

Remote Lab Design and Development to Support MEMS Education

AGBell 11/09/2018

Remote Lab Design and Development to Support MEMS Education

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This *presentation* will discuss the concept of using a remote lab to support the teaching of MEMS and engineering concepts. What is a remote lab? A remote lab allows students to interface to experiments and equipment that are in a remote location. Remote labs allow colleges to maximize the use of expensive equipment via the internet. Teaching MEMS concepts can necessitate the use of cleanroom and other equipment that may not be readily available at all colleges. Online courses further accent the need for remote access to equipment to fulfill the need for “hands on” learning. Application of these concepts can support IoT (Internet of Things), aerodynamics, precision agriculture, cyber security and other applications at a college and reduce the required footprint to provide a quality education.

For some reason my abstract is very long in the app, maybe because they duplicated?

What is a remote lab?

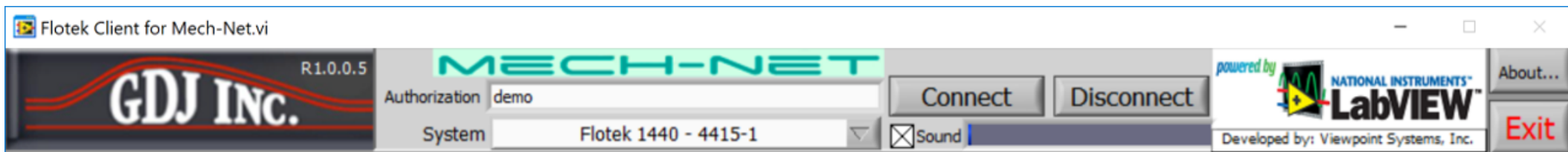
A remote lab allows users to interface to experiments and equipment that are in a remote location. Remote labs are conceptually related to the “Internet of Things” IoT

Our model for Remote Lab is MECH-NET (<http://www.mech-net.com/>)

They use LabView (software) and cRIO (hardware) to access Wind Tunnels, Engines, and other expensive equipment in a remote lab setting (Mentor Ohio).

Our reasons are

- 1.) lack of space (1 sq meter per engineering student)¹
- 2.) improved learning for students²
- 3.) better use of equipment that is currently under utilized³
- 4.) experimental testbed for future NSF ATE grants related to IoT



1 - 2017 Engineering Program Review for FW and 2018 Engineering Advisory Board Meeting

2 - Improving Learning Outcomes In EE2010I Using NI MYDAQ in an Inverted Lab

3 - Last inventory show we have ~ 175K of equipment from TecQuipment (not being used)

And now for the movie

The screenshot displays a LabVIEW remote control interface for a Flotek™ Airfoil 1440, powered by National Instruments LabVIEW. The interface is divided into several sections:

- Control Panel (Left):** Features three vertical sliders for Velocity (ft/sec), Motor Speed %, and Angle of Probe. Below these are buttons for 'Velocity Control', 'Data Record', 'Record', 'Clear', 'Setpoint' (set to 75), 'Ctrl Gain' (set to 0.5), and 'Motor On/Off'.
- Upper Surface Velocity (Top Left):** A 2D plot showing velocity data for the upper surface, with a color scale from 0 to 300 ft/sec.
- Upper Surface Pressure (Top Right):** A 2D plot showing pressure data for the upper surface, with a color scale from 0 to -10 inH.
- Lower Surface Velocity (Bottom Left):** A 2D plot showing velocity data for the lower surface, with a color scale from 0 to 300 ft/sec.
- Lower Surface Pressure (Bottom Right):** A 2D plot showing pressure data for the lower surface, with a color scale from 0 to -10 inH.

Below the plots are numerical data tables and control buttons (V and P) for each plot. The data tables are as follows:

Upper Surface Velocity	Upper Surface Pressure	Lower Surface Velocity	Lower Surface Pressure
8.17, 7.32, 4.61, 4.86, 5.06, 4.26, 2.90, 1.947	1.071, 1.06E, 1.047, 1.051, 1.051, 1.04E, 1.03E, 1.02E	2.53, 0.70, 1.66, 4.25, 3.86, 5.33, 7.06, 1.00E	1.03E, 1.04E, 1.022, 1.01C, 1.06E, 1.03E, 1.06E, 1.00C

On the right side of the screenshot, a web browser window shows a live view from an AXIS M1104 Network Camera. The browser address bar indicates the URL: `76.190.90.120/view/viewer_index.shtml?id=377`. The camera feed shows a close-up of the airfoil's upper surface with a probe attached.

The Windows taskbar at the bottom shows the system clock at 7:29 AM on 11/9/2018, and several open applications including 'Live view - AXIS...', 'Flotek Client fo...', 'cRIOMain.vi [Re...', and 'Paused...'.

Present State -TC1337

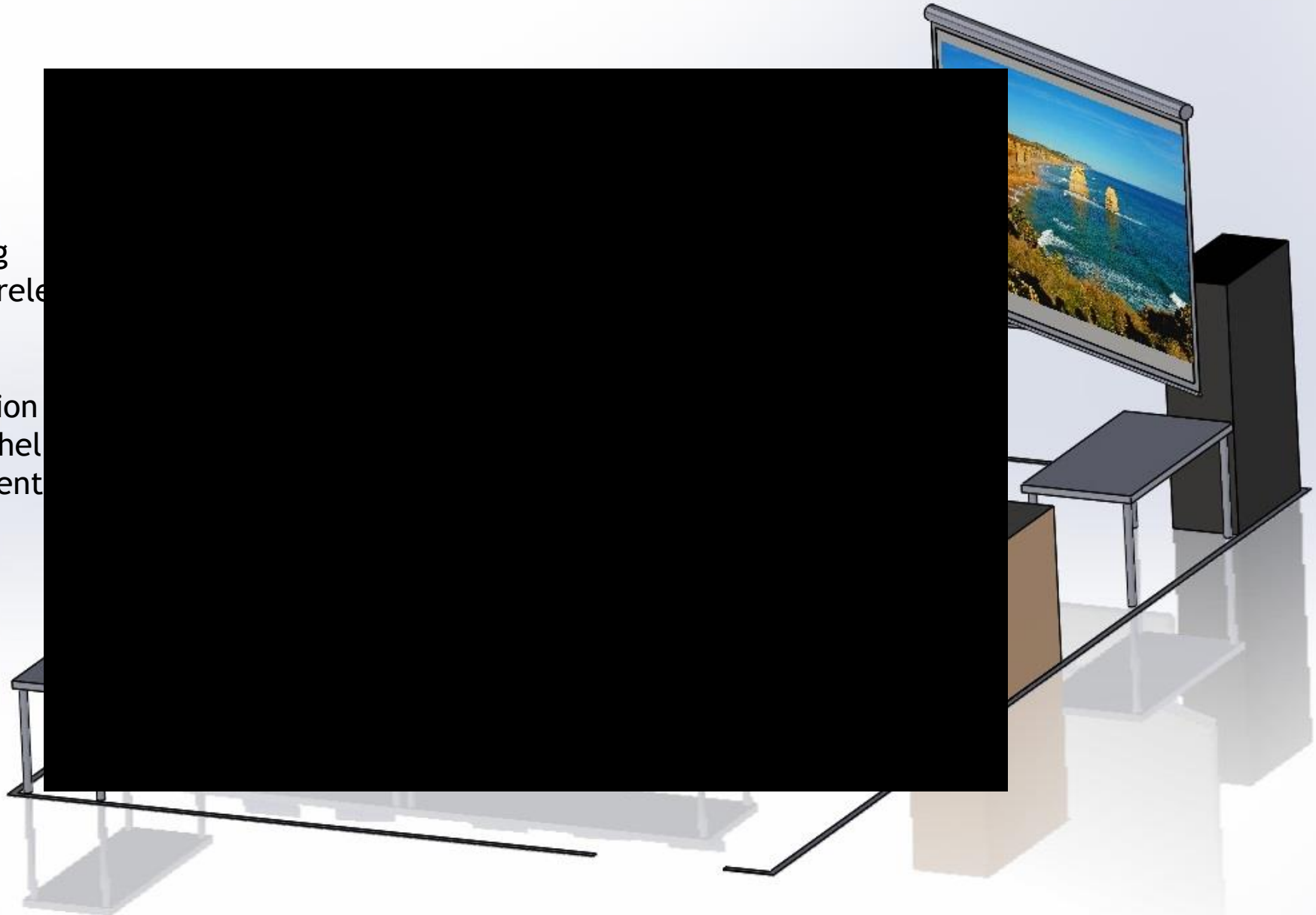
- 15 laptops
- Wireless connection
- Overhead projector
- Instructor PC

Pros

- Standard Classroom config
- Has computer that are wirele

Cons

- Tenuous internet connection
- Difficult for instructor to hel
- No dual monitors for student



Future State - TC1337

- 15 laptops
- Lan line connection
- 3 - 55" TVs
- Instructor PC
- Remote Lab Area
with 4 rack mounted PCs
- Common remote area

Pros

- Unique Classroom config
- Has computer that are on lan line
- Instructor has easy access to students
- 55" Monitors provide dual monitor
- Modifiable Remote Lab Area

Cons

- Cost for added lan lines
- Cost for power
- Cost for IP cameras ~ 200 each
- Cost of 55" TVs ~ 500 each
- Possible loss of classroom



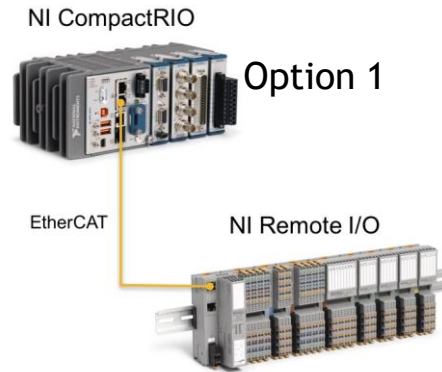
Data Acquisition & Control

Remote Lab Area - Data Acquisition & Control using NI products

Option 1 - cRIO ~ 5K each
new technology
matches MECH-NET config
Expandable & more like industry

Option 2 - Elvis III ~ 3K each
We already have 9 Elvis II +
Adaptable for mechanical or electrical
Has already been done at other schools1, 2

Option 3 - myRIO & myDAQ ~ 1K each
We already have 4 sets
Potential for inverted lab (student owned)
Very inexpensive with lots of support
Many schools use them



Computing and Network

Remote Lab Area - Computing & Networking

Computing with USB interface

4 rack mounted PCs ~ 800 each

Monitor with keyboard mouse ~ 600

Rack ~ 600

Dell PowerEdge R230 - rack-mountable

Xeon E3-1220V6 3 GHz - 8 GB - 1 TB

\$806.66

Tripp Lite KVM Rack Console w/ 19" LCD in

1URM Steel Drawer w Cable Kit

\$627.88

StarTech.com 22U 36in Knock Down Server

Rack Cabinet with Caster

\$607.12

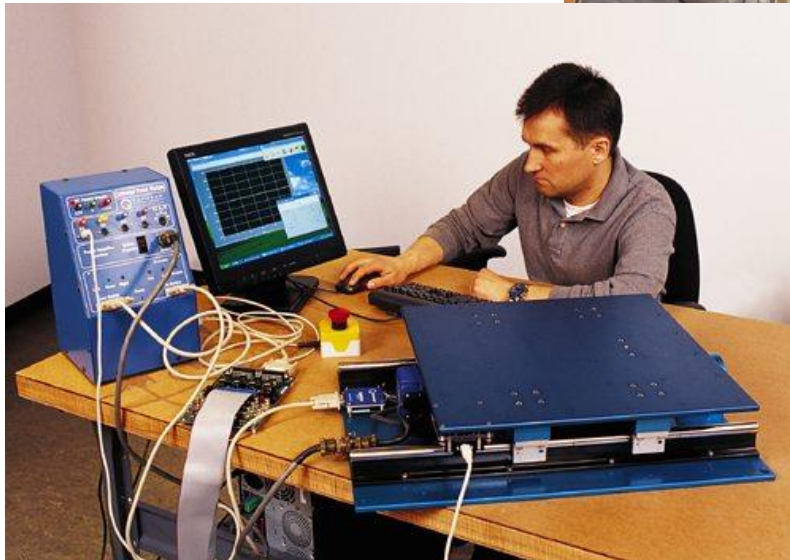


Experiments & labs

Remote Lab Area - Experiments
We already own much of this
No place to put it!

Experiments on wheels

- Pasco Bridge
- Shake Table
- Mechanical
- Material Science
- MEMS
- Electronics



We are still working on it.

Will be used in many courses to support all engineering programs

More on Ivy Tech MEMS

<http://www.ivytech-mems.org>

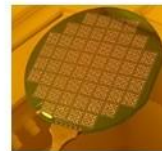


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MEMS 101

Introduction to Microsystems



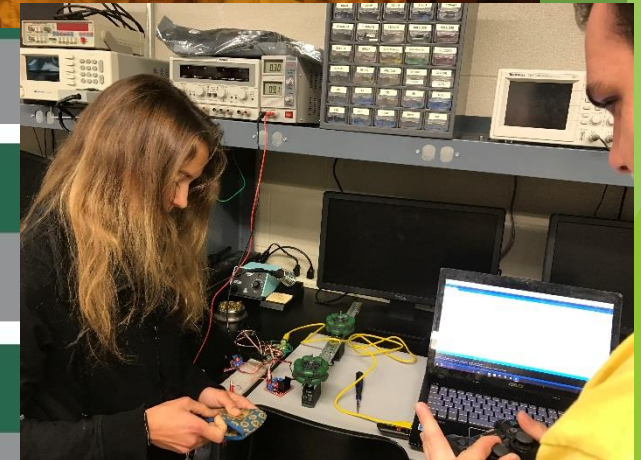
MEMS 102

Microsystems Characterization



MEMS 103

Microsystems and Electronics



Questions?



Option 1

1 - Supplement Your Control or Measurement System with NI Remote I/O

<http://www.ni.com/white-paper/53388/en/>

2 - MECH-NET <http://www.mech-net.com/>

3 - Developing Remote and Virtual Laboratories with LabVIEW

<http://sine.ni.com/cs/app/doc/p/id/cs-13030>

Option 2

4 - Open University talk on "An Internet of Laboratory Things" working in practice

<https://www.youtube.com/watch?v=v-k8-WXgNEM>

5 - Using NI ELVIS and LabVIEW for Remote Engineering Electronics Experiments

<http://sine.ni.com/cs/app/doc/p/id/cs-14002>

Option 3

6 - Improving Learning Outcomes in EE2010L Using NI MYDAQ in an Inverted Lab

https://corescholar.libraries.wright.edu/etd_all/1243/