Volodymyr Voytenko, Alexander Pisarevskiy
Department of Automatic Control, Lund University

Remote Laboratory for Training in Safety Controller Applications

Education is fundamentally based on the knowledge acquired by previous generations of scientists. The specificity of engineering education lies in the fact that a future developer of new technology, in addition to a solid theoretical foundation, must acquire practical skills working with samples of those artificial technical objects they will deal with shortly after completing their education. The acquisition of practical experience for future engineers mainly occurs through laboratory classes and, in some cases, directly at the study objects. However, there are challenges that complicate classroom work and, in some cases, even make it impossible for students to be physically present in the educational laboratory. One such challenge caught humanity off guard during the recent Covid-19 pandemic [1]. Another challenge is being fully experienced by Ukraine. However, no other country in the world can be confident in its future when international law is gradually collapsing. The era of turbulence into which the modern world is descending requires non-trivial solutions in various spheres of social life, including engineering education.

In [2], the following alternatives for organizing training laboratories based on the use of online technologies are highlighted: *Virtual Labs* and *Remote Labs*. While the first case uses a simulation of a traditional laboratory, the second uses real physical objects with remote access to them in real time.

The dispersion of students and teachers involved in engineering education is a pressing task that needs to be addressed in advance by planning a multi-variant implementation of the educational process.

The acquisition of theoretical knowledge is mostly an individual process, during which a person can listen to a lecturer, watch video materials, read textbooks, solve problems, and demonstrate acquired skills. Modern computer technologies often allow this to be done better than traditional classroom work. After all, each student assimilates information in their own individual way. The use of distance learning allows students to independently schedule their work, as well as choose both the sources of information and the pace of their study, to ensure that the individual successfully completes the course and demonstrates the learning outcomes provided by the educational program.

A more complex issue is the acquisition of practical skills by future engineers [3]. On the one hand, individuals have an inherent desire to independently organize their daily schedule. The use of a certain educational equipment at home allows this problem to be addressed. However, not every educational setup can be provided to students for individual work and used at home. Therefore, another task arises: the implementation of a stationary educational laboratory in such a way that the participant in the educational process can be physically located at any distance from the educational institution. In this case, additional opportunities arise for sharing material resources between different organizations (both educational institutions and enterprises – potential employers of the graduates of these institutions). This sharing reduces costs for both the development and acquisition of educational equipment, as well as its operation, since it reduces the range of devices and increases the degree of specialization of the maintenance personnel.

Let's consider the combination of distance education opportunities with practical research of a technical object using the example of a prototype of a Remote Educational Laboratory for the study of industrial controllers, which is being developed by the Department of Automatic Control at Lund University (Sweden) in collaboration with the Department of Electronics, Automation, Robotics, and Mechatronics at the Chernihiv National Polytechnic University (Ukraine).

The skills of mechanical connection or electrical switching of components of a certain technological object, which may be mandatory for an operator working on this object, are not as necessary for an engineer, whose main tool is the brain, not the hands. Everyday life allows anyone to navigate space and perform certain actions with technical objects at a household level. The use of computer technologies that provide remote access to physical objects allows participants in the educational process not only to observe but also to actively influence the experiment and take measurements, thus gaining practical skills in interacting with technology.

As an object for remotely acquiring practical skills in programming of safety controllers (industrial applications) is offered lab setup based on Sick Controller [4] (Fig. 1).

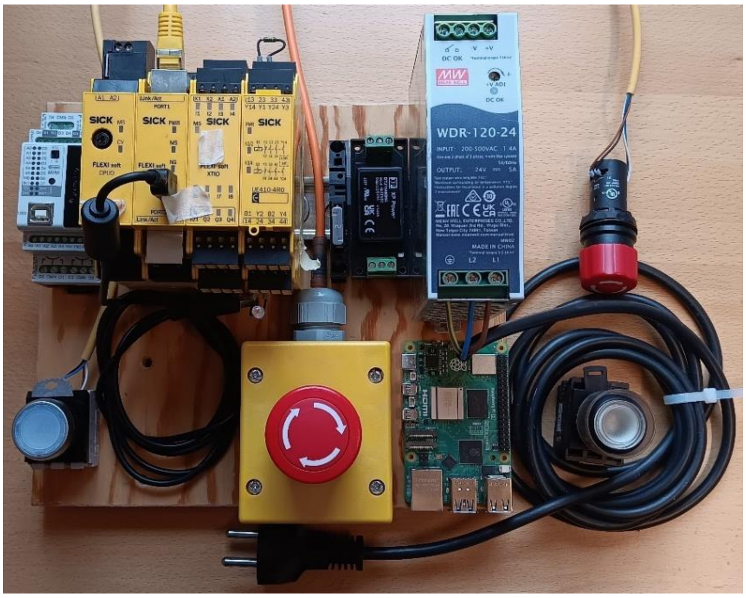

Fig. 1. Main hardware components of the remote lab

Setup also includes single-board computer Raspberry Pi 5 (SBC), which is used as a server for accessing of the system via Internet, reprograming of safety controller, support of video stream for user and sending commands to CONTROLLINO MINI controller [5].

The main software installed on the SBC (OS Linux, web server, Wine compatibility layer, Sick Safety designer, and mjpg-streamer) enables remote connection to the lab setup. It allows the adjustment of the safety controller using the Sick visual programming language, emulation of various input signals via CONTROLLINO and monitoring of the results through a web camera.

As an outcome, the user should be able to access the laboratory setup remotely using e.g. VNC Viewer. In the next step, the student can create a project and upload it to the Sick Controller according to the assigned task, using Sick software in the same manner as if the safety controller were physically nearby. By activating the CONTROLLINO's sketch, the user can emulate signals from various types of safety equipment (E-Stop buttons, safety scanners, etc.). The feedback from the safety controller can be verified against the expected results through online monitoring in Sick Safety Designer and by observing the system via the web camera. This dual-verification approach will support students in developing practical skills for future work in real-world environments.

References:

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