The Virtual Lab Experience

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Outline

- The Virtual Laboratory Concept
- Experience from Fall 1995 Semester
- Future Directions

Ok, buddy, just what is a “virtual laboratory?”
Problem: Instrument not Available

- Needs for special purpose instruments may exceed budgets
- Special purpose instruments may not be available in an isolated remote location (e.g., space!)

How can I get a multichannel digitizing flux capacitor???
Solution: Virtual Instrument

General purpose instruments can be programmed with a computer to behave like special purpose instruments that you don’t have!
Problem: Instruments not Accessible

- Needed instruments exist only at a distant location
- University lab is locked at 3:00am when student wants to do assignment
- University equipment under-utilized outside of scheduled lab times
Solution: Remote Instrumentation Access

- Make instruments available over the internet (or company intranet)
- Remote access paradigm is increasingly being used in industry along with telecommuting and teleconferencing
- CMU activity: introduce this paradigm into the undergraduate laboratory experience
Remote Access Application 1

- Students can use university laboratory instruments when the lab is not open
- Instruments can be shared among multiple universities
Remote Access Application 2

- Engineers/Scientists have remote access to a large, expensive piece of equipment
- saves travel expenses
- gives wider access to equipment
Remote Access Application 3

- Adjustments to equipment on a manufacturing line from a central (perhaps remote) location
- Saves travel time and expense
Remote Access Application 4

- Support Engineer can make adjustments to client’s system remotely
- Saves travel time and expense
Remote Access Application 5

- Remote exploration: space, sea, volcanoes, etc.
- Travel not physically possible
CMU ECE Virtual Laboratory

dorm room, office

LAN

dial-up

wireless

Virtual Instrument
digitizing oscilloscope
multimeter
function generator
circuit under test
What’s in a Name?

• “Virtual Laboratory” is a bit of a misnomer
  • We are not *simulating* laboratory experiments
  • We are providing remote access to *real* instruments and experiments

• Perhaps better name: “Telelaboratory”
Key Virtual Lab Software

- HP-VEE (Hewlett-Packard)
- QuickCam Software (Connectix)
- PC/TCP (FTP Software + CMU)
- Timbuktu (Farallon)
  - Complete cross-platform control from Macs or PCs
Key Virtual Lab Hardware

- Intel 100 MHz Pentium computers running Windows, with ethernet, HPIB interfaces
- HP54601B 100 MHz digitizing oscilloscopes
- HP34401A digital multimeter
- HP8116A 50 MHz Pulse/Function generator
CMU Wireless Initiative Infrastructure

- Ben Bennington, Alex Hills, and John Leong
- 915 MHz, 2 Mb/s AT&T WaveLAN in 5 main campus bldgs
- Bell Atlantic Mobile CDPD, 19.2 kb/s, all Pittsburgh area
- Mac & PC support

Diagram:
- High Speed NSF Funded
- CDPD Bell Atlantic
- Existing Wireline Andrew Network
Course Experience

- 18-439 Special Topics in ECE: “Advanced ECE Laboratory Techniques: Virtual Laboratory,” Fall 1995
- Wireless capability not yet used
- Will be offered again in Fall, 1996
- Labs will be improved based on experience gained in Fall 1995
Course Goals

• Increase the usefulness of general purpose test instruments
  • Improved understanding of basic capability
  • Virtual instruments
• Explore remote (virtual laboratory) capability
“Black Box” Lab

• Failure has occurred in remote telemetry filter
• Students given correct schematic diagram
• Limited to electrical measurements at input and output ports
• Students must remotely diagnose component failure
Martian Rescue

- Camera positioner failure on Martian Lander
- Students must program a new camera positioner remotely
- Use functioning camera to search for life on Martian landscape
Future Directions

• Add matrix switch, programmable power supply
• Improved real-time audio and video
• Integrate wireless capability into course
• Access via HPIB-LAN gateway instead of PC?
  • low-cost student version of HP-VEE needed
  • Audio/video may need direct LAN connection
Future Directions (cont.)

- Expand to cover more labs and instrumentation
- INTERNET tutorial capability for distance learning
- Virtual INTERNET space for student interactions
- Remote manipulation of objects
Next Generation Virtual Lab

INTERNET gateway

LAN

LAN-HPIB gateway

HPIB

Scope

waveform generator

matrix switch

system under test

power supply

multimeter

AV camera

analog connections

gateway to wireless LAN

Client
Wireless Telelaboratory Access
Virtual Laboratory Paradigm

Virtual Instrument

- Simulation
- Hands-on Laboratory
- Comp. control & reconfiguration

Persistent "virtual space" for human interactions (AV capability)

- Remote Access
- Remote Manipulation of objects
Technology-Based Distance Learning

Prof. Dawn Tilbury, Univ. of MI; Prof. Bill Messner, CMU

- Self-paced study over the World Wide Web
- Advantages of WWW instruction
  - Course materials immediately available
  - Learn by “seeing and doing”
  - On-line educational aids highly interconnected
  - Moving images aid visualization of dynamics
Summary

• Remote experimentation (telelaboratory) paradigm will spread along with telecommuting and teleconferencing
• ECE at CMU has introduced this paradigm to the undergraduate educational experience
• Future directions include extending the concept to additional instruments and distance learning