Introduction to LabVIEW

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LabVIEW Product Manager
Our Mission

We equip engineers and scientists with tools that accelerate productivity, innovation, and discovery.
Escalating Complexity Over Time
What We Do

We provide graphical software with modular hardware to build measurement and control systems.
Graphical System Design

A platform-based approach for measurement and control
Graphical System Design

A platform-based approach for measurement and control
Today, We’ll Explore:

<table>
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<tr>
<th>Introduction to LabVIEW</th>
<th>What is LabVIEW?</th>
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<td>Navigating the LabVIEW Environment</td>
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<td>Extending Functionality Through Code</td>
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Questions
Example Application: Air Quality Measurements

- **Potential Sensors Needed:**
  - **Context**
    - GPS
      - Timestamp
      - Position
    - Attitude
    - Altitude
    - Range Finder
  - **Environmental**
    - Temperature
    - Oxygen
    - Carbon Dioxide
    - Ozone
    - Nitrogen
<table>
<thead>
<tr>
<th>Sensor</th>
<th>Interface</th>
<th>Conditioning?</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS</td>
<td>RS232</td>
<td>No</td>
</tr>
<tr>
<td>Attitude, Altitude</td>
<td>RS232</td>
<td>No</td>
</tr>
<tr>
<td>LiDAR</td>
<td>Ethernet</td>
<td>No</td>
</tr>
<tr>
<td>Temperature</td>
<td>Analog Voltage</td>
<td>Required</td>
</tr>
<tr>
<td>O₂, CO₂, O₃, NH₃</td>
<td>Analog Voltage</td>
<td>Required</td>
</tr>
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</table>
# Software Provided With Sensors

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Software</th>
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<tbody>
<tr>
<td>GPS</td>
<td><img src="image" alt="GPS Sensor" /> <img src="image" alt="Software Interface" /></td>
</tr>
<tr>
<td>Attitude, Altitude</td>
<td><img src="image" alt="Attitude Sensor" /> <img src="image" alt="Software Interface" /></td>
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<tr>
<td>LiDAR</td>
<td><img src="image" alt="LiDAR Sensor" /> <img src="image" alt="Software Interface" /></td>
</tr>
<tr>
<td>Temperature</td>
<td><img src="image" alt="Temperature Sensor" /> <img src="image" alt="Software Interface" /></td>
</tr>
<tr>
<td>O₂, CO₂, O₃, NH₃</td>
<td>&lt;No Software Provided&gt;</td>
</tr>
</tbody>
</table>
With a System Like This, How Do You Accommodate…

• …changes in requirements?
• …mixed measurements in a single system?
• …varying connectivity?
• …signal conditioning for sensors?
• …adding or replacing measurements or sensors?
• …incorporating timing, triggering, or synchronization?
• …leveraging emerging technology trends?
• …multiple disparate software environments and APIs?
Architecture of an Integrated Measurement System

LabVIEW is system design software that provides engineers and scientists with the tools needed to create and deploy measurement and control systems through unprecedented hardware integration.

Sensor | Measurement Device | Software
---|---|---
Signal Conditioning | Analog-to-Digital Converter | Driver Software

Application Software
LabVIEW abstracts low-level complexity and integrates all of the tools engineers and scientists need to build any measurement or control system.
Introduction to LabVIEW

System Design Software for Any Measurement Application
Because It Has Been Proven Over Nearly 30 Years…
Withstanding the test of time across operating systems, buses, technologies, and more
…LabVIEW Is the Standard for Making Measurements

Software Used for Data Acquisition and Instrument Control

<table>
<thead>
<tr>
<th>Software</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI LabVIEW</td>
<td>35%</td>
</tr>
<tr>
<td>Microsoft Visual C/C++</td>
<td>20%</td>
</tr>
<tr>
<td>Microsoft Visual Basic</td>
<td>10%</td>
</tr>
<tr>
<td>Microsoft Visual Basic 6.0</td>
<td>5%</td>
</tr>
<tr>
<td>NI - LabWindows™/CVI</td>
<td>5%</td>
</tr>
<tr>
<td>Microsoft C#</td>
<td>5%</td>
</tr>
<tr>
<td>The MathWorks, Inc. - MATLAB®</td>
<td>5%</td>
</tr>
<tr>
<td>NI Measurement Studio</td>
<td>5%</td>
</tr>
<tr>
<td>Agilent VEE</td>
<td>5%</td>
</tr>
<tr>
<td>NI TestStand</td>
<td>5%</td>
</tr>
<tr>
<td>Agilent IO Libraries Suite</td>
<td>5%</td>
</tr>
<tr>
<td>Python</td>
<td>2%</td>
</tr>
<tr>
<td>GeoTest ATEasy</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
<tr>
<td>Don't use</td>
<td>0%</td>
</tr>
</tbody>
</table>
Unrivaled Hardware Integration in a Single Environment

• NI hardware
  • 200+ data acquisition devices
  • 450+ modular instruments
  • Cameras
  • Motion control

• Third-party hardware
  • Instrument Driver Network
    • 10,000+ instrument drivers
    • 350+ instrument vendors
    • 100+ instrument types
  • Communicate over any bus
The Foundation of LabVIEW: Virtual Instrumentation

Automation through software led to a realization about fixed-functionality instrumentation...

**Redundancy: Power Supplies**
Each separate instrument requires its own power supply to run measurement circuitry that captures the real-world signal.

**Redundancy: Displays**
Instrument vendors provide a limited-quality display per instrument, even though monitor technology is far more advanced.

**Redundancy: Processors**
Chip manufacturers rapidly enhance processors according to Moore’s law, but instruments have fixed processing power.

**Redundancy: Memory**
PCs can quickly capitalize on a performance boost from a memory upgrade from readily available RAM.

**Redundancy: Storage**
Each instrument duplicates onboard storage even though PC hard drives are plentiful and cost-effective.
Therefore, LabVIEW Building Blocks Are Called Virtual Instruments (*.VI)

Note: A *.vi file encapsulates all three elements
"SpaceX relies on LabVIEW to help control rocket engine test stands, operate launch pads, monitor and command Falcon rockets and control Dragon spacecraft resupplying the International Space Station. LabVIEW allows a small team of SpaceX engineers to prototype, test and deploy complex control systems quickly and cost-effectively."

Pat Lavezza
Mission Operations Software Engineer
Therefore, LabVIEW Building Blocks Are Called Virtual Instruments (*.VI)

LabVIEW Front Panel
The user interface of a VI

LabVIEW Block Diagram
The source code of a VI

Note: A *.vi file encapsulates all three elements
With LabVIEW, You Can Program the Way You Think

Diagram:

1. Get User Input
2. Initialize System
3. Wait for Trigger
4. Repeat 100 Times
   - Acquire Strain
   - Obtain Frequency
   - Loop Time
     - Higher than 100 Hz?
       - No
       - Yes: Exit
     - Output to Value
5. Email Notification
With LabVIEW, You Can Program the Way You Think

The graphical, dataflow-based G programming language is ideal for programming parallel data acquisition hardware.
Demonstration
Leveraging the LabVIEW Ecosystem

LabVIEW Tools Network
- 1,000,000+ Add-Ons Downloaded
- 26+ Certified Add-Ons
- 100+ Available Add-Ons

User Community
- 9,000+ Certified Users
- 700+ Alliance Partners
- 60+ Registered User Groups

Modules and Toolkits
- 40+ Toolkits and Modules Including:
  - LabVIEW Real-Time Module
  - LabVIEW FPGA Module
  - LabVIEW Embedded Module for ARM
  - LabVIEW Touch Panel Module
  - LabVIEW Wireless Sensor Network Module
  - LabVIEW C Code Generator
  - NI Real-Time Hypervisor
  - Vision Development Module for LabVIEW
  - Sound and Vibration Measurement Suite
  - Sound and Vibration Toolkit
  - LabVIEW Advanced Signal Processing Toolkit
  - LabVIEW Adaptive Filter Toolkit
  - LabVIEW Digital Filter Design Toolkit
  - LabVIEW MathScript RT Module
  - Spectral Measurements Toolkit
  - Modulation Toolkit for LabVIEW
  - LabVIEW Robotics Module
  - LabVIEW Biomedical Toolkit
  - ECU Measurement and Calibration Toolkit
  - GPS Simulation Toolkit for LabVIEW
  - Measurement Suite for Fixed WiMAX
  - WLAN Measurement Suite
  - Automotive Diagnostic Command Set
  - LabVIEW GPU Analysis Toolkit
  - Multicore Analysis and Sparse Matrix Toolkit
  - LabVIEW PID and Fuzzy Logic Toolkit
  - LabVIEW Control Design and Simulation Module
  - LabVIEW System Identification Toolkit
  - LabVIEW Simulation Interface Toolkit
  - LabVIEW SoftMotion Module
  - LabVIEW Datalogging and Supervisory Control Module
  - LabVIEW Report Generation Toolkit for Microsoft Office
  - LabVIEW Database Connectivity Toolkit
  - LabVIEW DataFinder Toolkit
  - LabVIEW SignalExpress
  - LabVIEW VI Analyzer Toolkit
  - LabVIEW Statechart Module
  - LabVIEW Desktop Execution Trace Toolkit
  - NI Requirements Gateway
  - NI Real-Time Execution Trace Toolkit
  - LabVIEW Unit Test Framework Toolkit
  - LabVIEW Application Builder for Windows
Questions