Learning by Doing with National Instruments Development Boards

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Preface

LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) is a platform and development environment for a visual programming language from National Instruments. The graphical language is named “G.” Originally released for the Apple Macintosh in 1986, LabVIEW is commonly used for data acquisition, instrument control and industrial automation on a various platforms including Microsoft Windows, various flavors of UNIX, Linux and Mac OS X.

LabVIEW integrates the creation of user interfaces (termed front panels) into the development cycle. LabVIEW programs-subroutines are termed virtual instruments (VIs). Each VI has three components: a block diagram, a front panel and a connector panel. The last is used to represent the VI in the block diagrams of other, calling VIs. The front panel is built using controls and indicators. Controls are inputs; they allow a user to supply information to the VI. Indicators are outputs; they indicate, or display, the results based on the inputs given to the VI. The back panel, which is a block diagram, contains the graphical source code. All of the objects placed on the front panel will appear on the back panel as terminals. The back panel also contains structures and functions which perform operations on controls and supply data to indicators. The structures and functions are found on the Functions palette and can be placed on the back panel. Collectively controls, indicators, structures and functions will be referred to as nodes. Nodes are connected to one another using wires, e.g. two controls and an indicator can be wired to the addition function so that the indicator displays the sum of the two controls. Thus a virtual instrument can be run as either a program, with the front panel serving as a user interface, or, when dropped as a node onto the block diagram, the front panel defines the inputs and outputs for the node through the connector pane. This implies each VI can be easily tested before being embedded as a subroutine into a larger program.

The graphical approach also allows nonprogrammers to build programs by dragging and dropping virtual representations of lab equipment with which they are already familiar. The LabVIEW programming environment, with the included examples and documentation, makes it simple to create small applications. This is a benefit on one side, but there is also a certain danger of underestimating the expertise needed for high-quality G programming. For complex algorithms or large-scale code, it is important that a programmer possess an extensive knowledge of the special LabVIEW syntax and the topology of its memory management. The most advanced LabVIEW development systems offer the ability to build stand-alone applications. Furthermore, it is possible to create distributed applications, which communicate by a client–server model, and are thus easier to implement due to the inherently parallel nature of G.

One benefit of LabVIEW over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices. The provided driver interfaces save program development time.

Chapter 1 includes a brief glimpse of LabVIEW, virtual instrumentation, the relationship between VI and LabVIEW, basics of LabVIEW which includes a user interface and the front panel, with controls and indicators. Controls are knobs, push buttons, dials and other input devices. Indicators are graphs, LEDs and other displays. This chapter also includes programming with LabVIEW which consists of arrays, loops, clusters, structures, plotting of data, etc. The chapter will also feature how to install the software and license setup.

Chapter 2 describes the various board configuration setups. There are three different configurations, namely NI SPEEDY-33, NI ELVIS and myRIO. This chapter will explain in detail the different configurations and the differences between each of them.

Chapter 3 gives hands-on experience of performing experiments on the NI SPEEDY-33 board. This chapter includes various basic experiments like interfacing the board with LEDs, switches, keypad, digital filter design, modulation, audio signal processing (echo, reveberation) and creating digital music.

Chapter 4 includes various experiments performed using the NI ELVIS board. These include experiments like 4-bit adder, traffic light control, digital thermometer and hearing aid.

Chapter 5 describes basic experiments performed on myRIO. The basic experiments include keypad interfacing, pushbutton switch interface, LED interfacing, seven-segment LED display, UART, SPI and I2C interface.

Authors

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Ingrid Anne Nazareth, born in Sharjah, UAE, is currently working as assistant professor in the Department of Electronics at Goa University, India. She completed her PhD from the same university with the thesis titled "Estimation of Human Blood Cholesterol." She completed her Masters in Electronics having secured first place and is an awardee of the "IV SERC School in Physics Gold Medal." She was appointed a project fellow in the project "Design of Hyperspectral Smart Sensors Using Soft-Core Processors and IP Cores." She was also a visiting faculty at the Goa University. Her research interest is in the field of biomedical electronics. She has attended a number of national symposiums and conferences where she has presented her research work.

Dr. Rajendra S. Gad is professor of Electronics at Goa University. He received BSc (Physics) and MSc (Electronics) degrees from Goa University in 1995 and 1997 respectively. He worked for his PhD in areas of non-invasive measurements to understand problems of human body glucose measurement in 2009. His group was judged winner in Indiato design LC3 processor at Mentor Graphics University Design Contest 2010. He established MOU with AlTERA Inc. USA under a university program to develop an FPGA SoC laboratory. His areas of interest are micro-UAVs, real time system verifications, smart sensors systems, signal processing and networks. He has co-authored two books in the area of embedded systems published by Springer and Lambart Publishing.

Prof. Gourish Naik (Dean Faculty of Natural Science, Head Department of Electronics) obtained his PhD from the Indian Institute of Science, Bangalore (1987) and served the institute as research associate in the areas of Opto-electronics and Communication until 1993. For the last 25 years, he has been associated with the Goa University Electronics Program. He is the founding head of the University Instrumentation Center and established fiber optic LAN and wireless communication networks at Goa University. He was also the coordinator of DEITI (an educational broadcast studio supported by Indian Space Research). His other commitments are regulating the digitization center at Goa University to support the various digital repository projects like DIGITAP (Digital Repository for Fighter Aircrafts Documentation) of the Indian Navy, the Million Book project of Ministry of Information Technology and Antarctica Study Center (NCAOR). He has to his credit around 50 odd research papers published in international journals and has presented research works at various national and international forums. He has delivered several key note addresses and has been invited to talks at various institutes and also authored four books on embedded systems and allied areas published by Springer, Lambert, etc. He was a member of Goa State Rural Development Authority and also advisor for Directorate of Education. He is governing body member of the engineering college of Goa and also a member of the faculty board of Goa University. Presently he is head of the Electronics Department at Goa University.