The High-Tech Tools and Toys Labs*

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National Instruments
Scientific Imaging Symposium
Chelmsford, MA

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CenSSIS ERC Partners

Education Leaders:

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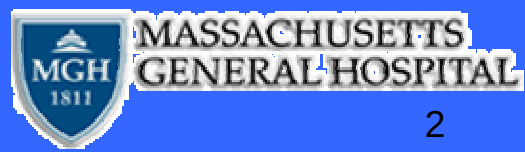
R. Rodriguez-Solis, UPRM

Northeastern University

Rensselaer

RPInfo: Rensselaer's Information System

Woods Hole Oceanographic Institution



What is the High-Tech Tools and Toys Lab?

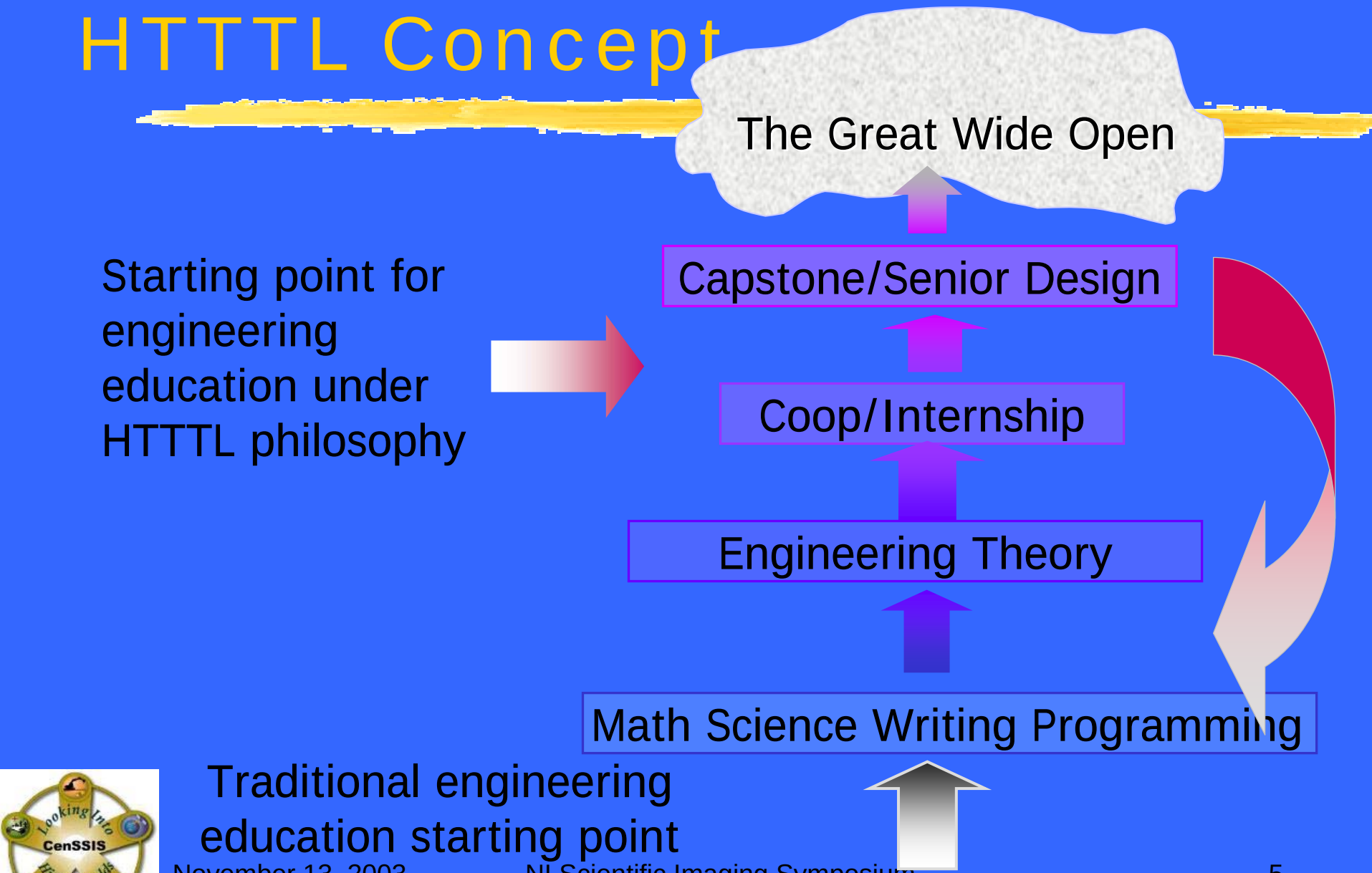
Connects learning to engineering practice!

Introduces engineering by exposing students to state-of-the-art high-tech products and lets them learn by operating, interfacing, and benchmarking these instruments.

HTTTL Elements

- Freshman stand-along discovery lab
- Interface computers with “high-tech” instrumentation and equipment
- Active learning/inquiry-based introduction to engineering

HTTTL Concept



Starting point for engineering education under HTTTL philosophy

Traditional engineering education starting point

Northeastern University: GE1102/1101

- Programming stepper motor control
- X-Y position control
- Sound velocity measurement
- Ultrasound imaging of hidden shapes

  MATLAB/EXCEL C/C++

Boston University: EK130 Modules

- Liquid-Level Detection (LabView)
- Coin Recognition (LabVIEW)
- Tracking slot cars (Vision Builder)
- Hover controller (Vision Builder)
- Ultrasound ranging (LabVIEW)
- Microscope stage control (LabVIEW)

U of Puerto Rico: HTTTL

- Image Processing: optical filters (MATLAB)
- CD Player: audio filters (MATLAB)
- Lego Mindstorm Robots
- Ultrasound positioning and imaging

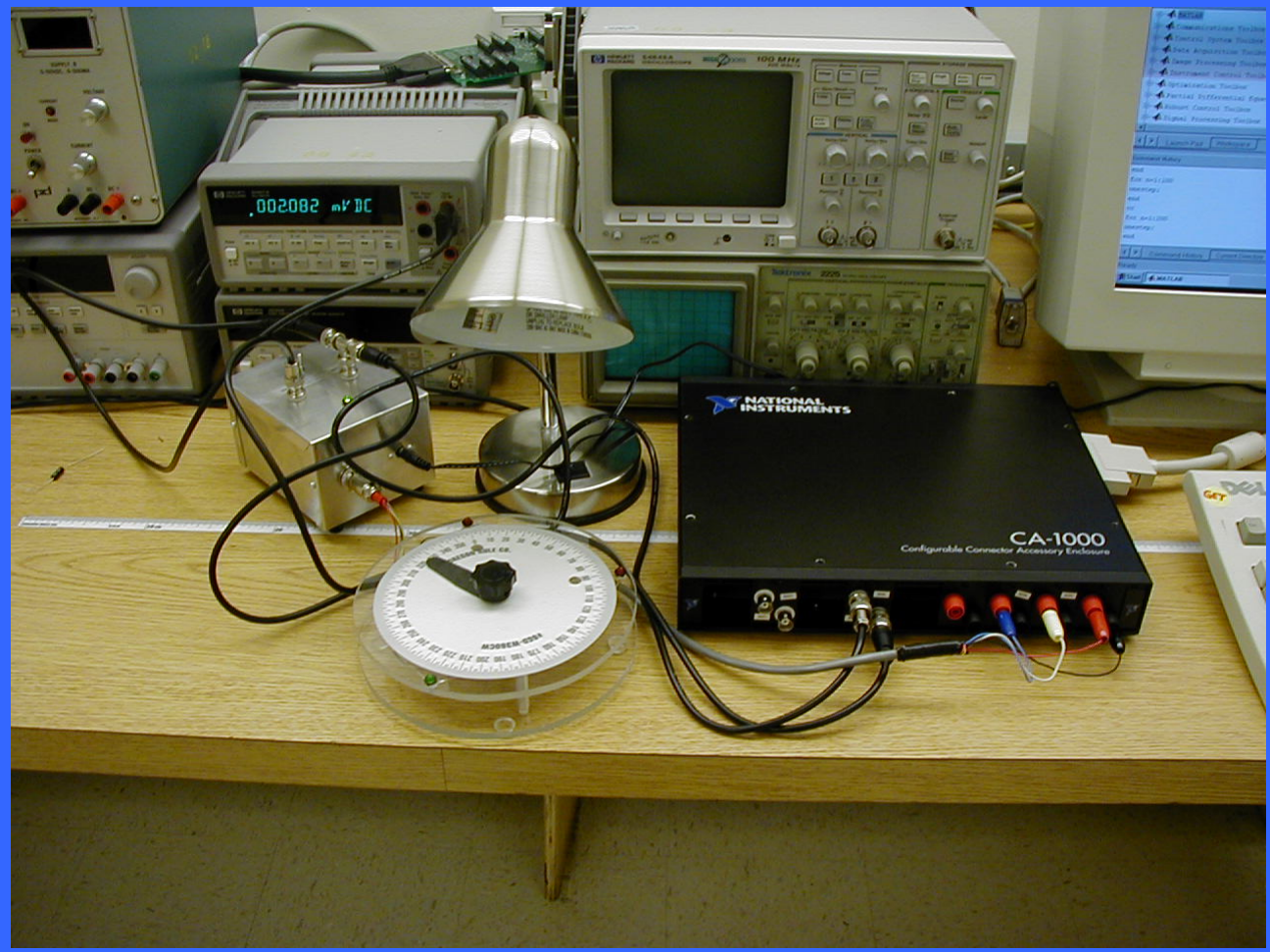
Northeastern University

- Freshman computation
- Elective course
- Acoustic imaging
- MATLAB, NI hardware

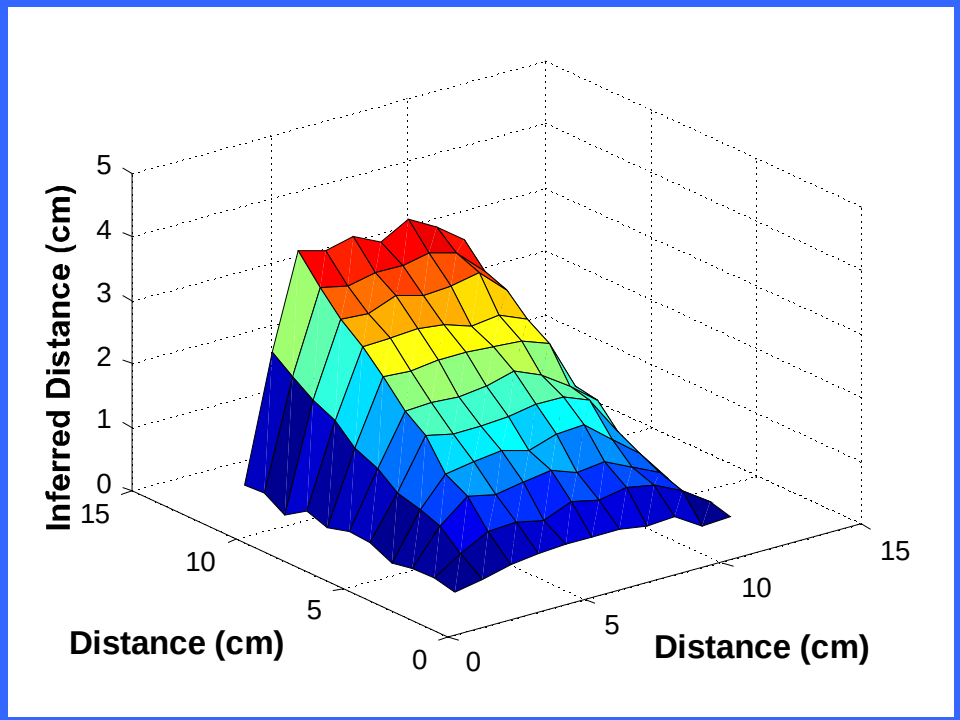
Northeastern
UNIVERSITY

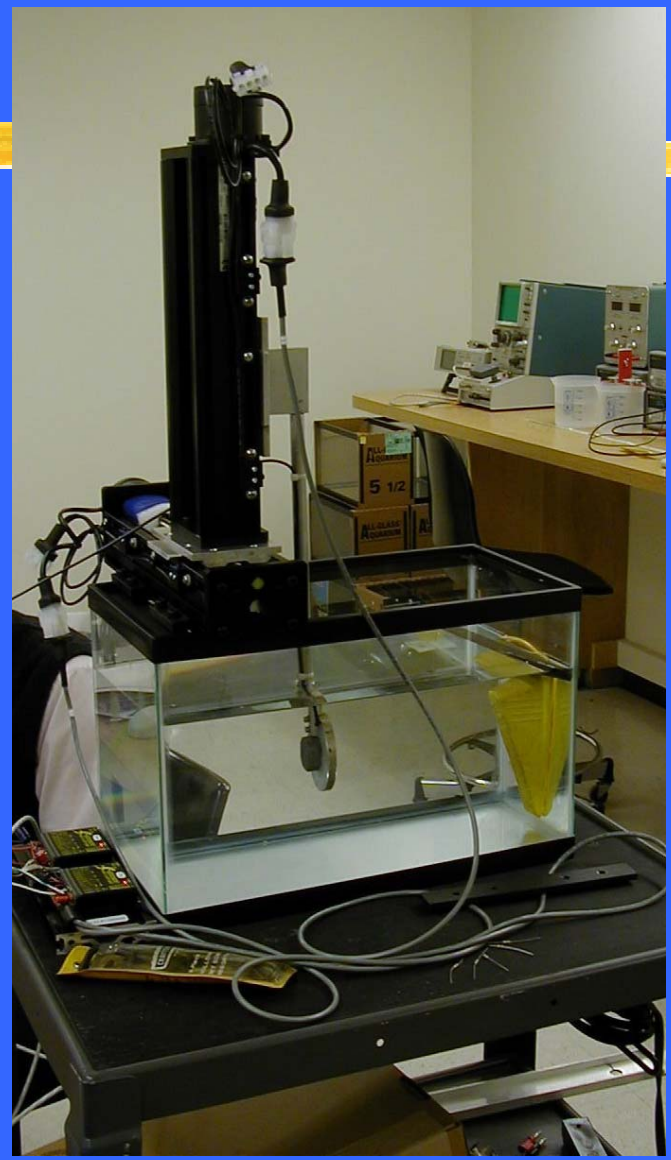
Measuring Speed of Sound in Air (MS Excel)

Control of Stepper Motor



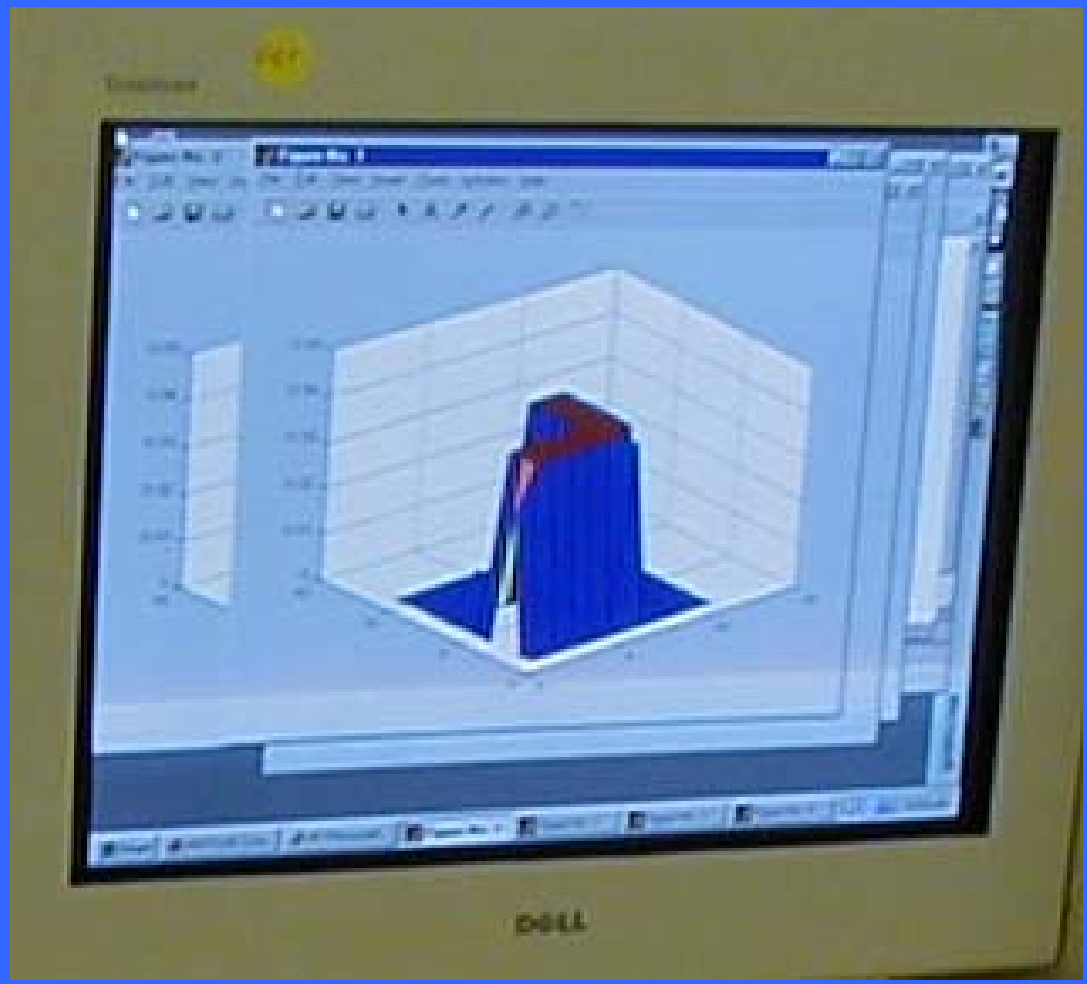
Ultrasonic Imaging





Subsurface Shape in Opaque Gelatin

Subsurface Object Imaged

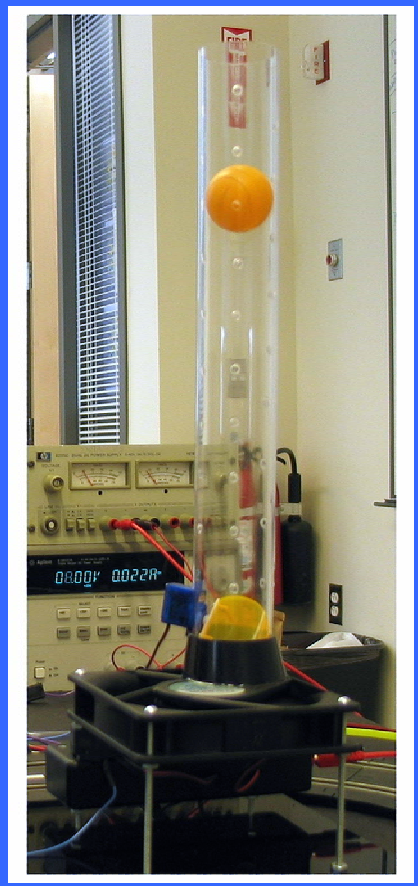


Boston University

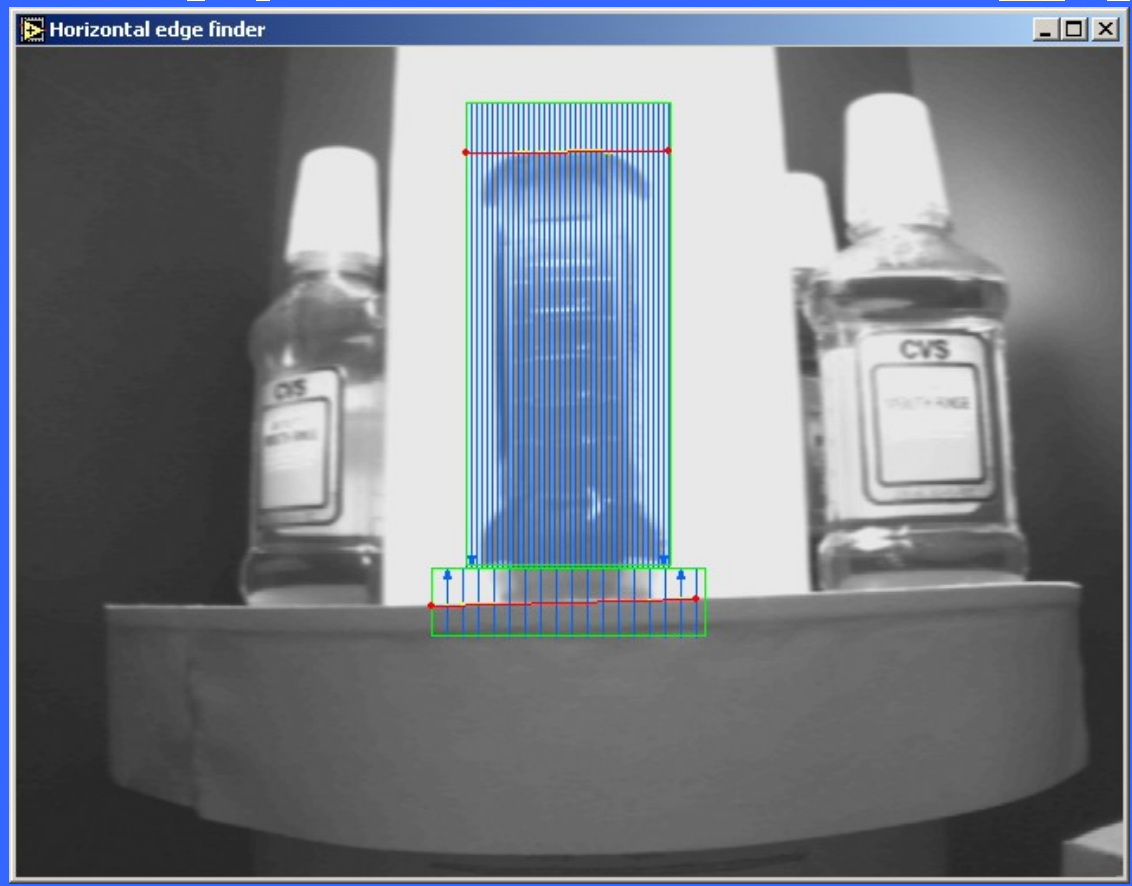
- Freshman Intro to Engineering
- Elective modules
- Imaging, hands-on stations
- MATLAB, LabVIEW, IMAQ, Vision Builder, Hardware

With thanks to John Callan (NI)!!

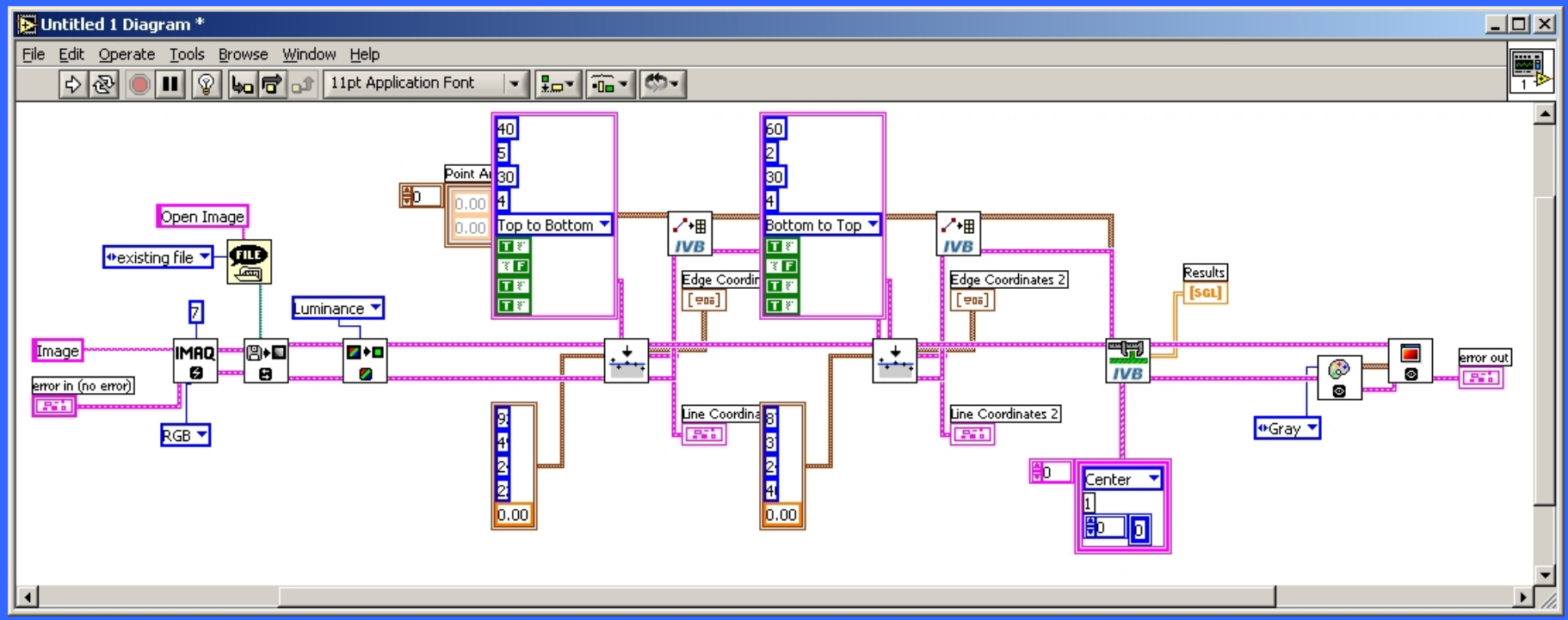
Diverse Experiments



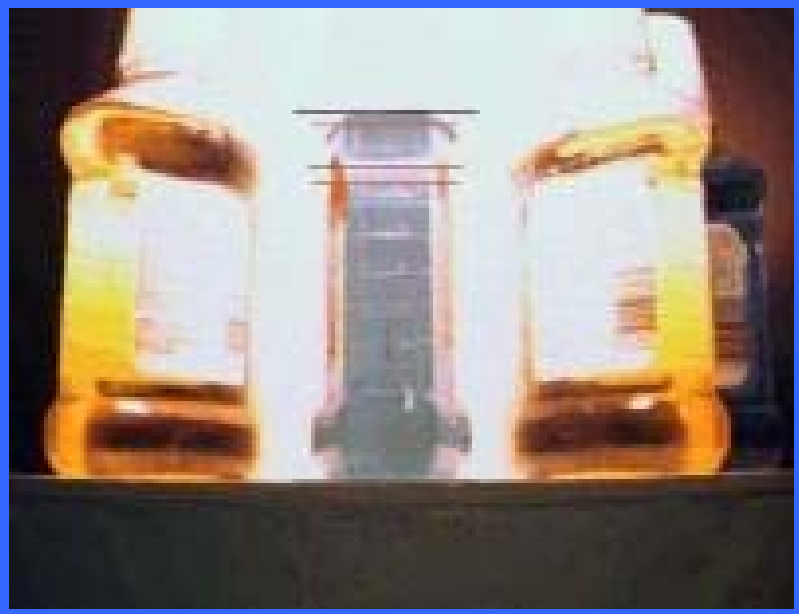
Machine Vision

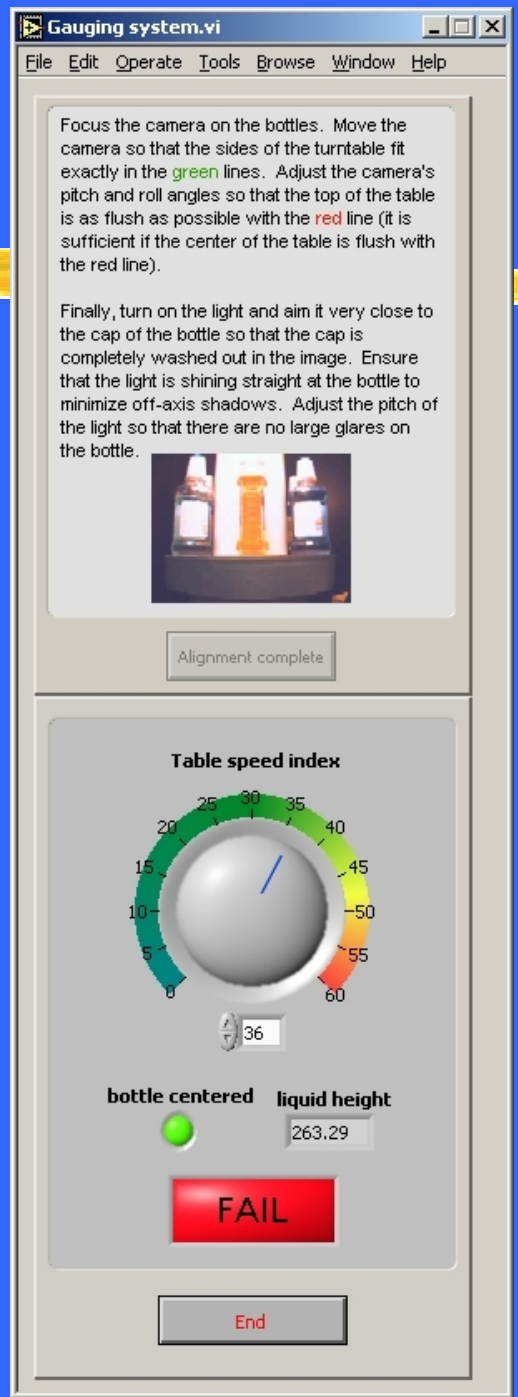


LabVIEW by TFs, UROPs, HSS



Interface, speed





FROP Lighting Controller

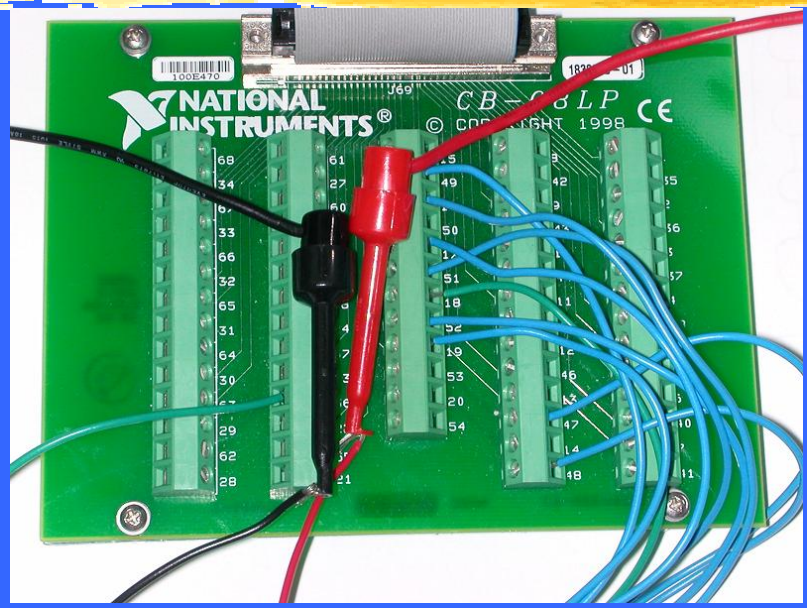
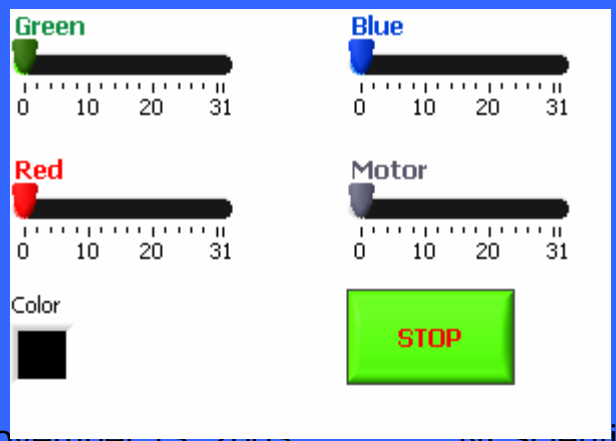


Figure 19
DAQ card and power lines for DAC chip



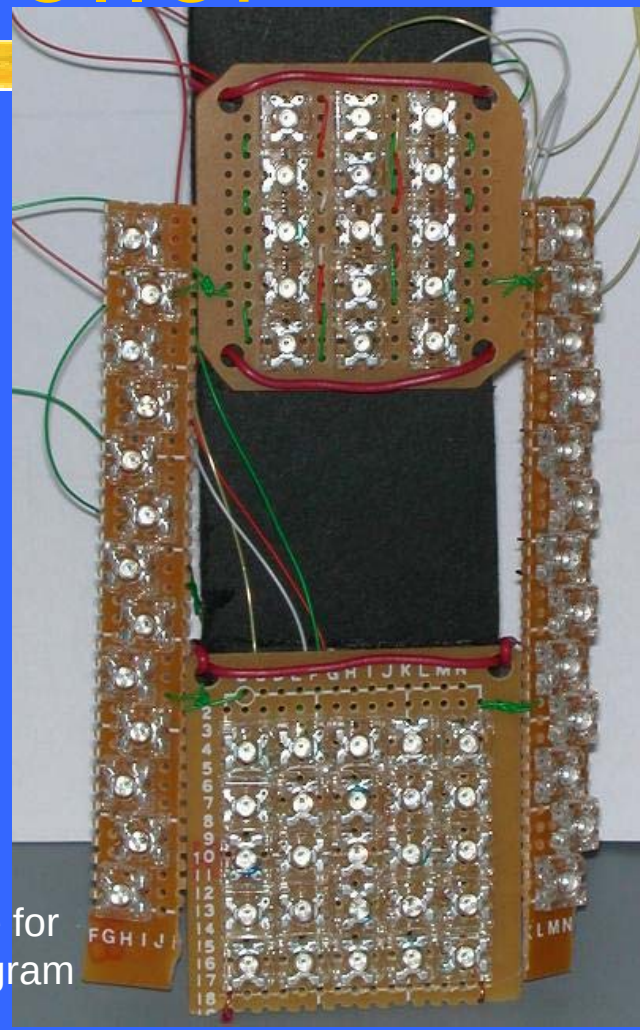
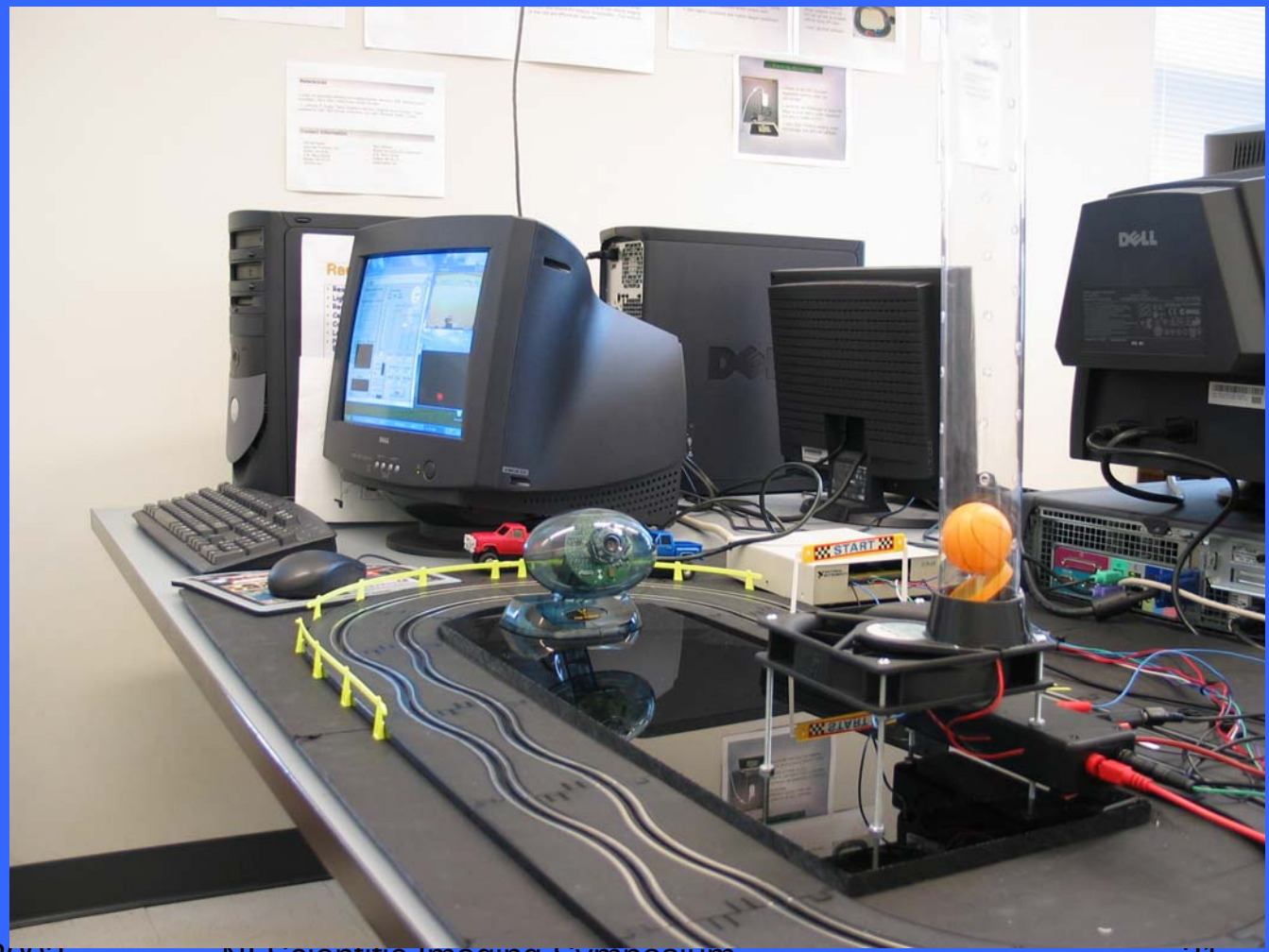
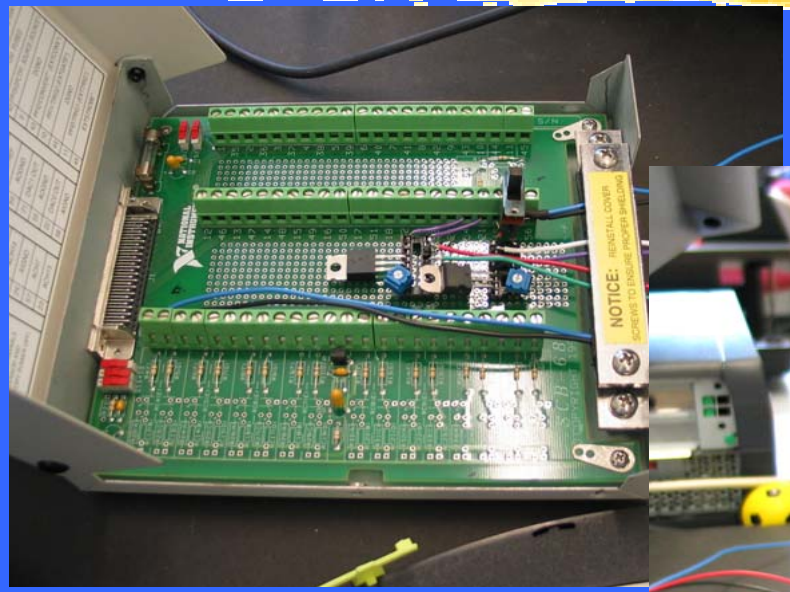


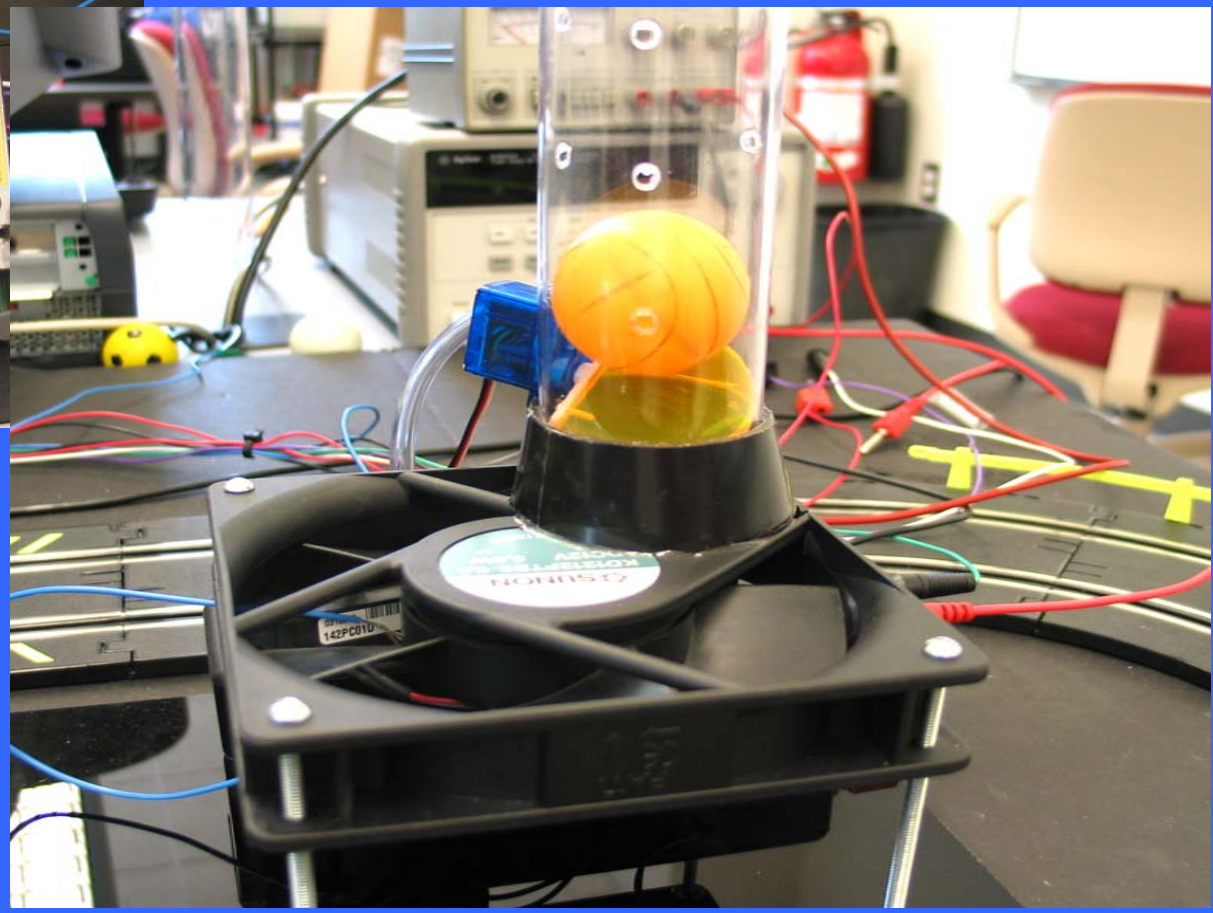
Figure 20
Graphical interface for DAC LabVIEW program

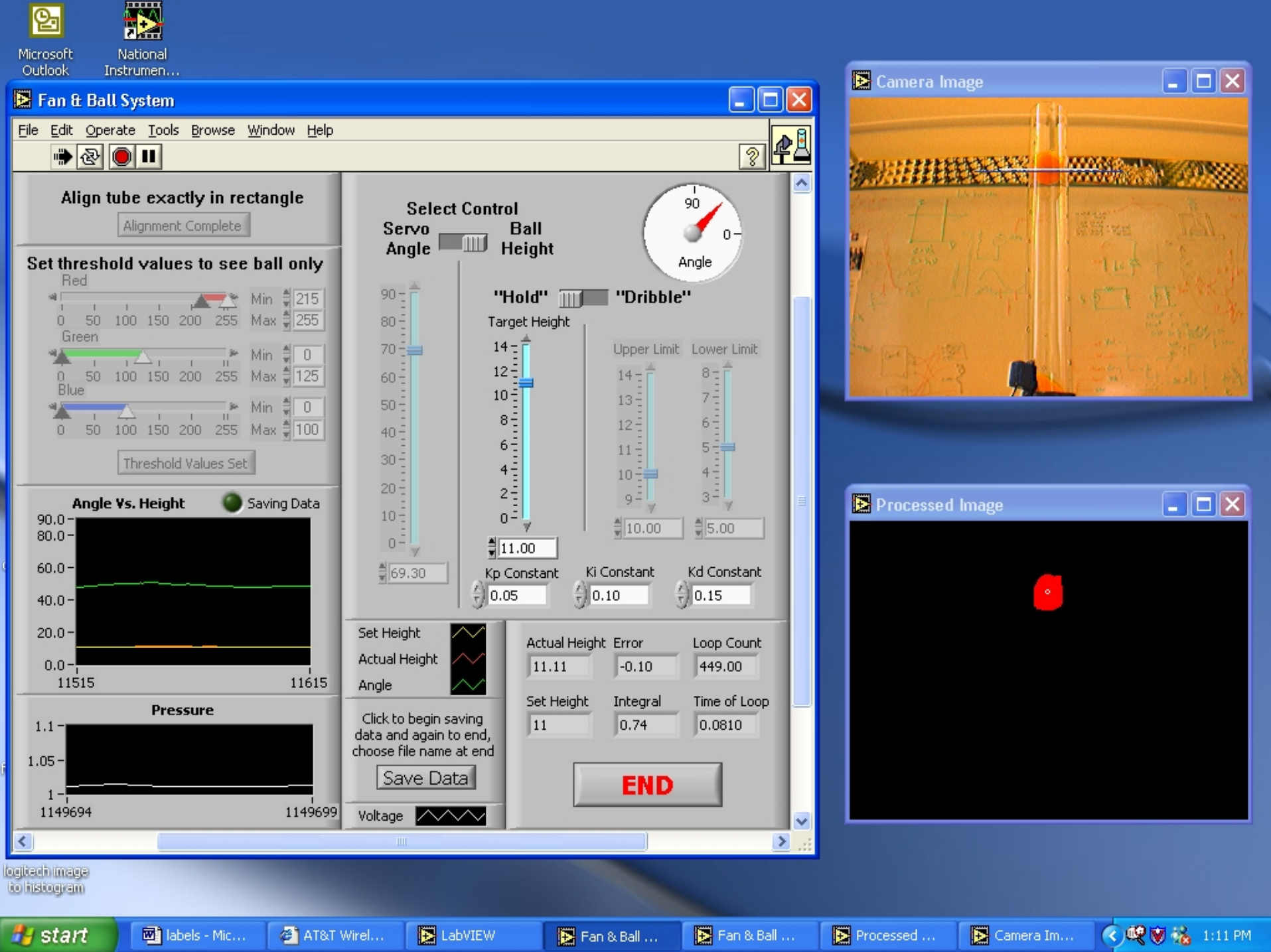
Hovering Ball - PID Control



Motor and Throttle






Microsoft Outlook
National Instrumen...
Fan & Ball System
File Edit Operate Tools Browse Window Help
Align tube exactly in rectangle
Alignment Complete
Set threshold values to see ball only
Red
Min 215
Max 255
Green
Min 0
Max 125
Blue
Min 0
Max 100
Threshold Values Set
Angle Vs. Height
Saving Data
90.0
80.0
60.0
40.0
20.0
0.0
11515
11615
Pressure
1.1
1.05
1
1149694
1149699
Select Control
Servo Angle
Ball Height
90
0
Angle
"Hold"
"Dribble"
Target Height
Upper Limit
Lower Limit
11.00
10.00
5.00
69.30
Kp Constant
0.05
Ki Constant
0.10
Kd Constant
0.15
Set Height
Actual Height
Angle
Click to begin saving data and again to end, choose file name at end
Save Data
Voltage
Actual Height
11.11
Error
-0.10
Loop Count
449.00
Set Height
11
Integral
0.74
Time of Loop
0.0810
END
Camera Image
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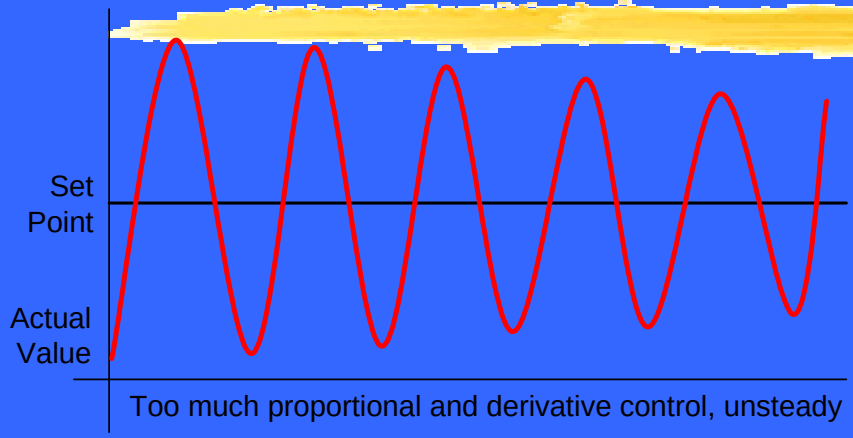
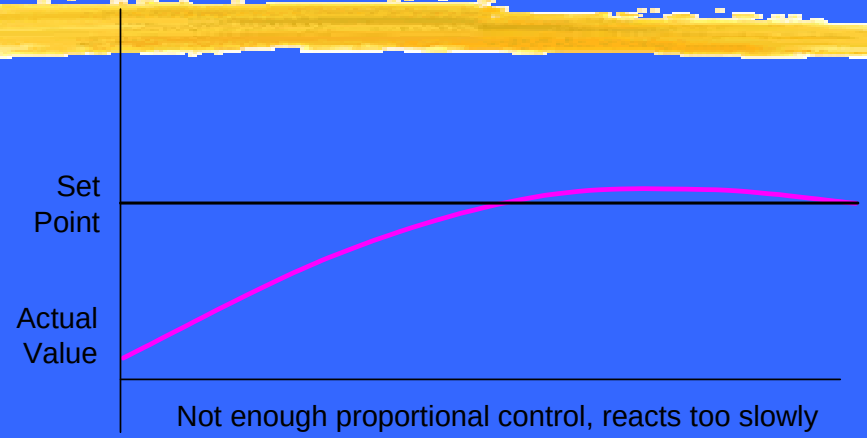
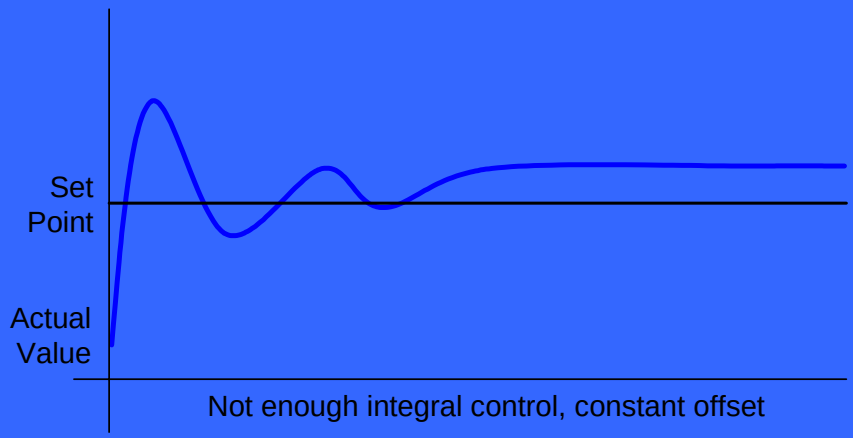
LabVIEW
Fan & Ball ...
Fan & Ball ...
Processed ...
Camera Im...
1:11 PM



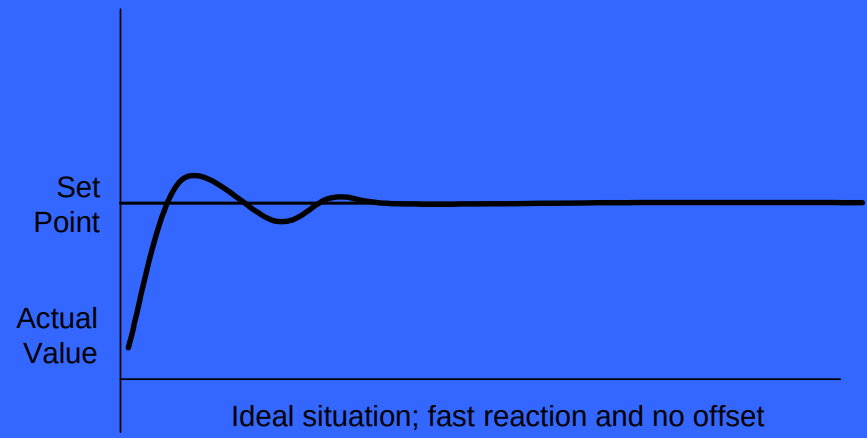
Too much proportional and derivative control, unsteady



Not enough proportional control, reacts too slowly

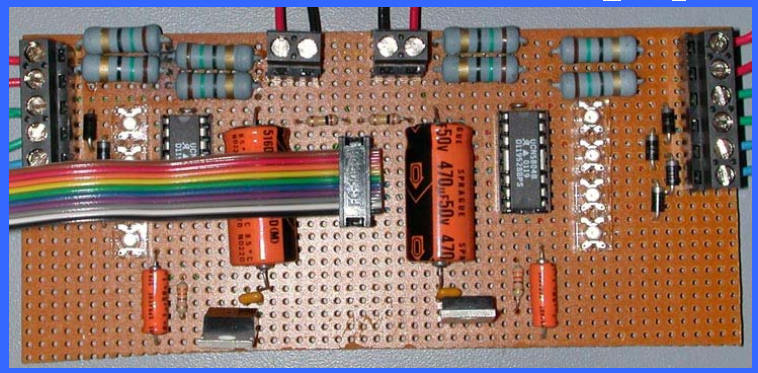


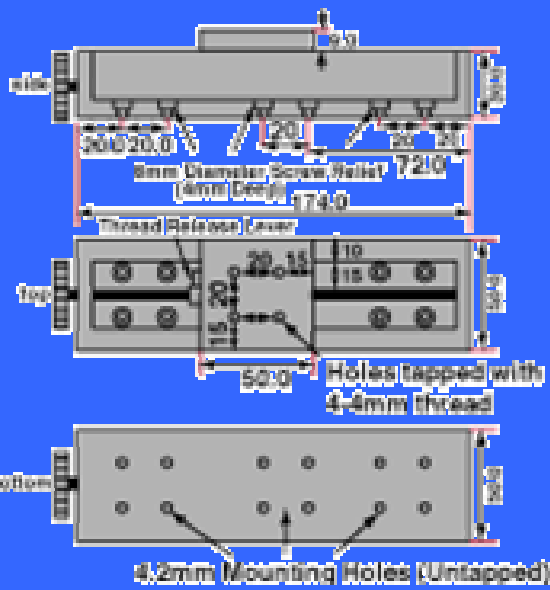
Not enough integral control, constant offset



Ideal situation; fast reaction and no offset

Stage Controller





Slot Car Controller

- Vision Builder
- ROI vignetting
- Tracking
- Position rules
- Direct V control
- Students compete

Other Stations

- Low cost acoustic imaging (steppers, LabVIEW, electronics)
- Coin counting
- Microscope interface
- Laser mine detection metaphor
- Biohazard detector
- IR camera imaging

Senior Capstone Design & CenSSIS

Boston University HTTTL

Acoustic 2-D Imaging

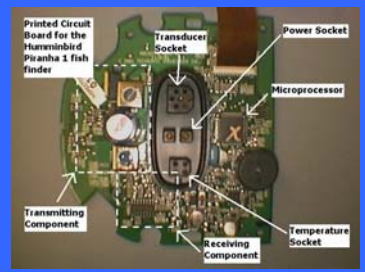
AUV Acoustic Sensors

CenSSIS has supported 8 senior design teams in ECE and AME on acoustic, EIT, and sonar applications

ECE Day

3-D Acoustic Mapping

32 Electrode EIT



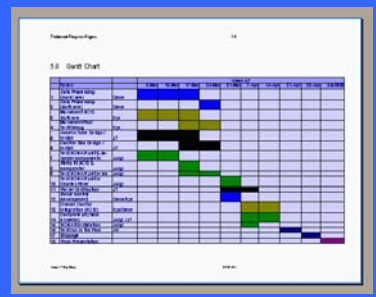
Reverse Acoustic Engineering

HTT&L houses some projects, provides materials, and advising.

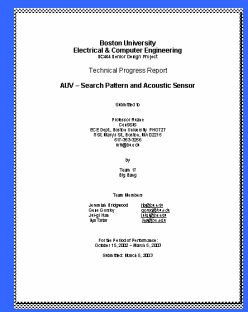
Proposal Talks

Acoustic Homing

AME AUV Hull Design



Project Planning



Reporting Design

March 25, 2003 mfr

BU CenSSIS High Tech Tools and Toys Lab

Paul Laplume (BU), Professor Michael Ruane (BU)

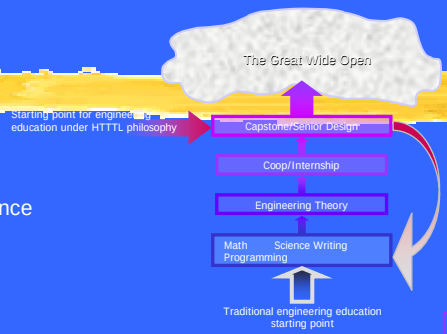
This work was supported in part by CenSSIS, the Center for Subsurface Sensing and Imaging Systems, under the Engineering Research Centers Program of the National Science Foundation (Award Number EEC-9986821).

CenSSIS Philosophy

- Engineering as problem solving
- Systems approach
- Engineering education as a top-down process

BU HTTTL Philosophy

- Challenge students with problems that create a lasting experience
- In solving, they gain a *firsthand* understanding of engineering
- Supplement with theory in classes and UROP/IUROP



Goals

- Increase technical knowledge of imaging hardware/software
- Teach new engineering skills
- Create confident attitude about solving engineering challenges

EK130 Course Description

In seven weeks, freshmen engineering students are introduced to image processing, problem solving, and design. They advance in teams to the HTTTL to use several imaging stations and extend their functionality. Two modules per semester.

Project Stations

Gauging Station

- System designed to descry bottles with out-of-tolerance liquid levels
- Students challenged to modify system to discriminate based on liquid color
- Uses ADS Technologies FireWire Web camera and NI LabVIEW software

Optical Coin Calculator

- System initially recognizes quarters and pennies
- Students extend it to recognize all four US coins, ignore fakes (e.g. subway tokens)
- Uses Hitachi camera, Data Translation frame grabber, and DT Vision Foundry software

Open Microscope

- System initially recognizes one type of bad component
- Students must train it to find others and move stage to center them
- Built around Sony FireWire camera, Linos microscope, and MATLAB software

SONAR Imaging System

- Students taught to control underwater piezoelectric transducer mounted to dual axis stepper motor
- Extend system to raster scan objects and display 3D plot in MATLAB
- Based on Northeastern University HTTTL project – being redesigned by senior capstone design project team
- Uses Agilent equipment and custom stepper positioners

Motion Tracking

- System tracks motion of cars around track
- Students challenged to design program that will run cars as fast as possible without flying off track

Current Status

- Gauging station and optical coin calculator are functional for module I.
- Open microscope and motion tracking systems will be added for module II.
- [illegible] is working on a redesign of the SONAR system.
- [illegible] team is working on a 3D motion tracker in collaboration with an artist from BU College of Fine Arts.

Future Plans

- Additional senior design projects in sensing and imaging
- Upper-level engineering courses
- Online access to project stations

Contact Information

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References

[1] P. Laplume, M. Ruane. "Using Imaging to Introduce Engineering to Freshmen." Paper submitted for ASEE 2002 Annual Conference. June 2002, Montreal, Quebec, Canada.

Conclusions

- Freshman introduction to imaging, sensing, systems issues
- Elective, hands-on modules
- Imaging and LabVIEW themes
- Motivated students anxious to learn more...
- http://www.censsis.neu.edu
- RICC Nov 18-19 at NEU