Analytical Instrumentation

A graduate course (Chem9532a/b)

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Course content

1. Introductions. 1 hr
2. Building a Virtual Instrument 2 hrs
3. Analyzing and Saving a Signal 2 hrs
4. Expanding the Features of a VI 2 hrs
5. Acquiring Data and Communicating with Instruments 2 hrs
6. Using Other LabVIEW Features 2 hrs
7. Using External Code in LabVIEW 4 hrs
8. Case studies 8 hrs
   - Case study 1. Monitoring synthetic procedure in situ
   - Case study 2. Electrochemistry
   - Case study 3. Spectroelectrochemistry
   - Case study 4. Laser photochemistry and photoelectrochemistry
   - Case study 5 Scanning Probe Microscopy
   - Case study 6 PID control in chemical engineering
9. Evaluation. 4-5 hrs

Students will make a VI for their own research, write a report (specification) on the VI and present it to the class.

Why LabVIEW?

Graphical Programming
- Easy to use
- Faster Development Time
- Graphical User Interface
- Graphical Source Code
- Easily Modularized
- Application Builder to create stand-alone executables
- Localized in French, German, Korean, Chinese and Japanese

LabVIEW History

Express 8.6 **2008 - LabVIEW 8.6**
Express 8.2 **2006 - LabVIEW 8.2 Express 20 years**
Express 8 **2005 - LabVIEW 8 Express**
Express 7 2003 - LabVIEW 7 Express
6.1 2002 - LabVIEW 6.1 significant new features like remote panels and event structures
6i 2000 - LabVIEW 6i brings the internet to measurement and automation
5 1998 - LabVIEW 5 connectivity, multithreading
4 1996 - LabVIEW 4 has customizable interface
3 1994 - LabVIEW 3 has add-on toolkits
2 1990 - LabVIEW 2 is now a compiler
1 1986 - LabVIEW 1 introduced on the Mac

Multi-Platform Compatibility

Platform neutral

Migrate applications between platforms

Network-based Measurement & Automation

Your entire Measurement and Automation system can be controlled with LabVIEW locally, or over the Internet

Acquisition with LabVIEW

LabVIEW is completely compatible with National Instruments hardware, and also works with a variety of third party devices

LabVIEW can acquire data by using one or more of the following devices:

- GPIB
- Serial
- Data Acquisition (DAQ)
- Remote Data Acquisition (RDA)
- PCI eXtensions for Instrumentation (PXI)
- Image Acquisition (IMAQ)
- Motion Control
- Real-Time (RT) Board
- PLC (through OPC Server)

Analysis with LabVIEW

Analysis can either be done directly in LabVIEW, or with third party software such as Matlab, HiQ, or C

LabVIEW includes the following tools to help you analyze your data:

- Analysis VIs for Differential Equations, Optimization, Curve Fitting, Calculus, Linear Algebra, Statistics, etc.
- Signal Processing VIs for Filtering, Windowing, Transforms, Peak Detection, Harmonic Analysis, Spectrum Analysis, etc.

Presentation with LabVIEW

Presentation with LabVIEW can be done on your PC or over a network, and you can use third party software like Excel, or DIAdem

LabVIEW includes the following tools to help you present your data:

- On your machine - Graphs, Charts, Tables, Gauges, Meters, Tanks, 3D Controls, Picture Control, 3D Graphs (Windows Only), Report Generation (Windows Only)
- Over the Internet - Web Publishing Tools, Datasocket (Windows Only), TCP/IP, VI Server
- Enterprise Connectivity Toolset - SQL Tools (Databases), Internet Tools (FTP, E-mail, Telnet, HTML)

Course Goals

This course prepares you to:

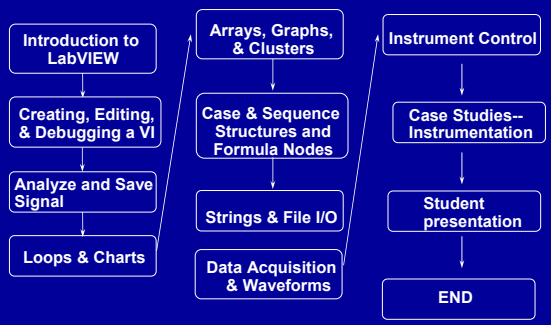
- **Use LabVIEW to create your applications**
- **Use various debugging techniques**
- **Understand front panels, block diagrams, and connectors/ icons**
- **Use both built-in LabVIEW functions and library VIs**
- **Create and save your own VIs so you can use them as subVIs**
- **Create applications that use plug-in data acquisition (DAQ) boards**
- **Create applications that use GPIB and serial port instruments**

Course Non-Goals

It is *not* the purpose of this course to discuss the following:

- **Instrument Circuit Design**
- **Programming theory**
- **Every built-in LabVIEW object, function, or library VI**
- **Analog-to-digital (A/D) theory**
- **The detailed operation of the serial port or GPIB bus**
- **How to develop an instrument driver**
- **The development of a complete application for any student in the class**

Course Map



Lesson 1
Introduction to LabVIEW/Jan 21

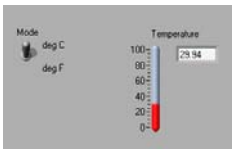
You Will Learn:

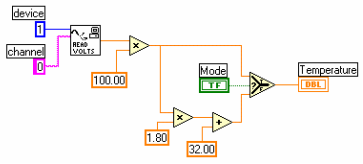
A. What a virtual instrument (VI) is
B. The LabVIEW environment
C. LabVIEW Help Options

Virtual Instruments (VIs)

Front Panel
- Controls = Inputs
- Indicators = Outputs

Block Diagram
- Accompanying "program" for front panel
- Components "wired" together





Hands-on: C to F conversion

Icon/Connector

icon

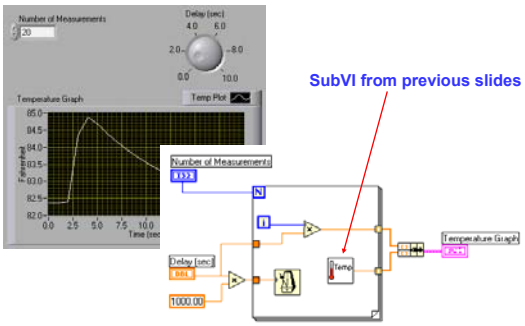
- An icon represents a VI in other block diagrams

terminals

connector

- A connector passes data to and receives data from a "subVI" through terminals

Example: Temperature VI



SubVI from previous slides

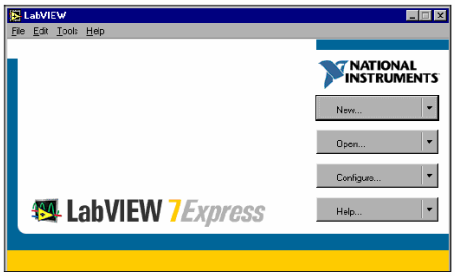
LabVIEW Files

Start menu (task bar)»Programs»
National Instruments LabVIEW

activity	AppLibs	cintools
examples	help	instr.lib
manuals	menus	project
resource	Templates	tutorials
user.lib	vi.lib	www
LabVIEW.exe	LabVIEW.ini	serpdrv

- Keep vi.lib in the LabVIEW directory
- Place items in User.lib or Instr.lib to have them appear in the LabVIEW Control and Function Palettes

LabVIEW Startup Screen



Panel Window

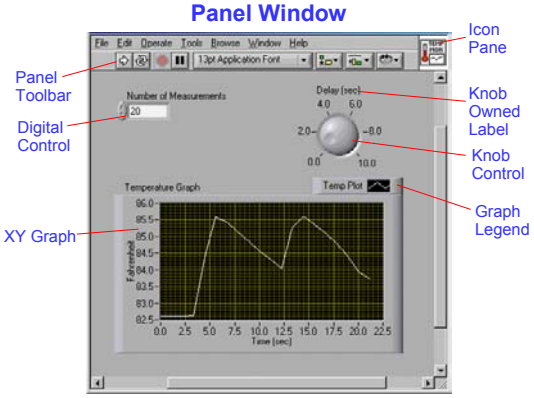
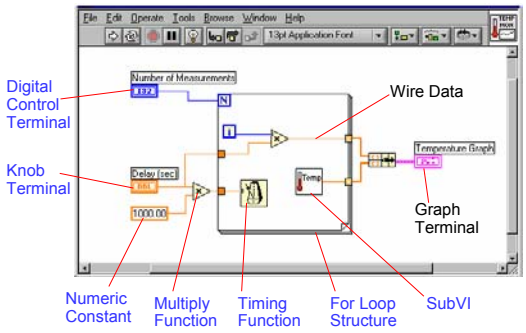
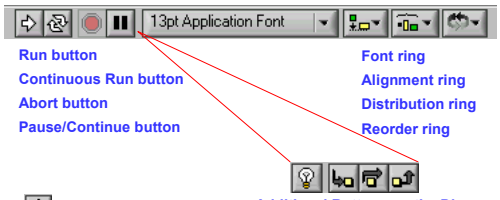


Diagram Window



Status Toolbar



- Run button
- Continuous Run button
- Abort button
- Pause/Continue button
- Font ring
- Alignment ring
- Distribution ring
- Reorder ring
- Warning indicator
- Enter button
- Additional Buttons on the Diagram Toolbar
  - Execution Highlighting button
  - Step Into button
  - Step Over button
  - Step Out button

Menus

- **Pull Down Menus**

- **LabVIEW Shortcut Menus**
  - ***Windows and UNIX*** **- Right-Click on object with mouse**
  - ***MacOS*** **- Hold down open-apple and click with mouse button**

Tools Palette

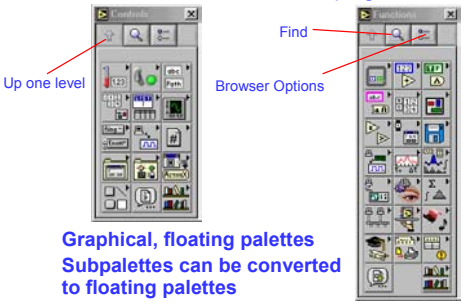
- Editing and Debugging Tools
- Floating Palette

- Automatic Tool Selection
- Operating Tool
- Positioning/Resizing Tool
- Labeling Tool
- Wiring Tool
- Pop-Up Menu Tool
- Scrolling Tool
- Breakpoint Tool
- Probe Tool
- Color Copying Tool
- Coloring Tool

Control and Function Palettes

Controls Palette
(Panel Window)

Functions Palette
(Diagram Window)



Graphical, floating palettes
Subpalettes can be converted to floating palettes

Moving VIs Across Platforms

- LabVIEW automatically translates and recompiles VIs
- File transfer utility mounts a disk from another platform
  - *Windows* : MacDisk and TransferPro
  - *MacOS* : DOS Mounter and Apple File Exchange
  - *Sun* : PC File System (PCFS)

Note: Certain operating system-specific VIs are not portable – for example, DDE, ActiveX, and AppleEvents

Help Options

Show Context Help (Help menu)
- Simple/Detailed Diagram Help
- Lock Help
- Online Help

Contents and Index (Help menu)
- All menus online
- Right-click on functions in diagram to access online info directly

Summary

Virtual instruments (VIs) have three main parts: the front panel, the block diagram, and the icon/connector

The front panel is the user interface of a LabVIEW program and the block diagram is the executable code

Menu options allow you to access different features in LabVIEW

Use shortcut menus to customize any object in LabVIEW. Right mouse click on Windows and UNIX or Command-click for MacOS

Floating Palettes
- Tools Palette
- Controls Palette (only when Panel Window is active)
- Functions Palette (only when Diagram Window is active)

There are help utilities including the Context Help Window and Contents and Index…

Homework: F to C conversion VI