Automated Industrial Wind Tunnel Network Control with LabView

Functional Description and Complete System Block Diagram

Matt Draear

Advisor: Alexander Malinowski

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Introduction

The purpose of this project is to upgrade the controls on the mechanical engineering department's wind tunnel. The end goal is to create an easy to use automated user interface that will allow for both manual control of the wind tunnel and predefined tests to control the wind tunnel. In addition, the project will include adding the ability for remote operation of the wind tunnel for use in high schools. There are two ways in which this may be accomplished. The first option would be to rewrite and build upon the existing code. A preferred option would be to replace part of the current hardware with National Instruments (NI) hardware and streamline the user input control with the wind tunnel.

System Block Diagrams

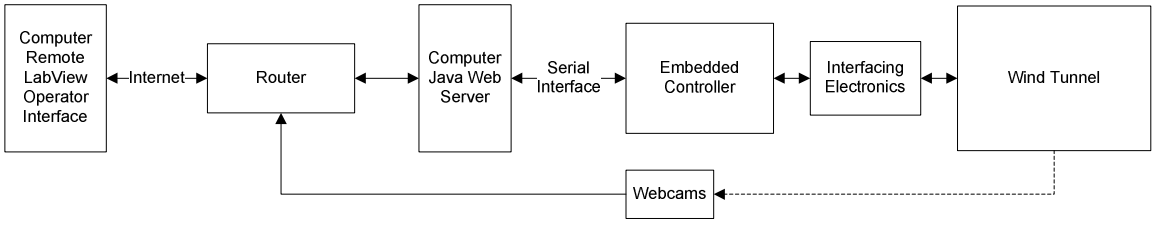

Fig. 1 - System Block Diagram Using Existing Hardware

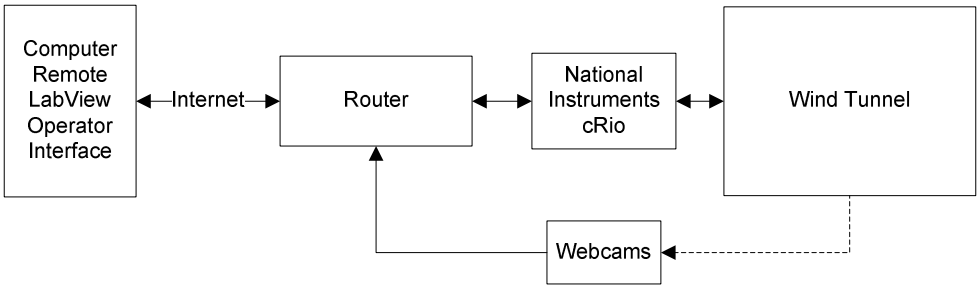

Fig. 2 - System Block Diagram Using Upgraded NI Hardware

Functional Descriptions of Figures 1 and 2

Computer Remote LabView Operator Interface

The remote LabView operator interface computer in figures 1 and 2 is the computer that will be running the LabView client application that connects to the controlling hardware over the internet. This computer will function as the user interface to control the wind tunnel.

Router
The router in figures 1 and 2 will act as the connection point from the internet to the cameras and the hardware that controls the wind tunnel.

Webcams
The webcam block in figures 1 and 2 consists of three webcams situated around the wind tunnel system. These will be placed to allow the operator to see how the part being tested is performing in the wind tunnel. They will also allow the operator to see the status of the surrounding area of the wind tunnel. The webcam handling will be modular such that more webcams can be added to the system.

Wind Tunnel
The wind tunnel block in figures 1 and 2 consists of a large blower turbine attached to a damper which then leads to the testing chamber. This damper can be opened or closed to adjust the speed of the air owing through the system. The wind tunnel also has a platform where the piece being tested sits. This platform has a linear actuator which can angle the test part up and down. Connected to this platform are two pressure sensors which are used to measure the lift and drag forces on the test part. There is also a fog machine attached to the wind tunnel which is used to visualize the flow of air over an airfoil.

Computer Running Java Web Server
The computer that is running the Java web server in figure 1 will be used to host a web server that the remote computer running the operator interface can connect to. The web server computer will also be connected to the embedded controller allowing communication to pass between the operator interface computer and the embedded controller.

Embedded Controller
The embedded controller in figure 1 will be used as an interface between the web server computer and the electronics that will be used to interface to hardware. Serial communication will be used between the web server computer and the embedded controller.

Interfacing Electronics
These electronics in figures 1 and 2 allow the low current and voltage IO options on the embedded controller to interface with the blower motor, three linear control actuators, and a variable position damper on the wind tunnel.

National Instruments cRIO
The National Instruments cRIO in figures 2 and 3 is an expandable industrial controller. The cRIO includes an FPGA and real time controller. This combination allows for high speed IO capability with the FPGA as well as real-time controller functionality that can both be programmed using LabView. Figure 3 shows the workings of the cRIO The real time controller will be used to host the LabView web server as well as running control

loops. The FPGA will be used as an interface between the real-time controller and the IO to allow for high speed IO control that may be desired in the future. The cRIO also offers many IO options for interfacing directly to hardware without the need to add additional conditioning electronics.

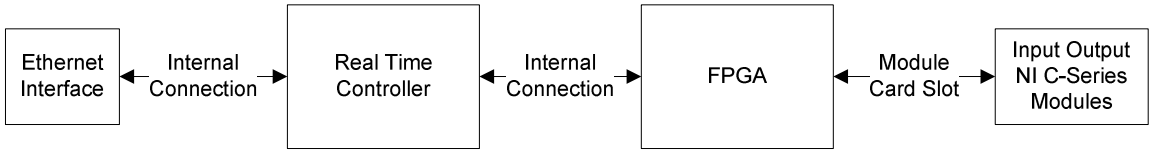

Fig. 3 – National Instruments cRIO

References

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[2] Nick Detrempe and Daniel Monahan. "Automated Industrial Wind Tunnel Controller", Senior Project, Electrical and Computer Engineering Department, Bradley University, April 2012, http://cegt201.bradley.edu/projects/proj2012/aiwt/

[3] NI CompactRIO, National Instruments, [Online] 2012, http://www.ni.com/compactrio