Automated Industrial Wind Tunnel Network Control with LabView

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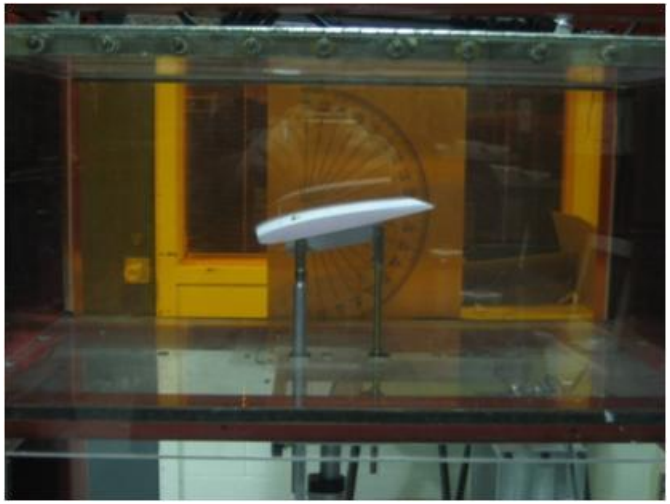
Presentation Outline

- Previous Work
- Preliminary Work
- Project Details
  - -System Overview
  - -New National Instruments Hardware
  - -LabView Graphical Programming Environment
- Equipment and Parts List
- Timeline



Previous Work

Michael Firman and Benjamin Morisson Web Based Wind Tunnel Control System 2010

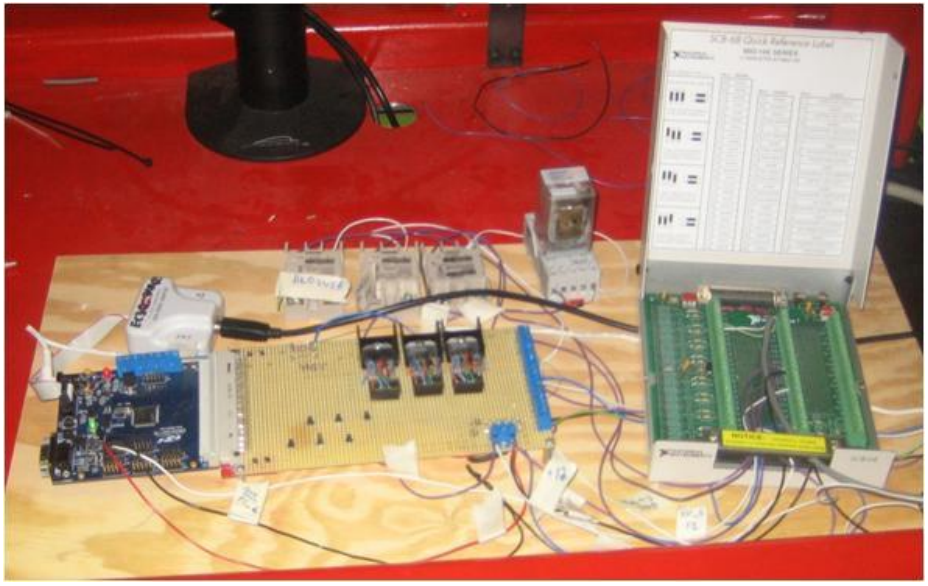
- System analysis
- Solid state relays to isolate control of damper and fan motors from control system
- Microcontroller and h-bridge design to control linear actuators

Adam Green Wind Tunnel Control (Remote Control and Measurement of Wind Tunnel System) 2011

- Network access to controls and measurements
- Use LabView on local PC to control wind tunnel
- Redesigned H-bridge interface with actuator(s) so that the attack angle of the object can be changed

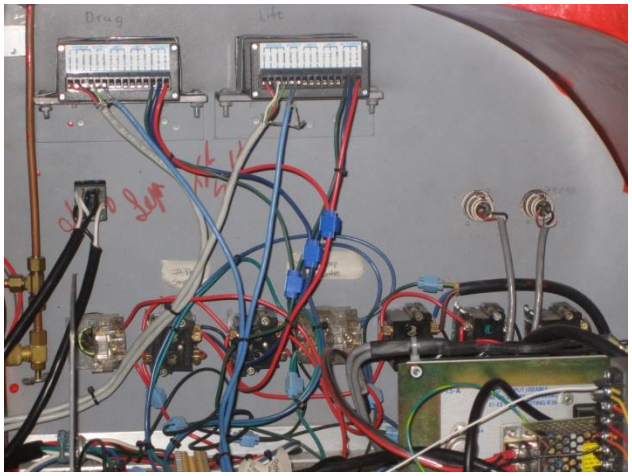
Daniel Monahan and Nicholas DeTrempe Automated Industrial Wind Tunnel 2012

- Replace National Instruments analog to digital converter with microcontroller
- Work on LabView user interface

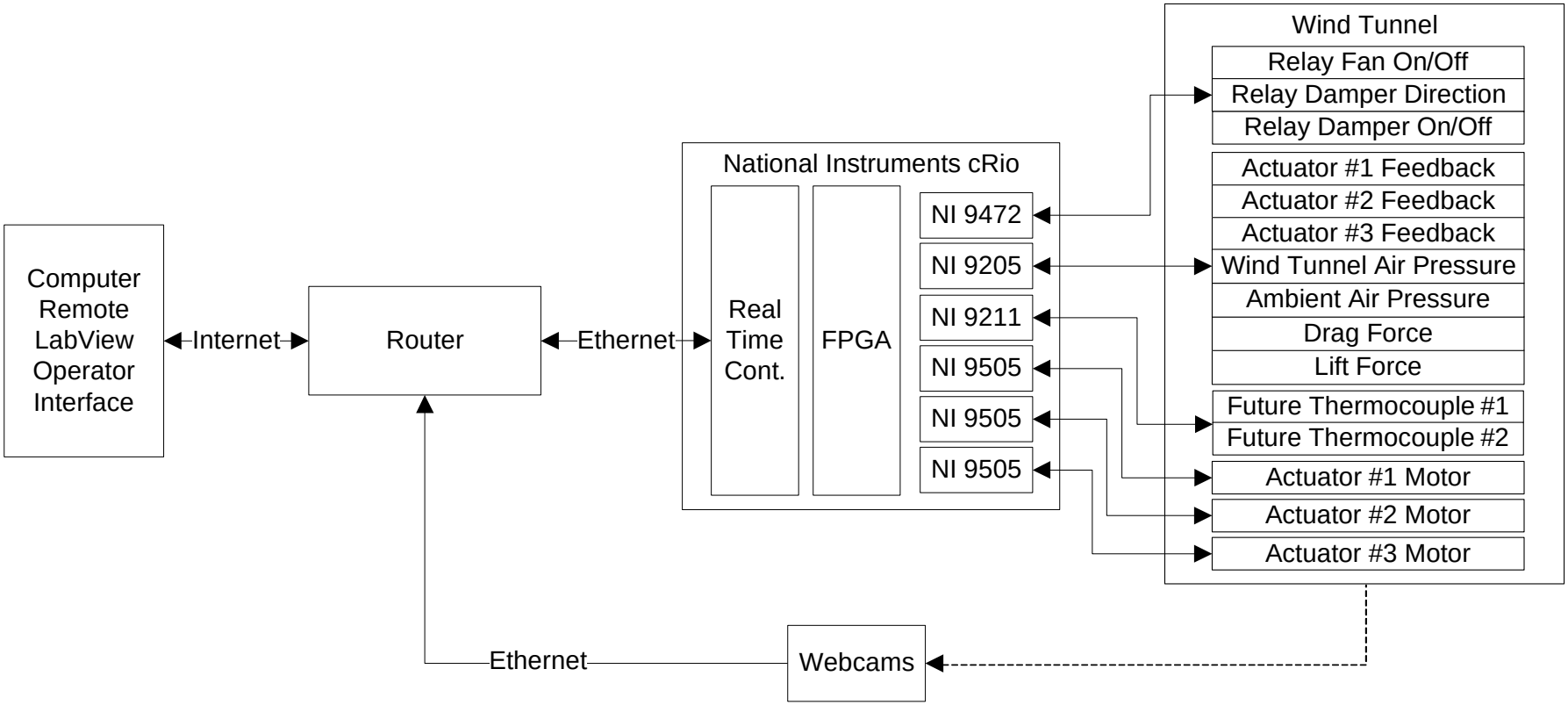


Preliminary Work

- Collected product requirements from customer
- Derived wind tunnel I/O control specifications from past project documentation
- Researched available LabView hardware for an affordable solution that would best interface as the wind tunnel controller
- Contacted National Instruments about the best way to host a LabView server
- Finalized functionality and hardware parts list by discussing it with the customer



Overall System with Proposed New Hardware



National Instruments cRIO – 9074

- Rugged, embedded control and monitoring system
- 400 MHz industrial real-time processor for control, data logging, and analysis
- 2M gate, 8-slot FPGA chassis for custom I/O timing, control, and processing
- Two 10/100BASE-T Ethernet ports; RS232 serial port for connection to peripherals
- Single 19 to 30 VDC power supply input
- 8 slot chassis

Analog Input NI - 9205

ADC Project Requirements

(Minimum 10-bit ADC Resolution)

- Wind tunnel pressure sensor (0-5V)
- Ambient pressure sensor (0-5V)
- Actuator one position feedback (0-5V)
- Actuator two position feedback (0-5V)
- Actuator three position feedback (0-5V)
- Lift force sensor (0-1V)
- Drag force sensor (0-1V)

National Instruments 9205 Quick Hardware Specifications

- 32 single-ended or 16 differential analog inputs
- 16-bit resolution; 250 kS/s aggregate sampling rate
- ±200 mV, ±1, ±5, and ±10 V programmable input ranges
- Overvoltage protection; isolation; NIST-traceable calibration

Thermocouple Input NI - 9211

<u>Temperature Project Requirements</u>

- Support for two future thermocouples

<u>National Instruments 9211 Quick Hardware Specifications</u>

- 4 thermocouple or ±80 mV analog inputs
- 24-bit resolution; 50/60 Hz noise rejection
- Works over temperature ranges defined by NIST(J, K, T, E, N, B, R, S thermocouple types)

Digital Output NI - 9472

Digital Output Project Requirements

(Transition time < 1s, 5-24V, 7mA)

Solid state relay for fan on/off control

Solid state relay for damper on/off control

Solid state relay for damper direction control

National Instruments 9472 Quick Hardware Specifications

- 8-channel, 100 µs digital output
- 6 to 30 V range, sourcing digital output
- Extreme industrial certifications/ratings

Motor Controller NI - 9505

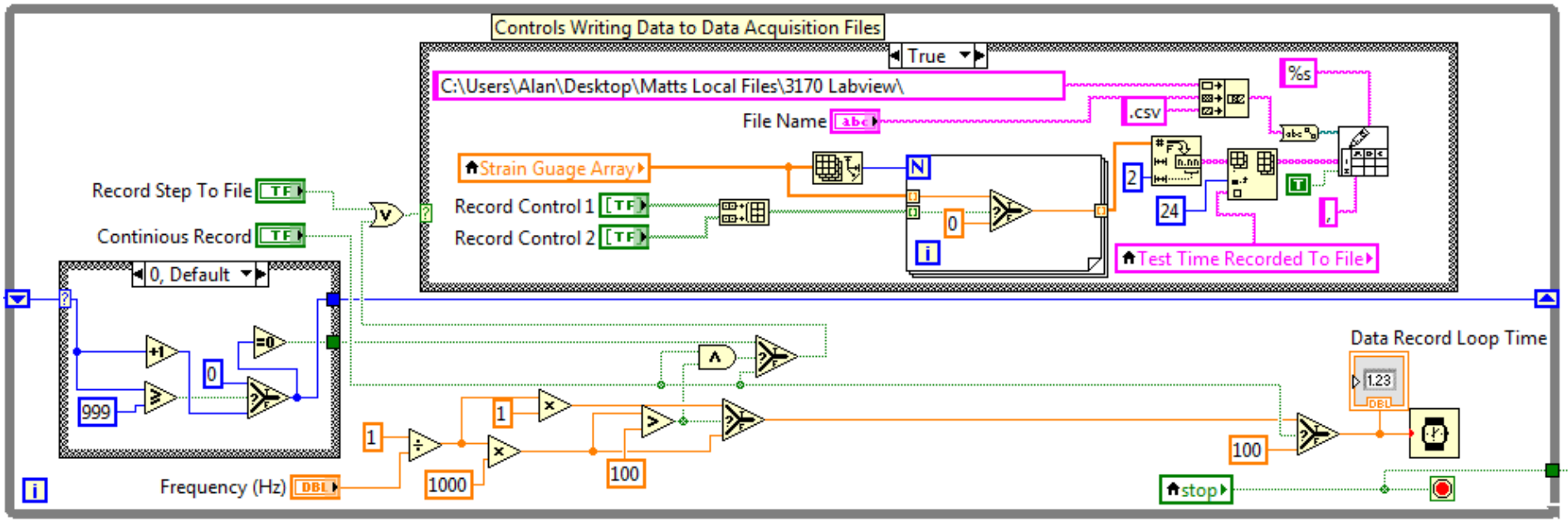
Motor Controller Project Requirements

- Control FA-PO-150-12-4 linear actuator
- Bi-directional control
- Operating current 3 amps
- Inrush current 7 amps

National Instruments 9211 Quick Hardware Specifications

- Continuous current of up to 5 amps at 40 °C
- Full H-bridge brushed servo motor drive with a built-in current sensor
- Peak current 12 amps < 2 seconds max
- Direct connectivity to actuators - fractional horsepower brushed DC servo motors, relays, lamps

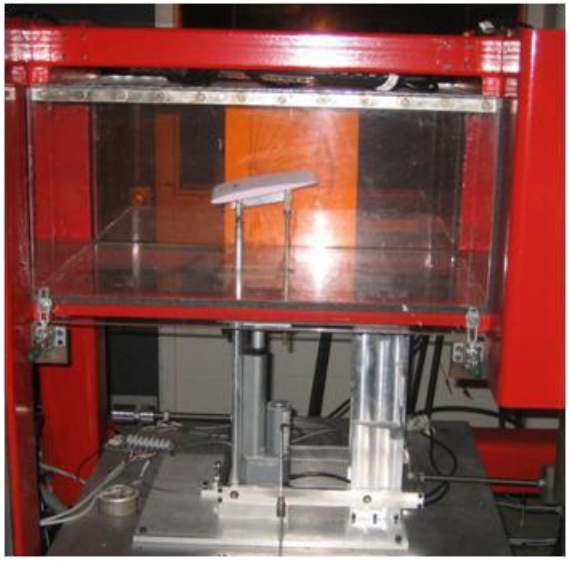
LabView Graphical Programming Interface



Example: Writing to File Loop

Equipment and Parts List

- NI cRIO - 9074
- Analog Input Card NI-9205
- Thermocouple Input Card NI-9211
- Digital Input Card NI-9472
- Three Motor Controller Cards NI-9505
- Local PC with LabView software
  -(Real Time and FPGA Modules)
- Wind Tunnel System and Peripheral Components



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Timeline

Task	Week Number	1	2	3	4	5	6	7	Break	8	9	10	11	12	12	14
	Week Starting	1/27	2/3	2/10	2/17	2/24	3/3	3/10	3/17	3/24	3/31	4/7	4/14	4/21	4/28	5/5
Create Basic Program to Test Hardware																
Test Individual Hardware Components																
Program FPGA I/O																
Program FPGA Control Loops																
Test FPGA Programming																
Program Real Time Controller FPGA Interface																
Program Real Time Controller Test Sequence																
Program Real Time Controller Web Server																
Test FPGA with Real Time Controller																
Program Client User Interface																
Test All Software Together																
Connect Hardware																
Test Complete System																
Write Final Project Paper																
Preparation for Oral Presentation																

Sources

[1] Ben Morrison and Mike Firman. “Web Enabled Wind Tunnel System”, Senior Project, Electrical and Computer Engineering Department, Bradley University, March 2010, http://cegt201.bradley.edu/projects/proj2010/webwind/

[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