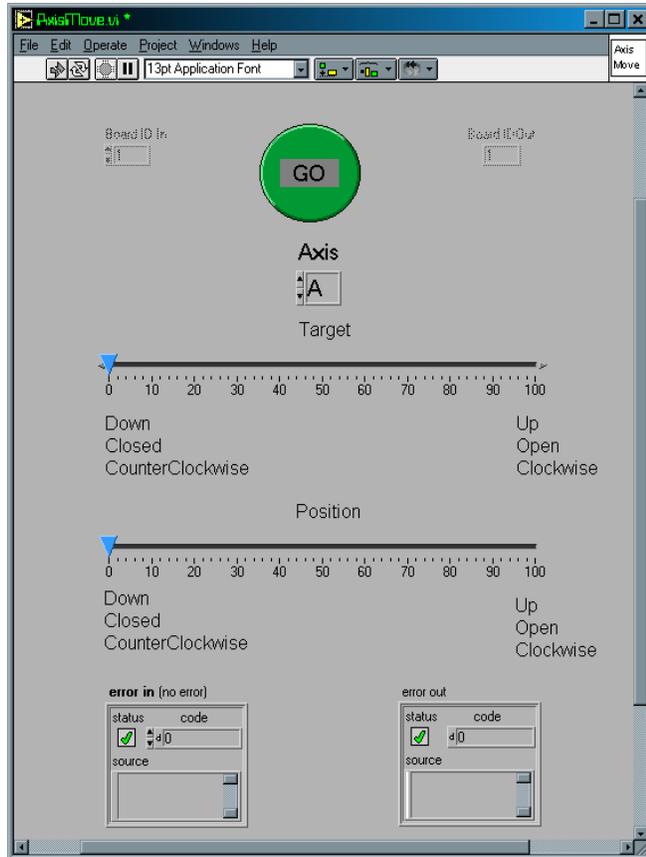


Figure 3: Example Front Panel

At the start of this project, this system required that both the local and remote computers had LabVIEW running. Thus, the user in the remote location must have purchased a copy from National Instruments. Another application (e.g. Visual Basic) that uses ActiveX controls could be developed for the remote computer. A simpler and less expensive solution is

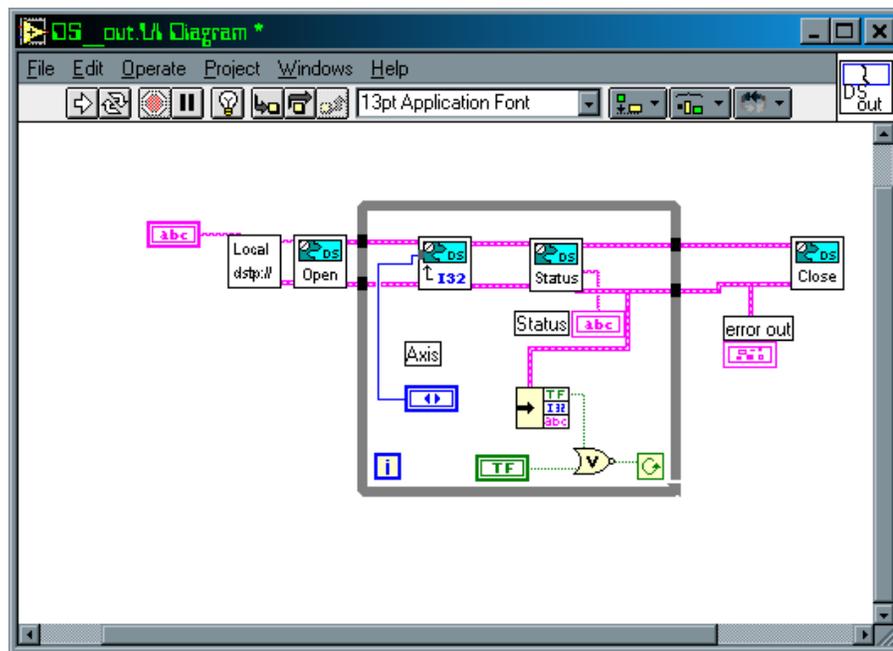


Figure 4: Data Out Diagram

now available with the release of the free, download-able LabVIEW Player. LabVIEW player is able to run the remote control VI, but not edit it. It is available at http://www.ni.com/labview/lv_player.htm .

Conclusion

When configuring a motion control system, it is crucial to have a thorough understanding of all the input and output requirements of every element of the system. The authors would like to thank Donald Peacock of National Instruments for his help with the hardware configuration.

Using new motion control hardware and software and existing driver circuitry, an antiquated robot controller has been replaced. Students are now able to control and monitor four axis of SCARA robot using LabVIEW. Further, by means of DataSocket server (which comes integrated with LabVIEW 6i) and the World Wide Web, the robot can be controlled remotely.

Bibliography

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