Prof. Pasquale Daponte
Responsible for the Project
"Laboratorio Didattico Remoto Italo-Croato Distribuito
su   Rete Geografica"
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Zagreb, May 13th, 2010.

Dear Professor Daponte,

We are glad to declare that the objectives of the project "Laboratorio Didattico Remoto Italo-Croato Distribuito su Rete Geografica" (Italian-Croatian Remote Educational Laboratory Distributed on Geographically Network) were fully fulfilled.

This project gave the opportunity to experience new technologies in an international cooperation. In particular, the project gave the opportunity to enforce the already long cooperation with some Italian Universities.

The common educational activity in the field of electrical and electronic measurements produced a set of courses that are included in the Croatian educational system at University of Zagreb, University of Split, and in the Italian educational system at University of Sannio, University of Calabria, and University "Mediterranea" of Reggio Calabria. The developed system is available at http://www.misureremote.unisannio.it:7001/.

In the Annex the details about the tasks performed and the results obtained are reported.

With regards,

Dean:

Prof. Vedran Mornar Ph.D.

Annex

Management and dissemination of the results.

Cooperation between Italian Universities and University of Zagreb was commenced on the basis of common need for remote laboratories. Courses that could take part in the remote laboratory system were chosen and plans for administrative and technical part of the work were realized. By providing administrative and technical support for exchange of the education resources, a firm basis for dissemination of the results among students and teaching personnel was created.

Planning and design of the Remote Laboratory.

To eliminate the formal barriers for the exchange of knowledge and resources (equipment, experiments, teaching materials and underlying services) several tasks were performed:

a) Multilingual operation. Experiments that support multilingual user interface were designed and implemented, including new and already developed ones. Learning Management System (LMS) was changed in order to support work in Italian, Croatian and English language, but also to provide support for potential new languages that could use realized laboratory.

b) To enable exchange services like remote laboratory functionality among universities a common administrative infrastructure is required. Management of the user rights has to be performed on domicile university or faculty, while enrolment rights for common courses has to be regulated on the basis of courses. Widely used open source LMS Moodle was used to support exchange of user rights among universities. The Moodle was installed and optimized to support work with the original LA.DI.RE. platform and additional services were developed to support required functionality.

c) To enable fully "of the shelf" operation of the laboratory, particular accent was put on the design of the courses supporting remote laboratories. Guidelines in a form of a practical learning model had to be created to enable inexperienced personnel to use the laboratory effectively.

Implementation, development and testing of the laboratory.

The optimization of the "LA.DI.RE. "G.Savastano" was carried out to improve the laboratory and enhance its usability in education. The optimization was performed at multiple levels: the advanced experiment design, the testing of the remote laboratory in comparison with the hands-on, the technical improvement of the architecture and the functionality of the system, the development of a model for integration of the remote laboratories in electrical engineering courses and the realization of the mobile remote laboratory system. The analysis of the advantages and drawbacks of the remote laboratory was performed first. The factors that influence the remote laboratory effectiveness were identified and theoretical background for the testing was prepared. Thereafter the advanced experiment design which enhances the usability of the

remote experiments was realized. Showed on the example of the Magnetic Measurements experiment, this design includes adaptive multilingual user interface with automatic feedback and flow control, optimal video link and integration with LMS with results retrieval. After that the testing of the remote laboratory in comparison with hands-on was conducted. Croatian and Italian students took part in this testing. Analysis of the testing results showed numerous advantages of the remote laboratory system and a pedagogical effectiveness similar to the effectiveness of hands-on labs. Other critical aspects of remote laboratories were identified and they were used for the creation of the model for integration of remote laboratories in the courses that need them. Several services that increase the usability of the laboratory in engineering courses were added to the "LA.DI.RE. *G.Savastano*" architecture. Those are: module for administration of the remote experiments, the module for reservation of operating time, the system for retrieval of the experiment results and the integrated video link. Several recommendations for the future improvement of the laboratory were also presented, although recommended solutions are out of the project's scope.

Mobile Remote Laboratory was also realized. Optimized to work on as much devices as possible, it does not require any particular software or plug-in except mobile browser. It uses Moodle as the LMS and the same hardware as the normal remote laboratory. Moodle LMS was modified to enable effective presentation of learning content on handheld devices. Additional functionalities were added to enable simple and transparent use of the system in electrical engineering courses. System was tested and the bandwidth consumption is satisfactory low, which enables the use of the system even with slower connections.

Finally, the Model for Integration of Remote Laboratories in Courses that use Laboratory and E-learning system (MIRACLE) was created. Model is based on user requirements obtained by the laboratory testing and the use of the Quality Function Deployment method. Findings of the learning theory applied to electrical engineering were analyzed and applied in that model. MIRACLE model raises effectiveness and usability of the remote laboratories by providing technological solutions for the concrete needs of the students and teachers in such an environment. System designed by the MIRACLE model was tested by the students and evident improvements were achieved.