WHY VISIR?

PROLIFERATIVE ACTIVITIES AND COLLABORATIVE WORK OF VISIR SYSTEM

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Abstract

Online laboratories have been increasingly deployed in several universities and institutions around the world. Besides helping to leverage a number of educational developments, they enable teachers and researchers to share their knowledge across institutional boundaries. It has been observed that online laboratories have a positive effect on students' skills acquisition because they promote collaborative work and allow students to perform physical experiments remotely usually 24/7. Today, one can find a wide range of online laboratories in the literature that are supporting many subjects in different engineering and sciences fields, especially in electric and electronic engineering. One such system is VISIR (Virtual Instrument Systems in Reality).
VISIR plays an important role in electrical and electronic engineering education by allowing both teachers and students to conduct real experiments with electric and electronic circuits, via the Internet. It also complements hands-on laboratories by serving thousands of students globally, as a result of being spread by several universities and institutes worldwide. Presently, VISIR is installed in eight higher education institutions), in six different countries (Austria, Sweden, Spain, Portugal, India, and Georgia), and is the first remote lab in the world supporting a MOOC (Massive Open Online Course). In addition, a number of experiments in VISIR can be freely accessed, using the guest user mode, depending on the institutions available resources.
In this study, we have used the data collection method focused on all scholarly papers that are related to the VISIR system, which allowed collecting references from many resources such as conference proceedings, book chapters, and journals.
The objective of the paper is to illustrate the researches activities, developments, and studies that contributed to making of VISIR the best remote controlled laboratory in the world, according to the GOLC (Global Online Laboratory Consortium). Our research included the following dimensions: a) courses and subjects that include experiments done in VISIR, from different universities and institutes; b) the number of scholarly papers and authors related to VISIR, with a reference to the publishing sources; c) the different technologies used to deliver the laboratory experiments; d) the total number (and its evolution) of users who have accessed the several VISIR nodes; e) finally, the collaborative work resulting from the use and share of the VISIR system. To conclude, the paper discusses the impact of VISIR in the role of the laboratory in undergraduate engineering education, in particular in electrical and electronic engineering, and its contribution to the collaborative work observed among the academic staff, researchers and students who used it.

Keywords: Online Laboratories, VISIR System, Data Collection Method, Collaborative Work.

1 INTRODUCTION

Practical work is a basic requirement of science and engineering education. It fosters learning and the acquisition of various skills, namely the skill to carry out hands-on experiments whose results are not completely known before hand and where failures offer occur. Experimental data thus collected is of great significance and of great pedagogical value. Furthermore, for researchers on online laboratory, observing and analyzing students doing practical work is of great interest [1]. In general, it can be quite expensive to set-up a new hands-on laboratory because of the cost of equipments and then cost of maintenance. Today, with the Internet rise, online laboratories technology has gained acceptance increasingly because it helps students to access to physical instruments with ease. This technology has been enabling students and teachers to run the experiments and control the instruments, which are located not in laboratories in the campus, but somewhere on the Internet. It is widely accepted as a part of the distance education in several universities and, in many case, it is augmented with hands-on laboratories [2]. Nowadays, it serves hundreds of students, allowing them to use the expensive laboratory equipment, which would not be available to them otherwise. Furthermore, they complete their work outside of university times, not having to conform to opening hours for laboratories [3].

Zubia et.al [4] showed that the online laboratory is a useful learning tool and it is complemented the hands-on laboratories. In addition, several advantages of online laboratory have been showed in [5], for example availability, organization of laboratories, society, and availability of distance courses. Moreover, online laboratories promote collaboration work among the students and teachers from various points in the world, as their share a common online laboratory [6].

In 1999, BTH (Blekinge Institute of Technology) in Sweden emanated the idea of the VISIR as open lab platform, which enables universities, secondary schools, and other organizations to open instructional laboratories for remote access. It has been implemented at six countries and it is available online now for students around the world [7]. In 2015, VISIR was awarded the best remote controlled laboratory award by GOLC[1] Executive Committee. Currently, there is a special community group of VISIR created by IAOE (International Association of Online Engineering). This community is called VISIR SIG (Special Interest Group)[2]. It is organized for people who are interested in online laboratories, especially in engineering laboratories, and it is used to create the collaborative environments.

This study determines the activities of VISIR system and describes the collaborative work among scholarly researchers from 2006 to 2014. In addition, it highlights the points that made VISIR accessible and qualified in the educational usage.

The rest of paper is divided into five sections. Section two is a brief description of VISIR system. Section three describes the work methodology we used in this paper. Our main results are presented in section four, together with a discussion of those results. Section five contains conclusion and our plans for future work.

2 VISIR SYSTEM

At end of 2006, VISIR project started disseminating the online laboratories concept by offering a software distribution released under a GNU GPL license, which can be used to implement online workbenches. This project enables students to perform experiments within limits set by the teacher and in much the same way they would use in a local laboratory. A complementary objective of VISIR is to create a community of researchers in the universities that use the system. For that, a platform was developed, allowing researchers and practitioners to collaborate, and to share resources and other materials [8], [9], [10].

VISIR is now operating in eight institutes from six countries at present: Austria, Sweden, Spain, Portugal, India, and the last one in Georgia. The vision of VISIR is to make the online laboratories as replicas to real hands-on laboratories and provide a more time (24/7) for students to perform their experiments over the Internet [9], [11].

The general architecture of VISIR and the hardware and software implementation of VISIR system is described in several papers [9], [11], [12]. Moreover, it has been developed by PXI and LXI hardware platform [13], [14], [15] and it is integrated with another platform project, such as iLab, and with Learning Management system (LMS), such as Moodle [12], [16].

VISIR is recognized as a good education tool for students because it can serve them with an increasing number of experiments in topics that are relevant to them [12], [17] and it allows them to share the ideas, lab exercises and learning material among colleagues in many part of the world.

3 WORK METHODOLOGY

This work started by collecting papers and other resources related to the VISIR system, such as book chapters, manuals, thesis, etc. These resources have been gathered from several places, namely REV

[1] http://online-lab.org/index.php?option=com_content&view=article&id=38&Itemid=50
[2] http://online-engineering.org/SIG_visir.php

and EDUCON conferences and iJOE journal. Furthermore, we used the VISIR keyword in Google Search Engine to find more resources that are related to the VISIR system.
The structure of work has been categorized in three phases (A, B, and C) which are detailed below, in Fig.1.

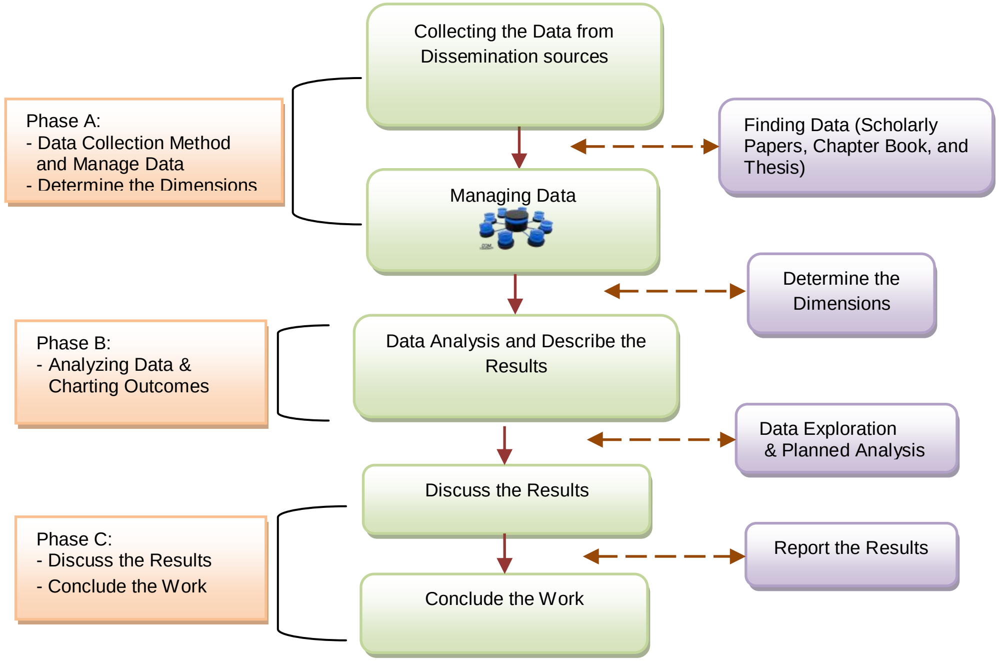

Fig.1: Phases of methodology work

3.1 Phase (A): Data Collection Method and Manage Data

Data collection method played an important role to evaluate the study by providing the useful information and observing the results. It can be used to improve the quality of survey-based evaluations and increase the credibility of findings [18]. There are various methods for collecting data, for example: Surveys, Observation, Existing Data, and Documents [18], [19]. In our study, we used documents method for collecting the data. One of the main advantages of this method is the existing data, which has already been indexed in several resources [19]. Our data have been collected from several resources, for instance REV and EDUCON conferences, iJOE journal, and other. The handle way focused on scholarly papers that related to the VISIR system directly or mentioned the VISIR in paragraph(s). The result of data collected was as follows: 85 papers, 6 theses (3 PhD and 3 MSc.), and 7 chapters in four different books[1].
Afterward, to keep our data, we used a MENDELEY platform to create an open community group for uploading VISIR references and activities such as papers, thesis, and available books. This platform is a research tool and free reference manager to share the resources and academic activities. It helps to create a personal research library for managing, organizing, collaborating, sharing the resources, and research papers in one place [20]. This group is now available in the MENDELY website, namely "*VISIR Activities*[2]".
Furthermore, this open group can help creating a wide communication among the people who have interesting to work with VISIR and share its ideas.
For presenting the objective of this paper, we determined the dimensions that may have helped VISIR to become the best remote controlled laboratory in 2015, as sited in the GOLC website. These dimensions are stated in below and they described in the sub-section 3.2.

1- Determine the number of researchers who were involved, what year, and the number of papers that were published about the VISIR system, which resources, and what years.

[1] Name of books are:
I. Advances on remote laboratories and e-learning experiences, chapter 11, in 2007.
II. Using Remote Labs in Education: Two Little Ducks in Remote Experimentation, chapter 7 and 9, in 2011.
III. Internet Accessible Remote Laboratories: Scalable E-Learning Tools for Engineering and Science Disciplines, chapter 15 and 16, in 2012.
IV. IT Innovative Practices in Secondary Schools: Remote Experiments, chapter 7 and 8, 2013.

[2] https://www.mendeley.com/groups/6702311/visir-activities/papers/

2- Determine the institutions that used the VISIR system, in which course and subject.
3- Describe the technologies used to delivery experiments.
4- Determine the number of users that have accessed the VISIR system.
5- Describe the collaboration work among researchers.

3.2 Phase (B): Analyzing Data and Charting the Outcomes

In this sub-section, we analyzed the data to achieve our dimensions. The first dimension is divided into two parts: number of contributions and authors.
First part: It is related to the number of contributions that were published from 2006 to 2014 and from which sources. The result of contributions was 92 publications resources (85 papers and 7 book chapters) in several languages. Most of contributions have been published in English and few in Swedish, Portuguese, and Spanish.
As shown in Fig.2, the number of contributions has increased in the last three years, note really: 23 in 2012; 16 in 2013; 19 is 2014. These contributions are indexed in 31 different conferences and Journals. We have only selected the five top VISIR sources, as shown in Fig.3.
the conference with the largest base of VISIR contributions were the REV and EDUCON conferences editions, with 23 and 12 contributions, respectively, while the best journal was iJOE journal.

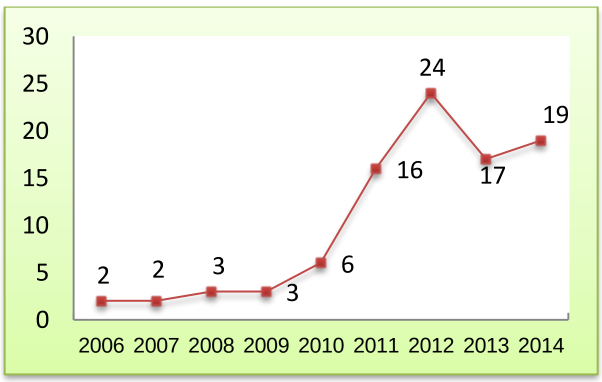

Fig.2: Number of VISIR contributions from 2006 to 2014

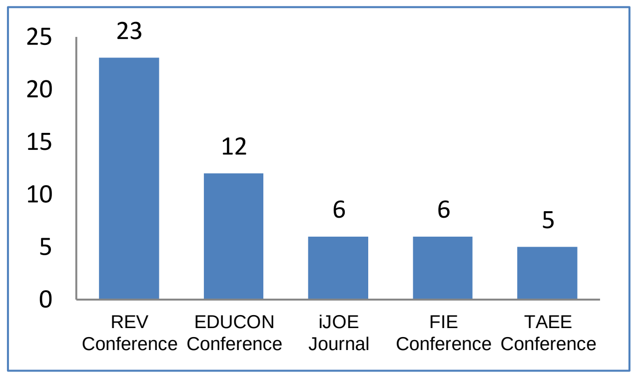

Fig.3: The five-top resources base for VISIR contributions

Second part: It is related to the number of researchers who involved of VISIR activities. As a matter of fact, during our survey we noticed that VISIR has attracted researchers from several countries. As shown in Fig.4, the number of researchers has been increased, especially after 2010. The total researchers involved were 127 from several countries. We selected only the top-ten researchers, as illustrated in Tab.1.

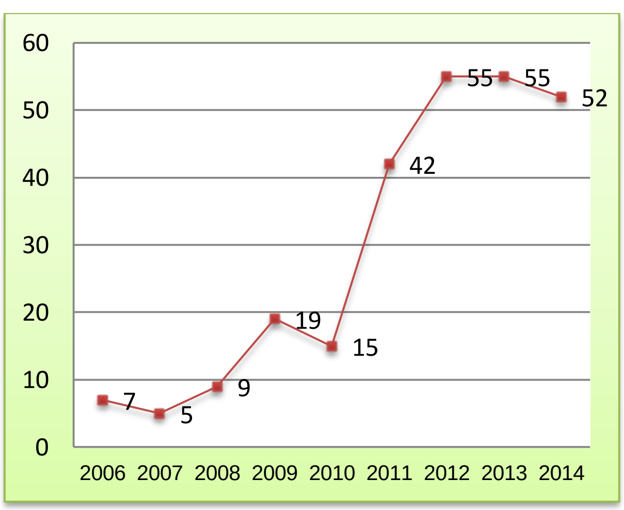

Fig.4: Number of researchers involved from 2006 to 2014

Tab.1: The top-ten researchers working with the VISIR system from 2006 to 2014.

No.	Name of Author	Number of contributions	Institute/country
1	Ingvar Gustavsson	38	BTH/ Sweden
2	Javier Garcia-Zubia	33	DEUSTO/ Spain
3	Manuel Castro	30	UNED/ Spain
4	Elio Sancristobal	29	UNED/ Spain
5	Mohamed Tawfik	27	UNED/ Spain
6	Gabriel Diaz	26	UNED/ Spain
7	Pablo Orduna	22	DEUSTO/ Spain
8	Johan Zackrisson	19	BTH/ Sweden
9	Lars Hakansson	19	BTH/ Sweden
10	Sergio Martin	18	UNED/ Spain

BTH = Blekinge Institute of Technology
DEUSTO = University of Deusto
UNED = National Distance Education University

The Second dimension is related to subjects and courses that are supported by VISIR system. From 2006 to 2014, VISIR system served the students in 15 courses from different institutions. Other than the university students, VISIR has been used with secondary school students, for example the Katedralskolan secondary school in Sweden and the Urdaneta school in Spain. These courses that offered by VISIR are shown in Tab.2.

Tab.2: subjects that offered by VISIR system from 2006 to 2014.

	Name of Course	Institution	Year
Higher Education Institutions	Circuit Analysis	BTH	2006
	Analog Electronics	BTH	2006
	Digital Electronics	Deusto	2009
	Foundations on Electronic Engineering	UNED	2011
	AC/DC Experiment	ISEP	2011
	Electronic Circuits and Components	Deusto	2011
	Computers Technology	Deusto	2012
	Circuits	Deusto	2012
	Electricity	ISEP	2011
	Applied Instrumentation	ISEP	2011
	Physics	ISEP	2011
	Circuits Theory	ISEP	2011
	Mechanical Engineering	ISEP	2011
	Operational Amplifiers	Federal Institute of Santa Catarina	2013
	Instrumentations and Control Systems	Al-Quds University	2014
Secondary School	Physics Subject	Katedralskolan Secondary School	2012
	AC/DC Experiment- Ohm's & Kirchhoff's laws	Urdaneta School	2013
ISEP = Instituto Superior de Engenharia do Porto			

The third dimension is related to the technologies used to delivery VISIR experiments. As mentioned above, VISIR has been adapted with other educational and social environments. In this dimension we must consider the hardware and software technologies that were used to implemented VISIR system. In the software side [21], VISIR is divided into four parts, Web interface, Experiment Client, Measurement Server, and Equipment Server. The Web Interface has been implemented by using PHP language and MySql and installed in the webserver assigned for VISIR. In addition, there is another VISIR installation in which the Web interface has been implemented using HTML5.

The Experiment Client has been written in Adobe Flash. It is programmed to display the virtual interface of equipment such as Breadboard, Function Generator, DC Power Supply, Digital Multi-Meter, and Oscilloscope.

The Measurement Server was written in Microsoft Visual C++. It defines in four steps: authentication, validation, time-sharing, and control. This part is responsible to receive the measurement requests from the experiment client.

The Equipment Server which was written in LabView. It handles the instrument interface and hosts the VISIR hardware together with the Relay Switching Matrix (*hardware part*).

The VISIR hardware [21] is divided into two parts, Relay Switching Matrix and PC-based platform. The Relay Switching Matrix is a stack of PCI sized boards, which act as a circuit-wiring. The main one is manufactured by BTH (Blekinge Institute of Technology). It is designed for low frequency analog electronic circuit experiments and consists of instrument and component boards. The second part is a PC-based platform PXI (PCI eXtensions for Instrumentation) and LXI (LAN eXtensions for Instrumentation) that are used for measurement and automation systems. All institutions have implemented VISIR by using PXI manufactured by NI (National Instruments) expect the University of Deusto which has implemented VISIR by using PXI and LXI (industry consortium). These software and hardware details are displayed in Tab.3.

Tab. 3: Software and hardware parts of VISIR system

Software Implementations	Parts	Web Interface		Experiment Client	Measurement Server	Equipment Server
	Language used	HTML5	PHP, MySql	Adobe Flash	Microsoft Visual C++	LabVIew
Hardware Implementations	Parts	PC-based Platform		Relay Switching Matrix		
	Instruments	PXI	LXI	Component Board		

The fourth dimension is focused on the number of users and it divided into two categories. The first one is related to the number of students found from the VISIR papers. From 2006 to 2014, at least, the result was found is that VISIR served 3,764 students from different countries and courses in different VISIR nodes, as shown in Tab.4.

The second category is dependent on the number of users who logged in successfully (credential and guest users) to the VISIR system. We focused on the users who activated his email, which located in login.log[1] file. This file exported to a new.xlsx file, called login.xlsx. The xlsx file is included several columns such as date and time accessed, user type (Login, guest, admin), user e-mail, IP address, etc. We filtered these data in order to be able to count unique emails for students who had logged in to the system at least once.

As detailed in Tab.5, from 2006 to 2014, the number of login succeeded from (ISEP, UNED, and BTH)[2] nodes were 13,111 (with duplicate Email) and 1,555 (without duplicate email).

Tab.4: Number of users from 2006 to 214 from the paper

Students Institution/School	Year	Number of Students	VISIR Node used
ISEP	2011	1544	ISEP
Deusto	2011	40	Deusto
UNED	2013	2000	UNED
Katedralskolan School	2011	94	BTH
Federal Institute of Santa Catarina	2014	15	ISEP
Al-Quds University	2014	71	ISEP
Total		3,764	

Tab.5: Number of users from 2006 to 214 from login.txt file

VISIR Node	Started from - to	Total Access (Login and Guest) : With Duplicate	Total Access (Login and Guest) : Without Duplicate
ISEP	2010 to 2014	4282	751
UNED	2010 to 2014	5390	141
BTH	2008 to 2014	2646	189
CUAS	Not available in login.xlsx file	1000	42
Total	2008 to 2014	13,111	1,555
CUAS = Carinthia University of Applied Sciences			

The last dimension is related to collaboration work among researchers. As shown in Fig.4, the collaborative work among researchers has been clearly augmented, especially in recent years. This collaboration includes case with researchers from different countries in one continent or with other countries from another continent, for example European researchers have been worked with South or North America researcher, or with Asia researcher. As result, the total number of cases of collaborative involving at least two countries work was 31. Eleven countries are involved: Sweden, Spain, Portugal, Australia, USA, Austria, Brazil, Bulgaria, Ireland, Slovakia, and Palestine. These details are shown in Tab.5.

[1] This file is located in VISIR server and it is generating the user details such as date and hour login, user type, Email user, IP address, etc.

[2] We have also received the data from DEUSTO VISIR node but we did not include it in our statistics because their VISIR uses another module to do the registration, authentication, etc. tasks, which is created in the WebLab-Deusto.

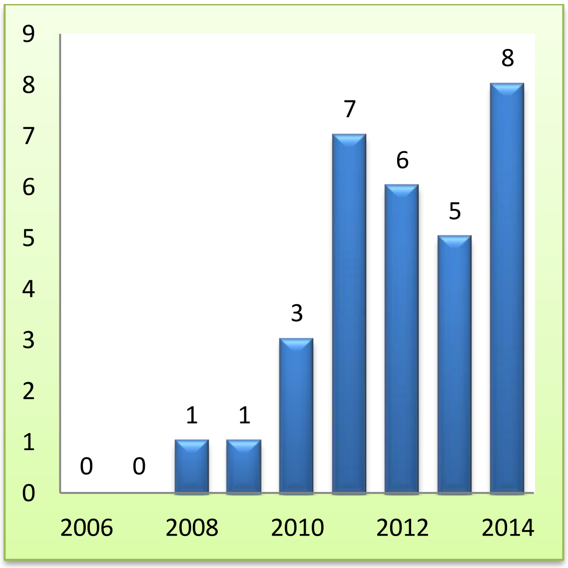

Fig.5: Number of Collaboration work from 2006 to 2014

Tab.5: Collaboration work among continent and countries Included from 2006 to 2014.

Year	Number of Collaborations	No. of collaborations among Continents	Countries included
2006	None	None	None
2007	None	None	None
2008	1	None	Sweden/Spain
2009	1	EU+AUS+NA	Sweden/ Spain/ Australia/ United State
2010	3	EU+EU EU+ AUS	Sweden/ Spain/ Australia/ Portugal
2011	7	EU+EU EU+SA	Sweden/ Spain/ Portugal/ Austria/ Brazil
2012	6	EU+EU EU+NA EU+SA	Sweden/ Spain/ Austria/ Portugal/ Brazil/ Bulgaria/ United State/ Ireland
2013	5	EU+EU EU+SA EU+AUS	Sweden/ Spain/ Austria/ Portugal/ Brazil/ Bulgaria/ Ireland/ Australia/ Slovakia
2014	8	EU+EU EU+SA EU+AS	Sweden/ Spain/ Portugal/ Palestine/ Brazil
Total	31	5	11
EU = Europe Continent, AUS = Australia Continent, NA = North America Continent, SA = South America Continent AS = Asia Continent			

3.3 Phase (C): Describe the Results and Conclude the work

As a result of this study, we collected several questions. These questions highlight the impact of collaboration work to the VISIR activities.

- Why the collaboration work has been increased among different countries?

VISIR system interfaces have been implemented in several languages. In addition, VISIR open source code is available in several languages: English, Swedish, Greek, Spanish, Portuguese, Arabic, and Kurdish[1]. This feature may help the students to work with VISIR and understand how to run the experiments easily, on their own. It is led to make the collaborative work becomes more easy among the students and teachers. The results of those VISIR students are distributed over the different countries and tongues, for example (English, Swedish, Spanish, Portuguese, and Arabic).

- How can students access to the VISIR system?

Students can access to VISIR system in two ways, *standard interface and simple interface*. The standard interface is the original one, developed with HTML and flash. With it, each student can access to the VISIR as a registered user or as a guest. All the universities who are implemented VISIR have been using this way for creating the experiments course, reservations for sets and time, etc. The simple interface created in HTML5 and JavaScript, without flash, for example Ohm's law experiment[2]. The students can access to VISIR experiments and do their tasks in the uncomplicated way and without login needs.

- Why is VISIR able to integrate within other education environments?

VISIR system is implemented by using open source code. This feature has allowed VISIR to integrate with other projects, social network, and education environments, for example, iMIT, Facebook, Moodle, and also MOOC. It has been made possible share experiments among the universities and institutions worldwide. Furthermore, it encouraged developers and researchers to share their ideas and to play with the source code to modify it according to their needs. Additionally, VISIR can be expended by using

[1] http://svn.openlabs.bth.se/trac/openlabsweb/browser/trunk/common/lang
[2] http://dev.openlabs.bth.se/~zeta/dav/git/test_exercise/test-instruction.html

standardized software such as IVI (Interchangeable Virtual Instruments) and equipment platforms such as PXI and LXI.

- Has the collaboration work been affected by the increasing the number of authors and contributions?
Because of the high number of authors and contributions, we used the following criteria to answer the question. We categorized the authors, contributions, and collaborative work into three groups. The first group included the authors, papers, and collaborative work from 2006 to 2008. The second group from 2009 to 2011 and the third from 2012 to 2014. Afterwards, we checked each group of authors and contributions with collaborative work. This criteria was helped us to focus on the relation between collaboration work and with increase of number of authors and number of papers. We concluded that the collaboration work among researcher has a positive influence on the number of papers published and on the number of authors. This trend can be observed in Fig.6 and Fig.7.

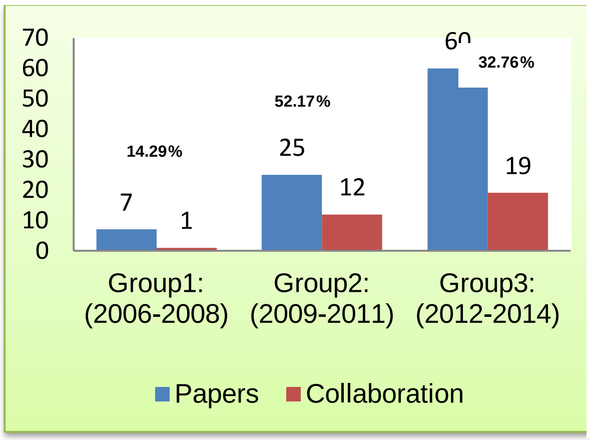

Fig.6: Number of collaboration work and papers

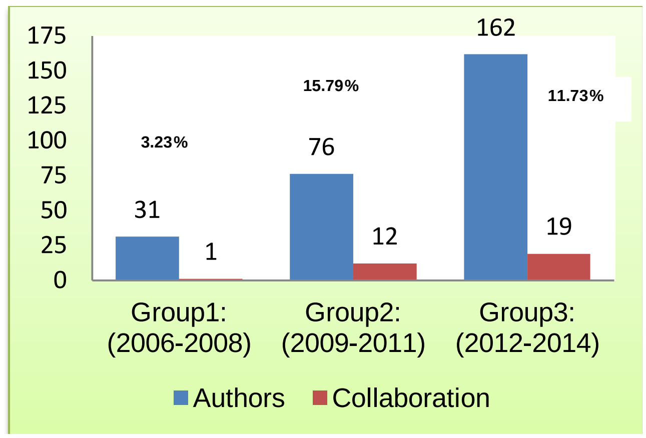

Fig.7: Number of collaboration work and authors

4 RESULT AND DISCUSSION

This study investigated the impact of online laboratories in general. We were able to conclude that VISIR is a good example of an online laboratory, capable of serve the students. Furthermore, from 2006 to 2014, VISIR has supported collaborative work among the institutions and researchers. This collaborative work has raised the number of people using the system, is has helped them to diversify their competence, is has contributed to the development of VISIR system, and has increased the number of scholarly papers and the number of authors. All these aspects are part of the original idea of having online laboratories. And in our survey, we discovered that they are related, as Fig.8 illustrates.

In general, several features within VISIR itself have supported collaborative work among researcher, for example user interfaces in various languages, open source code, and adaption with education environment. In recent years, the number of researchers and contributions has been growing steadily, as a result collaborative work. Moreover, collaborative work has helped developers to expand the system by adding extra functions and services. For example, although the system was originally meant to serve the students of higher education institutions, is has evolved to serve the students from secondary school as well by making the system interface is lucid to access the experiments.

Essentially, in our view, online laboratories system can help to reform the higher education system of many countries. We particularly interested in the MENA (Middle East and North Africa) countries, where the need for such system is very acute. In this region, online laboratories may stimulate the collaboration and cooperation interaction work among the researchers from the region by sharing the resources and knowledge remotely [22], as it now happens with regard to researchers from further away countries.

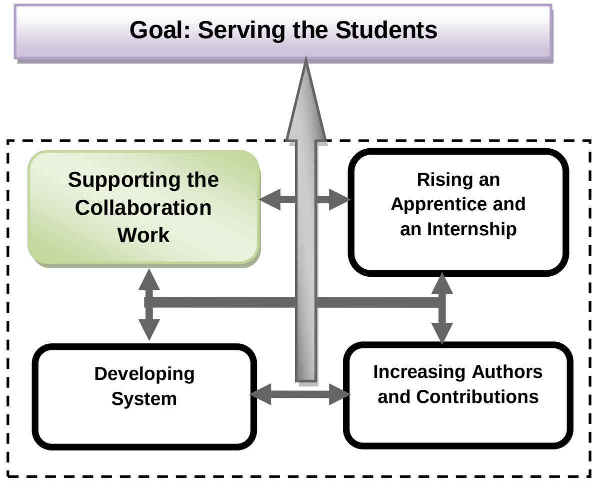

Fig.8: The life cycle of online system model

5 CONCLUSION AND FUTURE WORK

During the last two decades, education online laboratories have been designed and deployed in many parts of the world. The general goal of online laboratories is to provide a large collection of online experiments available to students from anywhere and at any time, and at a low cost for corresponding 7institutions. They have become attractive to students and have engaged many researchers worldwide. In addition, they were a means to increase the collaborative work among researchers from different countries.

In fact, since 2006, VISIR has attracted attention of many researchers around the world. Several of its features have made VISIR as a good example of successful online laboratory, for example: it is possible for students to run their experiments 24/7, it has been adapted to be used from within an LMS such as MOOC and Moodle, and it served both universalities and secondary schools from different countries. Moreover, the available experiments can be used by students globally, as there are distributed in various languages.

Currently, VISIR has been integrated with PXI and LXI standard instruments. It means that it has possibility to implement VISIR system by using equivalent instruments. Therefore, the new idea is Integrating VISIR with a low-cost instrument, namely Virtual Bench[1], by re-using the VISIR open source code. This platform is released by National Instruments and it comprises five instruments (a mixed-signal oscilloscope, function generator, digital multimeter, programmable DC power supply and digital I/O) in one device. This idea may support many countries in the world, which have the limitations of hands-on laboratory available and where the number of students is rising sharply.

REFERENCES

[1] Bochicchio, M.A. and Longo, A. (2011). Collaborative web labs as a service: challenges and opportunities. Proceedings of the First Global Online Laboratory Consortium Remote Laboratories Workshop: Improving Laboratory Learning Outcomes, pp.1–8.

[2] Deniz, D. Z., Bulancak, A. and Ozcan, G. (2003). A Novel Approach to Remote Laboratories. ASEE/IEEE Frontiers in Education Conference, pp. T3E8-T3E12.

[3] Chen, S.H. *et al*. (1999). Development of Remote Laboratory Experimentation through Internet. Proceedings 1999 IEEE Hong Kong Symp. Robot. Contr., pp.756 -760.

[4] Garcia-Zubia, J. *et al*. (2009). Acceptance, Usability and Usefulness of WebLab-Deusto from the Students Point of View. International Journal of Online Engineering (iJOE) 1(5).

[5] Garcia-Zubia, J., Lopez-de-Ipina, D. and Orduna, P. (2008). Mobile Devices and Remote Labs in Engineering Education. Eighth IEEE International Conference on Advanced Learning Technologies, pp. 620-622.

[1] http://www.ni.com/virtualbench/pt/

[6] Garcia-Zubia, J. *et al*. (2007). An Approach for WebLabs Analysis. International Journal of Online Engineering (iJOE) 2(3), pp. 1-5.

[7] Gustavsson, I., Zackrisson, J. and Lundberg, J. (2014). VISIR work in progress. 2014 IEEE Global Engineering Education Conference (EDUCON), pp. 1139-1148.

[8] Gustavsson, I. *et a*l. (2009). On Objectives of Instructional Laboratories, Individual Assessment, and Use of Collaborative Remote Laboratories. IEEE Transactions on Learning Technologies, 4(2), pp. 263- 274.

[9] Odeh, S. *et al*. (2014). Experiences with Deploying VISIR at Al-Quds University in Jerusalem. 2014 IEEE Global Engineering Education Conference (EDUCON), pp. 273-279.

[10] Gustavsson, I. *et a*l. (2011). The VISIR Open Lab Platform 5.0 - an architecture for a federation of remote laboratories. In Remote Engineering and Virtual Instrumentation (REV), 2011 8th International Conference, pp. 284-288.

[11] Ruiz, E.S. *et al*. (2013). Design, Development and Implementation of Remote Laboratories in Distance Electronics, Control and Computer Subjects. In Remote Engineering and Virtual Instrumentation (REV), 2013 10th International Conference, pp. 1-5.

[12] Tawfik, M. *et al*. (2013). Virtual Instrument Systems in Reality (VISIR) for Remote Wiring and Measurement of Electronic Circuits on Breadboard. IEEE Transactions on Learning Technologies, 1(6), pp. 60- 72.

[13] Garcia-Zubia, J. *et al*. (2014). Experiencia de Uso y Evaluación de VISIR en Electrónica Analógica. In Proceedings of conference: TAEE2014, pp. 1-6. (In Spanish)

[14] Garcia-Zubia, J. and Hernandez-Jayo, U. (2010). LXI technologies for remote labs: an extension of the VISIR project. In Remote Engineering and Virtual Instrumentation (REV), 2010 7th International Conference, pp. 1-11.

[15] Tawfik, M. *et al*. (2011). Remote Laboratories for Electrical & Electronic Subjects in New Engineering Grades. 2011 Promotion and Innovation with New Technologies in Engineering Education FINTDI 2011, pp. 1-6.

[16] Alves, G. R. *et al*. (2011). Using VISIR in a large undergraduate course: Preliminary assessment results. 2010 IEEE Global Engineering Education Conference (EDUCON), pp. 1125-1132.

[17] Nafalski, A. *et al*. (2010). Student and staff experiences with international collaboration in the remote laboratory NetLab. 1st WIETE Annual Conference on Engineering and Technology Education, pp. 40-45.

[18] Eau Claire. (n.d). Data Collection Methods: Quantitative and Qualitative Data collection methods. Retrieved from: http://people.uwec.edu/piercech/researchmethods/data%20collection%20methods/data%20collection%20methods.htm. Arrived April 12, 2015.

[19] CDC. (n.d). Selecting Data Collection Methods. Retrieved from: http://www.cdc.gov/std/Program/pupestd/Selecting%20Data%20Collection%20Methods.pdf. Arrived April12, 2015.

[20] Cambridge, D., Kaplan, S. and Suter, V. (2005). Community of Practice Design Guide A Step-by-Step Guide for Designing & Cultivating Communities of Practice in Higher Education. pp. 1-8.

[21] Tawfik, M. *et al*. (2011). VISIR Installation & Start-up Guide. Document Released from VISIR Special Interest Group (VSIG). Retrieved from: http://www.academia.edu/2567616/VISIR_Installation_and_Start-Up_Guide. Arrived April 10, 2015.

[22] Salah, R.M., Alves, G.R. and Guerreiro, P. (2014). Reshaping Higher Education Systems in the MENA Region: The Contribution of Remote and Virtual Labs. In Remote Engineering and Virtual Instrumentation (REV), 2014 11th International Conference, pp. 240-245.