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RemoteLabs: Different approaches

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Summary. — The workshop was focused on different possible approaches to the remote control of laboratory equipments aimed at experimental science teaching.

PACS 01.50.-i – Educational aids.
PACS 01.50.F- – Audio and visual aids.

1. – RemoteLab

With the term "RemoteLab" we mean a computer-controlled apparatus, usually located at some research institute or university, that is made usable to external users through an internet connection.

The reason for creating a RemoteLab is manifold: some apparatuses are very expensive, or they require special skills not easily available, and therefore they are not accessible to the major part of potential users.

Let us make some examples: electronic microscopes or scanning probe microscopes, telescopes or radio telescopes, but also educational complex apparatuses such those made to study the electron diffraction or the photoelectric effect, are rarely used in standard teaching because the costs for purchase and maintenance are excessive, or because they cannot be used by a large number of students in parallel.

During the workshop three different methods for setting-up a RemoteLab were presented.

1˙1. *RCL.* – Hans Jorg Jodl and Sebastian Gröber, from Kaiserlautern University, illustrated the Project named RCL (`http://rcl.physik.uni-kl.de`, developed in collaboration with several partners in Germany) which offers many experiments remotely controlled using the same technique: free access to a web-page with a list of experiments where the user, after reading and the introductory explanations and theoretical background, may setup the remote apparatus and perform the chosen experiment by acting on buttons on the page that control the remote actuators; real data may be collected and

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analyzed by the user. Even if the selected RCL is controlled by another user, the running experiment and the collected data may be observed by other user who have access to the remote webcams and to the collected data output.

The examples shown during the workshop were: 1) measurement of the light speed using short LED pulses reflected by a mirror at variable distances and detected by a fast photo detector, by observing the time-delay of the reflected pulse with respect to the emitted pulse on an oscilloscope screen; 2) measurements of light intensity patterns produced by laser light beams diffracted by various slits.

This approach requires setting up an apparatus totally controlled by a PC (using suitable actuators and sensors) and then building a special web-page with the Java-code that converts the user clicks into signals passed to the actuators, and displays the experimental data output on the web. This technique offers a RemoteLab completely automatized, that does not requires assistance of local staff.

1˙2. *Home-made RemoteLab*. – Giacomo Torzo and Paolo Peranzoni, from Padova University, demonstrated how easy can be to remotize a computer-controlled apparatus by using free VNC (client/server) software and a remotely-controlled webcam.

They illustrated this simple approach by remotely controlling a Scanning Probe Microscope (NanoEducator SPM) that allows AFM/STM topography and microlithography.

This method, however, requires assistance of local staff (to accept internet connection requested by user, to start the apparatus, to place the samples and to monitor the user's actions to avoid potential danger to the SPM). The communication between the local assistant and the remote user is provided by audio/video connection through Skype: the user is guided to install the VNC-client software, to learn controlling the SPM, and to drive the webcam for observing the details of the remote laboratory.

1˙3. *WeColLab*. – Antonella Longo and Mario Bochicchio, from the Salento University, illustrated a package named *WeColLab*, specially developed to remotely control any experiment, while offering the maximum flexibility to the user. This approach requires setting up a complex hardware/software system, but it allows, for example, controlling several apparatuses in parallel, and multipoint audio-video communications, parallel-access of users at different level of privileges... Also this method needs local staff assistance that guides the users during the sessions of internet connections.

During the workshop the example chosen to illustrate various features of this approach was the remote control of a Scanning Electron Microscope (SEM).