

Oponent Review

Doctoral Thesis

Author:	Michal Krbeček, MSc.
Title:	Creation and administration of research remote laboratories at EU level
Study programme:	Engineering informatics
Field of study:	Engineering informatics
Tutor:	Asoc. prof. Dr. Miroslava Ožvoldová, PhD. Prof. Dr. František Schauer, DSc.
University:	Tomáš Baťa University in Zlín, Faculty of Applied Informatics
Scope of work:	117 pages, 49 images, 1 table, 80 bibliographic links and list of 22 author publications

The oponent review was drawn up on the basis of appointment by the opponent, by the letter of dean of the Faculty of Applied Informatics, Tomáš Baťa University in Zlín from day 11.9.2017.

Presented dissertation work contains 6 chapters, list of references, attachment, author's publication activities and curriculum vitae. The work is clear, the solved problems are explained in details and logically arranged. Formally, the work is processed in high quality.

The dissertation work deals with the technically aspect very interesting and highly topical issues in the field of remote laboratories. The current society is characterized by sharing resources and activities over the internet and increasing visualization in the area of information and communication technologies. This also includes the sharing of scientific information from remote experiments conducted in remote laboratories. The solved issue is current and belongs to the study department of Engineering informatics.

The objectives of the dissertation are described in the Chapter 2. They are focused on the design and creation of a complex software solution for remote laboratories. The dissertant focused its interest on introducing new remote labs, creating a development environment for remote laboratories, designing and optimizing remote laboratories for mobile devices, setting up a diagnostic server for remote experiments, and designing remote management laboratories. All the objectives of the dissertation are fulfilled.

The selected methods and the procedures for solving problems in remote laboratories are suitably chosen and the dissertant successfully solved a number of partial problems related to the solution of the given issue.

The dissertation is focused mainly on the creation of a complex system for remote laboratories, which will serve as a global tool for experimental administrators, as well as for the end-users. Dissertant has created a new remote experiment management environment called "Easy Remote Laboratory" (ERL). This environment will make it possible for the system to be used by ordinary users and will allow remote labs to be created without the knowledge of programming. As a result of the massive expansion of mobile devices, the dissertant has implemented several functionalities to provide a remote control environment for mobile devices. I also want to highlight the contribution of the dissertation in designing the RemLabNet management system for managing users and administrators of remote laboratories.

The dissertant has demonstrated through his work that he is able to solve challenging technical and scientific problems and that he successfully uses and controls methods of scientific work at the current world level. This is confirmed by the invitation of the dissertant by the Dean of the Faculty of Engineering and Information Technologies at the University of Sydney, Australia, as a visiting researcher, presenting the partial results of his dissertation.

In my opinion, the dissertation is a great asset for remote laboratories. The proposed methods of the dissertant have also practically verified what I consider to be of great benefit.

I have the following questions to work:

1. How is the remote availability of remote laboratories available to the user and what does it ensure?
2. How do you see the future of remote laboratories?

Final evaluation:

I consider the dissertation "Creation and administration of research remote laboratories at EU level" to be excellent. The thesis provides a complex solution of a defined problem with practical verification and application of theoretical knowledge into real form. The presented work fulfills all the requirements for dissertation work. The author has solved a number of partial problems, demonstrating the ability of independent creative research and development.

On the basis of the doctoral thesis and the list of publishing activities, I can state that the doctoral candidate has fulfilled the requirements for doctoral thesis and therefore I recommend it for defense and after successful defense to grant to Michal Krbeček, MSc. a title Ph.D. in the study field of Engineering informatics.

In Košice, 9. 10. 2017


Assoc. prof. Peter Frankovský, PhD.

**prof. Ing. Mikuláš Huba, PhD.
Slovak University of Technology in Bratislava
Faculty of Electrical Engineering and Information
Technology
Institute of Automotive Mechatronics**

Review of the Doctoral Thesis

Michal Krbeček, MSc.

**Creation and administration
of research remote laboratories at EU level**

**Bratislava
20.10. 2017**

Content

Besides of abstracts written both in English and Czech, the submitted thesis written in English consists of lists of figures, tables, attachments, symbols and abbreviations, introduction, goals of the thesis, 3 chapters defining the used methods and principles, main results of the work and contributions of the work, conclusions, references, attachments, publication activities of the author and Curriculum Vitae.

The introductory State of art explains basic motivation for studying problems of Remote laboratories (RL). It also briefly enumerates relevant literature sources and outlines basic types of RL classified according to:

- (i) the interaction level,
- (ii) the scheduling model,
- (iii) the used technologies.

Next subsection 1.2 European labs introduces as examples RL at the Faculty of Education University in Trnava, WebLab at the University of Deusto, UNILabs at the Spanish University for Distance Education UNED, Visir at BTH (Blekinge Institute of Technology) in Sweden and iSES e-Laboratory Project at the Faculty of Mathematics and Physics Charles University (MFF UK) in Prague. After introducing the Remote Laboratory management systems (RLMSs) with examples of iLab Shared Architecture, and Sahara it again comes to examples of European RLMSs represented by WebLab-Deusto, Lab2go, NETLab project and RVLab. At this place one has to ask, if it would not be more effective to merge the subsections introducing different RL with characterizing their RLMSs.

The last subsection of this introductory part deals with federalization, i.e. with sharing the local resources by several institutions in an international context and tries to identify basic setups existing in such situations.

Goals of the PhD thesis

Goals of the thesis are focused on the design and creation of a software solution for the remote laboratories that should cover their creation, administration and operation in an international context. This task was divided into followings goals:

1. Bringing RLs to a layman in the field – focused on spreading the remote laboratories by a new procedure for their creation.
2. Creating remote laboratories development environment – devoted to design of a new development environment for creation of remote laboratories.
3. Enabling RLs to mobile devices – dealing with design and optimization of RL by using mobile devices.
4. Setting up the diagnostic server for the remote experiments – proposing a robust diagnostic server to increase reliability of RLs.
5. Designing the remote laboratories management system – providing functions for the management, sharing and features enrichment of remote laboratories at an international level.

Actuality of the topic

The motivation of the thesis is clearly explained in the State of the art chapter and documented by the survey of the references. However, some aspects as, for example, federalization, are questionable and deserve a broader discussion. On the one hand, some institutions (as, for example, FernUniversität in Hagen, which is running remote

labs for two decades), do not have high interest in sharing their own resources, because they are fully used by their own students. Some other universities (STU Bratislava) do not have funds for running such labs with an open access and because there are some universities financed by EU projects which do so, there is no real market for such initiatives (and one could discuss if the support given to one consortium from more than 40 applied contributes to a progress in the area). At the same time, today there exist many low-cost solutions (see e.g. the plenary lecture by M. Egersted given at IFAC ACE 2016 <https://www.youtube.com/watch?v=I4erpLUnNKQ>) offering interesting alternatives to Remote laboratories. New initiatives as Internet of Things (IoT) may continue in this trend and also significantly influence the situation change in this area.

Comments and questions

In Chapter 3.1 the remote laboratories are classified into basic, complex and scientific. This classification is later recalled e.g. in dealing with the safety issues in Chapt.3.1.3. What is the difference between complex and scientific (just the price?).

From our point of view it is much more important, if the structure of the experiment is fully fixed and one may modify just its parameters (e.g. by an appropriate user interface), or it is possible to modify both the structure and parameter set (e.g. by uploading a Matlab/Simulink scheme).

Chapt. 3.5.4 describes extension modules of the considered CMS. In this context the title “Data analysis module” does not correspond to its function, since it only records history of the measurement. If understood correctly, the whole analysis is represented by the possibility to show the graph to the student, which then makes his/her own conclusions.

Chapt. 4 deals with the main thesis outputs. These are quit rich, but the presentation itself is less appropriate. Chapters 4.1 and 4.2 are written in style of bachelor, or diploma thesis. In doctoral thesis, one would rather expect discussion of trade-offs leading to particular choice.

At some paces, the thesis reminds a user guide. Several details regarding the developed CMS interesting for other designers would be welcomed. For example, you have mentioned HTML5, PHP, JavaScript and web sockets. What about some PHP frameworks (with explanation, why they were or not were used)?

Pp. 83, Fig. 40 shows a web validity test without adding some additional information. It would be interesting to explain, where has been found the critical error shown in the upper table and how it was eliminated.

Of course, one may imagine extent of the programming work and also the development of the diagnostic server (3.4, 4.3) and interconnection with other solutions (3.5.5, 4.4) deserves a special attention.

At the end (Chapt.5.2) you write “It was aimed as a centralisation system for RLs developed at Czech, Slovak and other European universities. It is first system of this kind developed in Czech and Slovak republic and even one of the first developed across the Europe.”

Of course, one has to respect your results offered e.g. for connection with GoLab. Despite to this, your conclusions seem to be too strong – you give no information about some RLs in Slovakia (with exception of Trnava). Then, how to believe that you guarantee compatibility with such systems (used e.g. at FEI STU, or at FCHTP STU)?

The thesis includes numerous typos and sometimes it is not easy to read. Numerous abbreviations used are either not explained at all and not included in the List of abbreviations, or explained but not included in the List of abbreviations – not always at the first use.

Some typos:

pp. 23

leaded by Javier Gacia-Zubia

...led by...

pp.25

which has been deployed with a domotics laboratory...what does it mean “domotics”?

pp.61

Frist one which is starting

... First one?

pp.64

Fig. 25 has English description of y-axis, but within the graph in Czech

pp.69

Fig. 27 is not readable

pp.82

3 different abbreviations – MP, PM, MD – do they represent the same?

Achievements and contributions of the thesis

Without repeating the aims of the thesis, it is possible to conclude that they have been fulfilled. However, because of the fact that the thesis represents a part of a team product, I would ask the applicant to define more explicitly his own contributions and the overall scheme of the division of work.

Conclusions

The applicant has shown the ability to work both in the theoretical and in the application domain. I recommend his thesis for the defense and I also recommend to the committee to award the applicant the PhD degree.

Bratislava, October 20, 2017



Mikuláš Huba

REVIEW OF THE DISSERTATION THESIS**REVIEWER:****DR. JAVIER GARCÍA-ZUBÍA**

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THESIS TITLE:

**Creation and administration of research remote laboratories
at EU level**

AUTHOR:**Michal Krbeček, MSc.****SUPERVISORS:**

Asoc. prof. Dr. Miroslava Otvoldová, PhD.
Prof. Dr. František Schauer, DSc.

Aim, scope and structure

The thesis forms a dissertation in the field of remote experimentation and remote laboratories, applying advanced tools and concepts of engineering informatics. It presents the state of the art in remote experimentation to remark the main drawbacks of the current situation, and to solve them in terms of universality, federation and popularization. All these advances are based in informatics sophisticated methods and tools. The thesis is well-structured and the extent is appropriate.

The remote experimentation is a research area connected to Technology Enhanced Learning and it started around middle 90's and it is focused in allowing students and users accessing real experiments in a remote way using the Internet as their hands, eyes and brain. This thesis is part of the project "Internet School Experimental System" (iSES) led by Franz. Schauer, one of the supervisors of the thesis what is a world reference in this research area.

Originality, scientific value

At the beginning of the remote experimentation all the efforts were made to allow the real control of the experiment, but after this step new objectives were established. A remote laboratory (RL) should have different characteristics to be considered a professional learning tool:

- Scope. The RL should offer not only one experiment, but several of them related with different knowledge areas (if possible).
- Universality. The RL should be accessible from any device in any place with any web browsers.
- Integrability. The RL should be integrated in an LMS, like Moodle, Google Classroom, etc. to allow teachers and students to use the remote experiment as part of a bigger learning experience.
- Federation. The RL should be federated with other RL of other universities/projects to share remote experiences among different actors.

In general the general objective of the thesis is to open the remote experimentation to new users and institutions creating a new Remote Laboratory Management System (RLMS), the REMLABNET. The main results of the thesis are:

- As the majority of the students and users are using mobile devices, and not only PC-laptops, the REMLABNET assures them that they can access, control and see the offered remote experiment in any mobile device. This characteristic improves the previous version of the iSES.
- REMLABNET is not only controlled by its designers, but also by other designers like teachers. If a teacher wants to add a new experiment to the REMLABNET, then he can do it using a new tool designed by the PhD. candidate, the ERL. From my point of view this is the first real environment in the world to offer a teacher to design his own remote experiment. So the REMLABNET is not only owned by the original designers, but also by the final users. Under this approach, REMLABNET is open, and this characteristic is owned only by iSES.
- One of the main drawbacks of remote experimentation is that it is frustrating for the users when they find that the selected remote experiment is not running properly. The thesis describes and implements a diagnostic server for the connected remote experiments (rigs). This method is most advanced in the area of remote experimentation.
- REMLABNET includes federalization features to share the RL in other RLMS, and vice versa. This approach opens the remote experimentation to the learners and designers community.



The scientific value of the thesis can be analyzed attending to the publication of results in journals and conferences. The most important conference in remote experimentation is REV (Remote Engineering and Virtual Instrumentation) and the most important journal is iJOE (International Journal of Online Engineering, <http://online-journals.org/i-joe>). The results of the thesis have been published in iJOE (3 papers) and in REV (8 papers). REV proceedings is included in WoS (web of science) and iJOE will be included the next year in JCR (it is expected). Other results have been presented and published in other journals and conferences helping to the dissemination of the remote experimentation. The publications remark the high scientific level of the thesis.

Formal quality

The thesis (the summary in English) is well-written and clear. The thesis has a structure that presents the general idea, the objectives, the methods and the results. Finally the thesis connects the different sections among them. When a result is established, it is connected with one objective. Using this approach is very easy to review the thesis.

The bibliography is rich, containing both well-proved monographs and fresh content from respected journals and conferences.

Remarks and queries

I have some questions after reading the thesis, but I imagine that all of them are because I have read the English version of the thesis, and it is a summary of the original one.

First I would like to compare the results obtained by REMLABNET with other similar projects and experiences like iLAB, LabShare and WebLab-Deusto.

Also it is important to delimitate the future work connected with thesis. This aspect will remark the level of the current thesis and the expectations for future theses.

Also I would like to read more specific results of the thesis: connected experiments, federations with other remote labs, real cases of use of ERL, etc. This would have improved the thesis. But I repeat, I imagine that these issues are better faced in the original thesis.

Final evaluation and recommendations

The thesis and its contents are of the high standards required for a Ph.D. candidate. **I recommend it for presentation and for acceptance as the Ph.D. thesis in partial fulfillment of the requirements of the Ph.D study in the field of Engineering Informatics. I also highly recommend with pleasure to award Ing. Michal Krbeček the Ph.D. degree in the mentioned field of study.**

Bilbao, 3.10.2017



Dr. Javier García-Zubía