Wind Tunnel Control

Functional Description and System Block Diagram

By:

Adam J. Green

Project Advisor

Dr. Aleksander Malinowski

Date:

November 8, 2010

Introduction

The web based control system for the wind tunnel system located in the mechanical engineering lab will provide students with remote access to both the controls for operation as well as measurement data. This configuration will simplify control of the wind tunnel as well as reduce time required to take measurements using the system. Users will use a LabVIEW based software application to remotely connect to PC local to the wind tunnel system, which will be connected to the data acquisition device and will control the system.

Goals

During the course of the project, my goals will be incremental steps toward achieving a complete, network based control/measure system.

- Turn the blower On/Off using LabVIEW.
- Move the wind speed damper Up/Down using LabVIEW.
- Control two actuators using positioning signals from LabVIEW.
- Read measurements from lift/drag/speed sensors in LabVIEW.
- Implement pass-through so that users can use the system remotely.
- Interface local system to remote users via the network.
- Build organized and effective GUI for remote application.

High-Level Block Diagram

The block diagram is shown below in Figure-1. The microcontroller will not need to be reprogrammed or modified after the system is complete, thus will not even need to be connected to the PC. The data acquisition device will pass the necessary signals from the network, through the local PC, to the rest of the system. The measurements will then be sent out through the same device to the remote users.

Figure-1: High-Level System Block Diagram
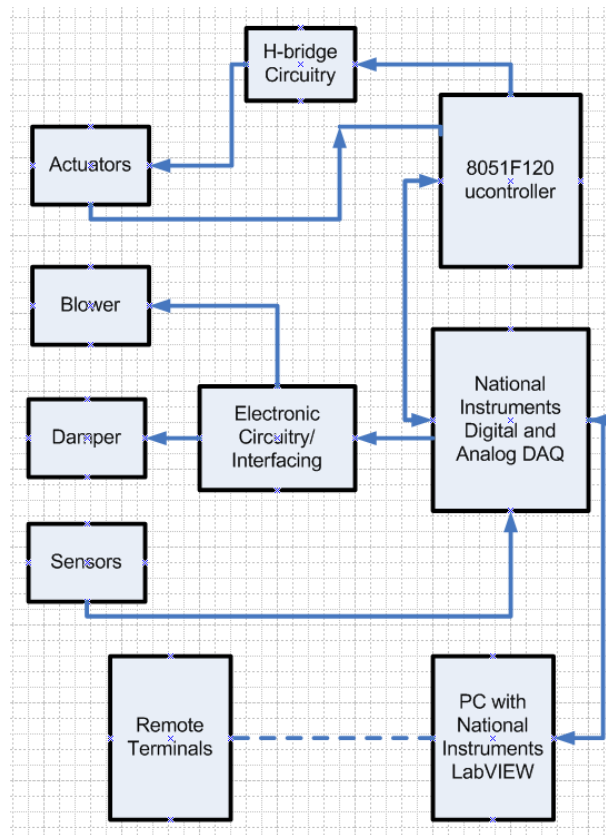
National Instruments Digital and Analog Data Acquisition Device:

This is the main I/O component of the system. All of the control and measure signals must be passed through this device in order to be seen in the LabVIEW software and thus seen by the remote users. For our system, we need a minimum of 3 analog outputs in order to control three actuators (two currently in the system with room for an additional). The DAQ will interface with the PC via the PCI interface and connect to the remote header via GPIB. This header then splits the lines for easy connecting to other components.

8051F120 Microcontroller:

The microcontroller will act as the PWM generator and proportional controller for the three actuators. It will be configured to simply read analog inputs to determine the current setting desired and generate PWM pulses for each actuator to position them correctly. It

will run when the system is turned on and will not need to be connected to the PC. Much of the code used was generated by Benjamin Morrison and Michael Firman, but modified to work with my system.

Figure-2: Microcontroller Software Block Diagram
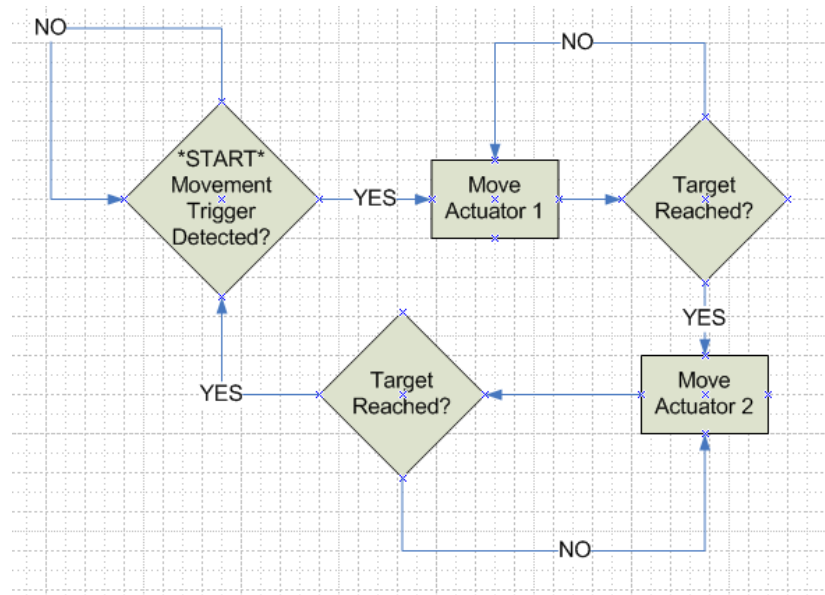
H-Bridge Circuitry:

This circuitry was produced by Benjamin Morrison and Michael Firman and will be used to convert the digital PWM signal from the microcontroller into 12VDC power signals used by the actuator. The circuitry is set up for bi-directional operation.

Electronic Circuitry/Interfacing:

The wind speed damper and blower on/off are 110 and 220VAC, high-amp motors and as such require certain caution during control design. This is overcome by using solid-state relays, which can use small, low-current DC signals to switch very high amp circuits. Also, a double-pole, double throw relay is required to enable directional control of the damper motor. These components will be laid out on a board to be permanently, conveniently, and safely mounted to the wind tunnel system.

Wind Tunnel Components:

The wind tunnel currently has lift and drag sensors attached. We will use these sensors and interface them to our system. The actuators are also present and will be connected to the h-bridges and microcontroller as shown. A useable wind speed sensor is not currently in the system but will be added at a later date.

PC – Remote Interface:

The remote interface will need to be developed in the LabVIEW software and use the existing network via the PC for remote connectivity.

Conclusion

While the overall goal is to implement a complete, remote package to control the wind tunnel system, a systematic approach will be the most beneficial. By working through each step, the system will become more complete while remaining in a useable state throughout the process. This is important so ME students can continue to use the wind tunnel throughout the course of the project.

References

[1] Ben Morrison, "Senior Project - Webwind", Senior Project, Electrical and Computer
        Engineering Department, Bradley University, March 2002.

[2] Silicon Laboratories, C8051F12x Development Kit User's Guide.

[3] Silicon Laboratories, C8051F120 Datasheet

[4] National Instruments, PCI-6229 Datasheet

[4] Omron, G3NA-225B Datasheet