# A Remote Laboratory for Electric Circuit using Passive Devices Controlled

ILhyeon Moon, Saeron Han, Kwansun Choi, Dongsik Kim, Changwan Jeon, Sunheum Lee*, Sangyeon Woo**
Department of Electrical Communication Engineering
*Department of Information Communication Engineering
**Department of Physical Education
Soonchunhyang University, Asan-si, ChoongNam-do, Republic of Korea

**Index Terms:** remote education system, remote laboratory, electric circuit, LabVIEW

**Abstract**

In this paper, we developed remote control devices that can be controlled passive component e.g. resistor, inductor, capacitor that is a basic element in the electric circuit. We embodied a remote laboratory for basic circuit theory which learners can experiment controlling element value to remote through the internet. It was seen that is useful applying passive component developing to a remote laboratory. Because developed passive components can response in an experiment altering several element values to remote, they will be used very usefully in a remote experiment that equipped with various experimental subjects. Therefore the proposed laboratory will be solved problems of virtual laboratory which students do not handle instruments in engineering experiment. With our proposed system, students can experiment any time, anywhere

## 1. Introduction

The development of the Internet has brought many changes not only to computer environment but also people's life. The Internet is switching the pivotal center of life from an offline to online. It has turned offline-based life with limitations in time and space to online-based life, which is not restricted by time and space.

This paradigm has also affected the education area, causing the emergence of virtual education system. The early type of virtual education was a text-based system using a Web browser. Such a system was advantageous in that learners could access at any time and in any place, but because of its static education method, learners easily lost interest in learning.

Complementing the static aspect of existing virtual education system, virtual laboratory emerged. Virtual laboratory was implemented so that learners can compose circuits using education contents. It stimulated learners' interest more than virtual education system, and helped their understanding of circuits. However, virtual laboratory could not show the actual operation of circuits and learner can not manipulate instruments for real experiments.

It is a remote experiment education that was proposed to solve problems in virtual education by maintaining experimental instruments and showing the operation of circuits using communication media. In remote experiment education, learners are educated by accessing through the Internet from a place other than the laboratory. That is, they can observe actual operations from afar through the Web.

## 2. Design and Implementation

### 2.1. System structure

The remote laboratory for Circuit theory is largely composed of Client, LabVIEW Server and Circuit system. Client access LabVIEW Server through the Internet. If a learner enters the address and the program name of LabVIEW Server, the front panel of the program appears on the explorer. The LabVIEW Server is connected to Client through the Web server function, and Client controls Circuit system and obtains data. Circuit has DAQ communication with the server through NI ELVIS, and a PC camera is connected through

[1] E-mail: cks1329@sch.ac.kr

USB communication. Fig.1 shows the proposed remote laboratory. Figure 2 shows the general structure of the remote laboratory system for electric circuit.

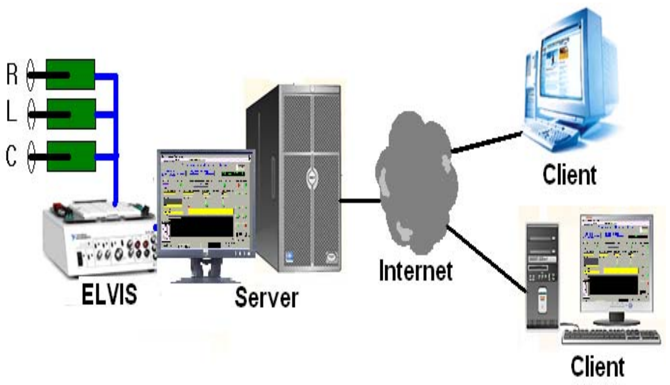


Fig. 1 : Remote Laboratory system

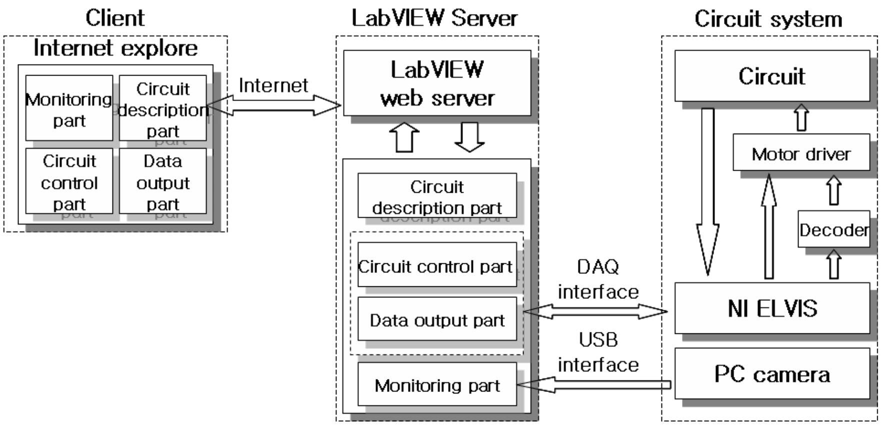


Fig. 2 : Remote laboratory system Construction for electric Circuit

## 2.2. Hardware section

The hardware section composes the circuit according to the purpose of experiment and sends the image through the PC camera. Figure 2.2 shows hardware components and the direction of data flow.

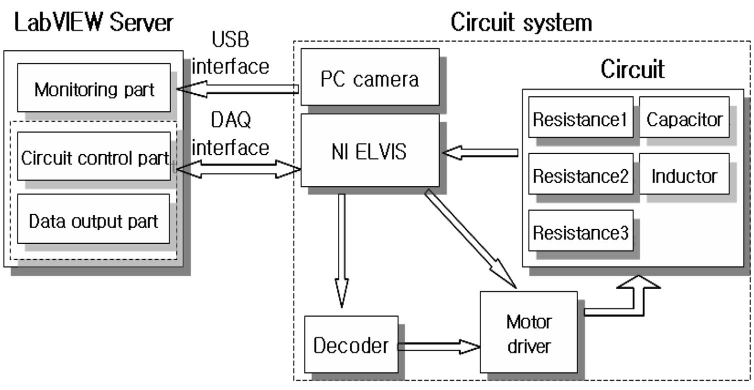


Fig. 3 : Hardware section composition

[1] E-mail: cks1329@sch.ac.kr

**1) DAQ card**

Using a DAQ card, one port (8 bits) is controlled. Bit 0 is RESET, which is used to operate the motor, and bit 1 is to control CW/CCW. In addition, bit 3-5 are used as an index to choose one of 21 motors used in circuits.

**2) NI ELVIS**

NI ELVIS plays three roles in remote laboratory. First, it receives an 8-bit control signal from DAQ and sends it to the decoder. Second, it generates signals (5 bits) necessary for the operation of the motors and sends them to the motors. Lastly, it supports DMM function, determining data wanted by the experimenter and sending the data to the data output section. The decoder analyses 5 bits from NI ELVIS, and send the ENABLE signal to one of 21 motors.

**3) Resistor, inductor and capacitor element for remote control**

(1) Resistor

There are a total of 9 resistors with a stepping motor, the selector and each unit. The minimum measuring unit is 10 ohms and the maximum measuring unit is 10 K ohms. Remote laboratory uses 3 resistors to experiment on serial-parallel mixed circuits.

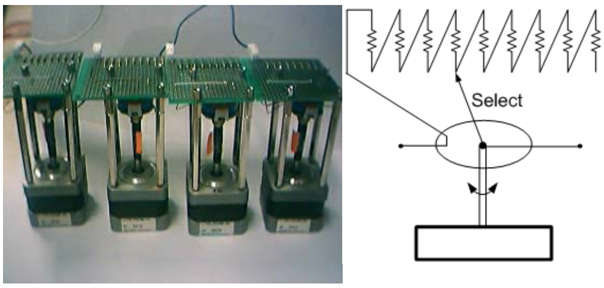


Fig. 4: Resistance and principle of operation

(2) Inductor

The inductor was designed to measure from 0mH to 99mH, and the principle of its operation is the same as that of resistor.

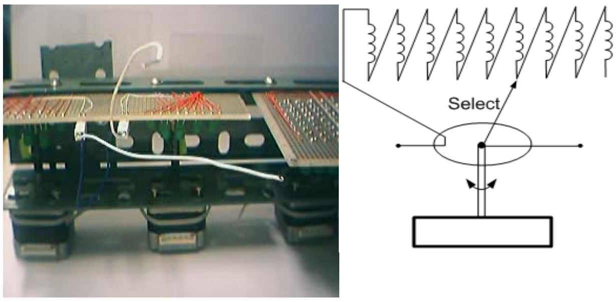


Fig. 5: Inductor and principle of operation

(3) Capacitor

The capacitor was designed to measure from 100pF to 999nF, and the principle of its operation is the same as that of resistor.

[1] E-mail: cks1329@sch.ac.kr

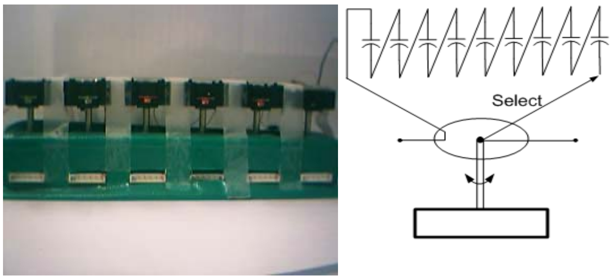


Fig. 6: capacitor and principle of operation

(4) Stepping motor & selector

The stepping motor contacts the selector so that the selector has a right value. If the selector is turned counterclockwise, the value increases, and if it is turned clockwise, the value decreases.

(5) Motor driver

The motor driver runs the stepping motor using 5 operation bits from NI ELVIS and 1 bit from the decoder. The PC camera communicates with the monitoring section through USB communication, and shows the client the construction and the operation of circuits.

### 2.3 Software section

The software part is a space where the learner learns through carrying out remote controls of the circuit and acquiring data. Figure 7 shows the software section screen of the remote laboratory, which is composed of (1) monitoring section, (2) circuit description section, (3) circuit control section, and (4) data output section.

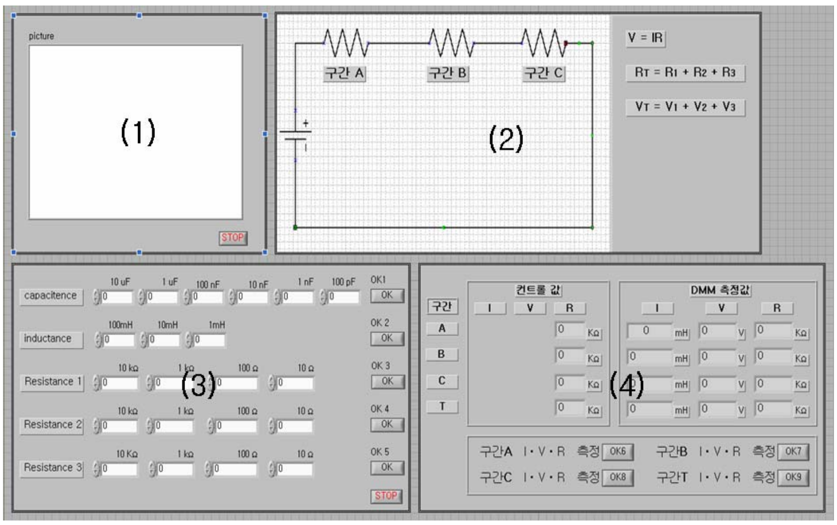


Fig. 7: Construction of software section

(1) Monitoring section
The monitoring section displays the circuit screen transmitted from CCD camera.

(2) Circuit description section

[1] E-mail: cks1329@sch.ac.kr

The circuit description section shows information about remote experiment. To help the learning of circuit, circuit connections are briefly diagramed. In addition, rules applied to remote experiment are listed to show if values from the data output part are normal or not.

(3) Circuit control section
The circuit controls part directly controls physical data. After student inserts into (3) value of electric elements composing the circuit of the section (2), the system will be automatically controlling according to the values. As the result, passive devices which we developed will have the same values as electric elements.

(4) Data output section
The data output section displays data obtained from the remote experimental equipment on the screen.

### 3. Results of RLC remote experiment

Remotely controlled passive elements which we developed are used in the remote laboratory suggested in fig. 9. We experimented performances of passive elements which are used in RLC series circuit.

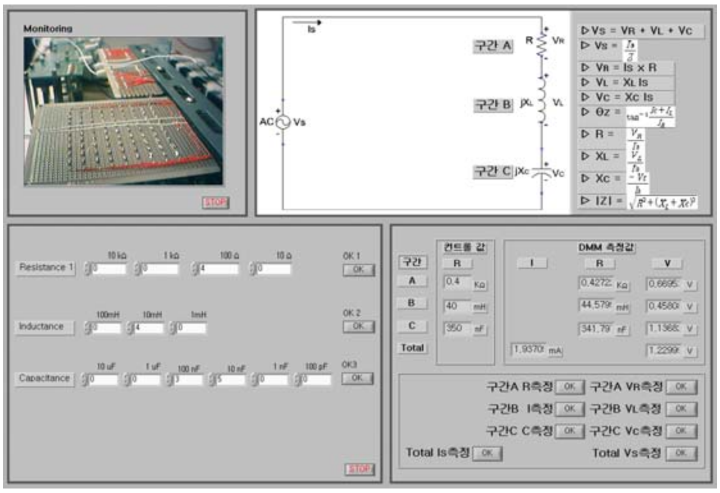


Fig. 8: RLC series circuit configuration

Table 1: Comparison between calculation and measured values in RLC series circuit

| | Calculation value | Measured value | error(%) |
|---|---|---|---|
| $V_R$ | 0.4[V] | 0.67[V] | 17.3 |
| $V_L$ | 0.27[V] | 0.46[V] | 33.3 |
| $V_C$ | 0.126[V] | 1.14[V] | 35.6 |
| $V_S$ | 1.11[V] | 1.23[V] | 10.89 |
| $I_S$ | 1.0[mA] | 1.14[mA] | 14 |
| **R** | 400[Ω] | 427.2[Ω] | 6.8 |
| **L** | 40[mH] | 44.6[mH] | 11.5 |
| **C** | 350[nF] | 341.8[nF] | 2.3 |

The average of remote controlling error for passive element R, L, C is below 6.86% in the table 1.

### 4. Conclusion

In this study, Our proposed system for remote laboratory was implemented in a way of helping the basic understanding of electric circuit. In especial we developed remote control devices that can be controlled passive component e.g. resistor, inductor, capacitor that is a basic element in the electric circuit. Because developed passive devices can response in an experiment altering several element values to remote, they will

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be used very usefully in the remote experiment which equipped with various experimental subjects. Therefore the proposed laboratory will be solved problems of virtual laboratory which students did not handle instruments in engineering experiment. With our proposed system, students can experiment any time, anywhere. But it is necessary to supplement several kinds in the remote laboratory. Because NI ELVIS equipment used to control hardware in the remote laboratory has large error tolerance during inputting/ outputting, we found that it happened to rise an error in some measure. It means that NI ELVIS is suited to educational equipment, not to industrial equipment which have to control and measure accurately. Because Devices used at the university experiment generally has 10% error tolerance or over, we can experiment with the passive devices in the remote laboratory. But if we develop passive devices having small error tolerance, the problems will be solved.

At present we are trying to overcome such limitations. There should be researching on technologies for the remote control of measuring instruments and for constructing, selecting and experimenting on various types of circuits

## REFERENCES


1. Rogers, P.L “Traditions to Transformations: The Forced Evolution of Higher Education", Education Technology Review, 9(1), 2001.
2. Anido, L., Lamas, M., and Fernandez, M.J., "Internet-based Learning by Doing", IEEE Transactions on Education 44(2):Accompanying CD-ROM, 2001.
3. Denise Consonni, Antonio Carlos Seara, “A Modern Approach to Teaching Basic Experimental Electricity and Electronics,” *IEEE TRANSACTIONS ON EDUCATION*, VOL. 44, PP.5-15, FEB. 2001.
4. Nedic, Z. Machotka, J., Nafalski, “Remote Laboratories versus virtual and real laboratories", 33rd ASEE/IEEE Frontiers in Education Conference, Boulder, Co,USA, 2003.
5. Hyounkyu Kim, “A Web-based Virtual Education System for Embedded System”, *Thesis for a bachelor’s degree*, Univ. of Soonchunhyang, 2003
6. Wansun Choi, “Development of Automation System for Filter Quality Test using LabVIEW”, *Thesis for a master’s degree,* Univ. of Soonchunhyang, 2004
7. http://www.mylv.net
8. http://www.ni.com/korea


[1] E-mail: cks1329@sch.ac.kr