Chapter 8
On the Experience of Using NI ELVIS III in Remote Laboratory Practice During Pandemic Lockdown

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Abstract By the beginning of COVID pandemic, remote education technology have was being implemented at some level by almost every educational institution, but the following lockdown forced the world to accelerate this process. In these circumstances, a lack of laboratory practice in online engineering education was revealed. The existing lab equipment, even quite modern, was focused on offline laboratory experience, and required enough efforts to be reachable from the outside. The International Scientific and Educational Center "National Instruments – Polytechnic" possessed a number of virtual instrumentation lab stations called NI ELVIS II, which had been being used in education for more than 10 years and allowed the replacement outdated bulky instruments with computer-based all-in-one virtual measurement solutions. But even these devices required additional development to allow students to work remotely, did not allow them to work in groups and manage access control. The new product applied by our professors called NI ELVIS III appeared to be a perfect solution to establish online lab practice. We managed to run several labs in electronics course with almost zero configuration, group collaboration and possible real-time teacher supervision. The paper describes the experience of applying NI ELVIS III in remote electronics lab, the benefits and caveats of using this platform.

Keywords Remote educational laboratory · NI ELVIS III

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8.1 COVID Lockdown Remote Education Issues

8.1.1 Prior Circumstances

As for the beginning of 2021 one can take an easy outlook at the evolution of COVID pandemic lockdown issues the world faced with in 2020. It was a major challenge for almost all the economy industries, especially for uninterruptible production processes, but finally for everyone.

Before the beginning of the pandemic most of the academic institutions used the remote educational technologies as a helpful tool supporting the offline course program [1–6]. Even if the institution did not adopt any centralized platform like Moodle e.g., the professors and students used cloud storage, messengers, and video meetings to communicate, interchange the materials and works and reduce the need of meeting in person. For some educational programs, like philosophy, law, history, etc. remote education platforms allowed the totally remote higher education without even visiting the University campus. But for natural sciences and engineering it was never an option to substitute the offline lab practice with remote education technology. But lockdown has shifted priorities, demanding a quick solution to the absence of an offline laboratory practice [7–18].

8.1.2 Using Virtual Instruments

Institute of Physics, Nanotechnology and Telecommunications of Peter the Great St. Petersburg Polytechnic University applied the virtual instrumentation teaching labs more than a decade before. It was relying on the NI ELVIS II [19] base stations with interchangeable lab circuit boards and engineering software like NI LabVIEW, Multisim etc. (Fig. 8.1) [20, 21]. It was a big leap from analogue bulky instruments with fixed functionality to a modern digital programmable flexible solution, allowing the educational process to expand from just observing physical phenomena to advanced experimental technology, measurement automation and process control, as in large physics facilities such as the LHC, ITER and others.

But those virtual instruments were not created for connected world and are not 100% ready for remote access. However, being a part of computer-based system, ELVIS II can be used as remote lab base with some commercial PC remote access solution, like AnyDesk or TeamViewer. This would require certain additional efforts to manage the access control, information security, and, of course, the third-party software licenses.

Fig. 8.1 Computer-based virtual instrumentation workstation using NI ELVIS II platform

8.2 NI ELVIS III for Remote Education Tryout

8.2.1 The Paradigm

In the end of 2019 the International Scientific and Educational Center "National Instruments – Polytechnic" at the Institute of Physics, Nanotechnology and Telecommunications of Peter the Great St.Petersburg Polytechnic University purchased a unit of new NI ELVIS III [22] platform (Fig. 8..2). This platform includes both the evolution of NI ELVIS II and totally different hardware and software architecture, that makes it ideal base for remote online education.

While NI ELVIS II platform relied a on data acquisition (DAQ) board, which required a PC with the ELVISmx driver installed (3.45 GB distributive size as for 2019 version), NI ELVIS III contains an NI RIO standalone controller inside with a webserver running on it. It results in browser-based instruments interfaces with no software installation requirements and no platform limitations.

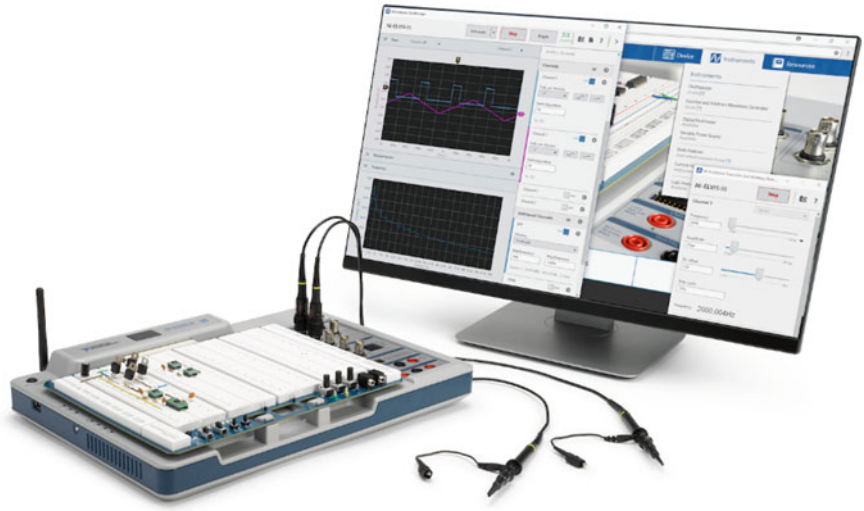

Fig. 8.2 NI ELVIS III with online web-based interface

8.2.2 Hardware

Compared to NI ELVIS II as an instrument, the new ELVIS III brings several improvements like more measurement channels, wider range, and new measurement types. The comprehensive comparison is shown in Table 8.1.

Additionally, the onboard real-time controller and FPGA allow the implementation embedded systems, such as IoT prototypes, fast control systems, long-time process registrations and many more [23]. This requires additional competencies in FPGA and RT programming, which National Instruments—Polytechnic International Science and Education Centre teaches students and engineers, but these capabilities are beyond the scope of this paper.

8.2.3 Basic Remote Access

The main advantages for fast rollout of the online educational laboratory are web-based interfaces, rich connectivity, standalone functioning, and multiple user simultaneous access to a single device. So, in the default approach the NI ELVIS III requires no additional configuration, no software installation on teacher's or students' workstations. While being connected to the internet, NI ELVIS III establishes a secure connection to https://measurementslive.ni.com/. The tiny display on the top of the device shows a temporary code, which a professor sends to students no matter where they are, and they can connect to the instruments of the station in groups, controlling or observing the measurements.

Table 8.1 The comparison of two generations of the NI Education platform

	Legacy NI ELVIS II/II+	**NI ELVIS III**
Oscilloscope	2 ch, 1.25 MS/s, 10 bits (100 MS/s for II+)	4 ch, 400 MS/s, 14 bits
Function generator	1 ch, 5 MHz, 10 bits	2 ch, 100 MS/s, 15 MHz, 14 bits
Logic analyzer/pattern generator	–	16 ch, 100 MS/s
IV Analyzer	–	± 10 V, ± 30 mA, 15 MHz
Digital multimeter	5½ digits	4½ digits
Variable power supply	± 12 V, 500 mA	± 15 V, 500 mA
Processor FPGA	–	Xilinx Zynq-7020
AI/AO	16 ch, 16 bits/2 ch, 16 bits	16 ch, 16 bits/4 ch, 16 bits
DIO	24 DIO, 15 PFI	40 ch
OS Support	Windows	Windows, Mac, Web
Connectivity	USB 2.0	USB Type-C, Ethernet, Wi-Fi
Programming Language support	LabVIEW	LabVIEW (Including Real-Time and FPGA), Python, C, Simulink

8.2.4 Advanced Remote Access Management and the Experience

If this zero-config access does not satisfy the needs of the laboratory in terms of access control, there is a possibility to get more flexible solution. It requires to install and configure a tiny Linux-based daemon called Signaling Server and edit configuration files on the ELVIS III stations. The Signaling Server gives a remote control of the whole lab of ELVIS III to a professor, setting the time of access, resetting the temporary access codes for students etc.

We applied this approach at the International Scientific and Educational Center "National Instruments – Polytechnic" and ran a series of lab practices in electronics course in 2020. That experience verified the described approach consistency. The work in student teams was easy and efficient. No software was installed on the student workstation, and no software platform dependency was noticed. The students even could connect and participate in lab practice using their smartphones, which was not expected to happen.

8.3 Conclusion

The pandemic lockdown has shown that laboratory practice in science and engineering education is not quite ready for online learning. The existing lab instruments, even the digital ones, are not perfectly suitable for remote access. Even with certain additional configuration, the access in groups remains challenging.

The tryout of NI ELVIS III lab station has shown that it is a perfect way to transform many labs into online. It is a standalone, basically zero-config, platform-independent solution, that we managed to implement easily in lockdown circumstances. Our experience should be expanded to other labs of our Institute and even to other Universities, because the remote education is supposed to take bigger part in upcoming years.

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