Remote Laboratory Development for the Education in the Field of Electronic Measurement

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Abstract: Continuous development and implementation of information and telecommunication technologies based on multimedia and global networks, causes innovations in the field of measurement and education. The model of a distance measurement laboratory for intelligent measurement module characteristics verification is presented in this paper. This remote laboratory provides students of electronic measurement course, at the Faculty of Electronic Engineering in Nis, to access measuring system via Internet and directly carry out real experiments, without their physical presence.

Keywords: distance learning, virtual laboratory

1   Introduction

Nowadays, in electronic measurement teaching the main problems are increase in student numbers and in instrument cost and complexity, on one side, and the limited budget for the laboratory technicians and equipment, on the other side. The development of telecommunication and information technologies has opened new possibilities in realisation of experimental teaching in the field of electronic measurement [1]. Low price of microprocessor's components and systems, made possible the realisation of remotely accessible laboratories, which can be used for education. Those laboratories provide students to access measuring system via Internet and directly carry out real experiments without their physical presence.

2   Distributed architecture

The laboratory model, which is explained in this paper, has been realized as a distributed measurement system. The distributed measurement systems, as it's known, are the systems where it is possible to realize the network by linking a great number of remote subsystems, and where it is possible to change theirs software. If access to these distributed measurement systems is allowed via Internet, we have remote measurement laboratory, i.e. distributed measurement system based on client-server architecture [2].

System is realized as a hierarchical structure on few levels (Fig. 1). Students can access through application level. Those realization can be classified as a client / server architecture, where the student's computers are clients, and the computers in the measuring laboratories are servers. System is based on standard protocols and features, and can be easily expand [3].
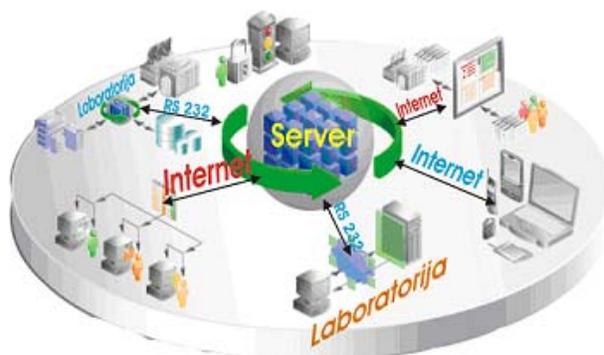

Fig. 1. Virtual laboratory

Main server manages the whole system. It allows access to the laboratory and the experiments, on one side, and forwards the assignment to the features which are in the environment, on the other side. The instruments in the laboratory are connected to the main server over standard interface RS-232, which routes the instructions and results of the experiment.

3   Software solution for the measurement laboratory realization

In order to develop the remote laboratory, the virtual instruments for measurement characteristics test of sensor module ADAM 4011 [4] are realized. These instruments are realized by program language LabVIEW [5]. They allows complete setup and control of the inteligent measurement module ADAM 4001, and measurement in all input bands.
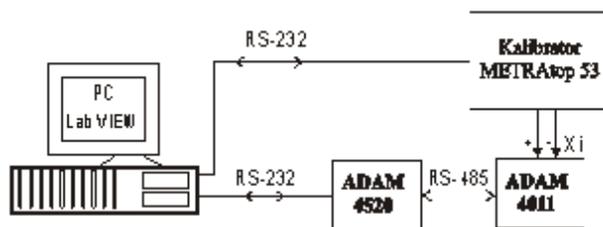

Fig. 2. Hardware connection scheme of the virtual instrument

Fig. 2 shows the hardware conection scheme of the virtual instrument. ADAM modules are connected to PC through RS-232/RS-485 converter, ADAM 4520. Standard values of

```
<script language="JavaScript">
<!--
function MM_goToURL() { //v3.0
var i, args=MM_goToURL.arguments;
document.MM_returnValue = false;
for (i=0; i<(args.length-1); i+=2)
eval(args[i]+".location='"+args[i+1]+"'");
}
```

Fig. 3. Example of the ASP pages' code

```
<script language="JavaScript">
   MM_goToURL('parent','vezba.asp');
</script>
```

Fig. 4. Example of the code 1.

electric signals, generated by calibrator METRAtop 53, are attached to inputs of intelligent measurement module [6].

Software solution, which connects the user and the appropriate LabVIEW application, is realized by standard procedure languages. In concrete system architecture, the Internet Information Server (IIS) is used as a web server. Student accesses the laboratory by standard browser and web address of the remote laboratory. Student requires the laboratory access by identifying itself through Login and Password. After that, browser forwards the requirement to the server.

The server checks added personal data and allows student to access the system only if the student exists in data base, which is created by the teacher or administrator. All information about the students who may access the laboratory, and all information about measurements which are made (including the measurement parameters and results) are placed in the data base. If student doesn't exist in data base, server refuses that student with a note to try again.

The access pages are done in ASP technology (Active Server Pages) and the biggest part of the pages' source code are Java and VB scripts.

Every page contains the piece of Java script, shown at Fig. 3, at the beginning of itself. In this way, the set of parameters can be automatically prepared, and redirect to the next page if it exists in the submitted array. Thus, by calling function MM_goToURL () with a set of strings between the brackets, it is able to redirect to any page and to submit a different subset of parameters.

Current implementation of the security is realized by using the session states. The access point to the application is through the user login page. There are no limitations in access to this page. When user (student) has entered his login information, a check of the laboratory availability is performed. Two different ways to access the laboratory are

implemented. The first one will let in the student only if the laboratory is free. Otherwise, the student will be returned to the very beginning. The second one will push a student into a waiting list and when it's turn come, demand for the laboratory access will be approved. The first solution is presented in Fig. 6.

Ones the student has entered his identification data, which considers username and password, query on the database performed. If the student's identification data are correct and such student exists in the database, a new session will be created for that student and he will get encoded key that will be used in the authentification process for every next access to some of the laboratory pages.

```
UserName = request ("user")
 Pass     = request ("pass")
 if (Session ("UcenikUsao") <> "") then
     .....
set Baza   = server.CreateObject ("adodb.connection")
set Tabela = server.CreateObject ("adodb.recordset")
baza.Open ("filedsn=BazaMerenja")
SQL = "select * from [user]
where (username='" & username & "')AND(pass='" & pass & "')"
set Tabela = Baza.Execute(SQL)
if Tabela.EOF then
  Tabela.Close
  Baza.close
  Session ("user") = UserName
else
   i        = Tabela ("ID")
  Ime      = Tabela ("ime")
  DPass    = Tabela ("dpass")
  Adr      = Tabela ("adresa")
  Prezime = Tabela ("prezime")
  Tabela.Close
  Baza.close
  dim s
  s = Encode (s);
  session("UcenikUsao") = s
  session.Timeout = 1
end if
```

Fig. 5. Example of the code 2

```
char *request_method = getenv("REQUEST_METHOD");
char *query_string = getenv("QUERY_STRING");
char *content_length = getenv("CONTENT_LENGTH");
if (request_method == NULL) return 0;
if (strcmp(request_method, "GET") == 0) {
    if (query_string == NULL) return 0;
    if (content_length == NULL)
        query_length = strlen(query_string);
    else
        query_length = atoi(content_length);
}
if (strcmp(request_method, "POST") == 0) {
if (content_length == NULL)
    return 0;
else
    query_length = atoi(content_length);
query_string = (char *)malloc(query_length);
if (query_string == NULL)  return 0;
for (pos = 0; pos < query_length; pos++)
query_string[pos] = fgetc(stdin);
}
```

Fig. 6. Example of the code 3

4   Example of the student's remote access

When the student's identification data are checked by the application and access is con-
firmed, the new page appears (Fig. 7). Student has to choose a measuring experiment.
When the choice is maden, in the next page (Fig. 8) the student has to enter specific set of
data (range, sample rate, number of measurements, etc.), which is necessary for laboratory
setup.

Based on this set of data, the input file of virtual instrument will be create. By pessing
OK button, the proper LabVIEW application runs up. LabVIEW application carries out
measurements with given parameters, and the acheived results puts into output data file.
Based on this data file, web page with the measurement results has been generated and the
results are shown to the student.

Important functionality of all standard programming languages is a possibility to make
an external call of another program application on the computer. This functionality is used
here for the calls of an appropriate LabVIEW application. When the input file is created, the
CGI script goes into a waiting state, while the appropriate LabVIEW application is running
and the output file is not created. Then, a HTML file is created and transferred to a student
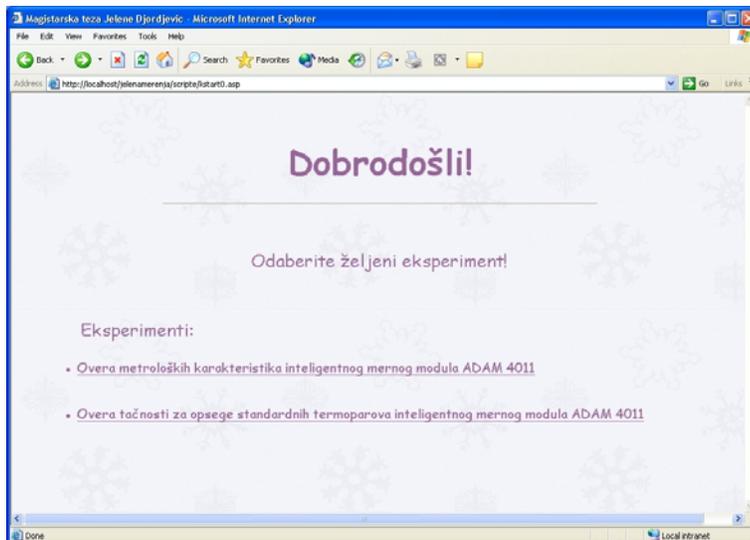[7] (Fig. 9).

Fig. 7. Page for the experiment choose.

In this case, the measurement results are given tabelary, thus the student can perform the required calculations and present the results graphicaly, if it is required from the teacher.Author names and affiliations are to be centered beneath the title and printed in Times 12-point, non-boldface type. Multiple authors may be shown in a two- or three-column format, with their affiliations italicized and centered below their respective names. Include e-mail addresses if possible. Author information should be followed by two 12-point blank lines.
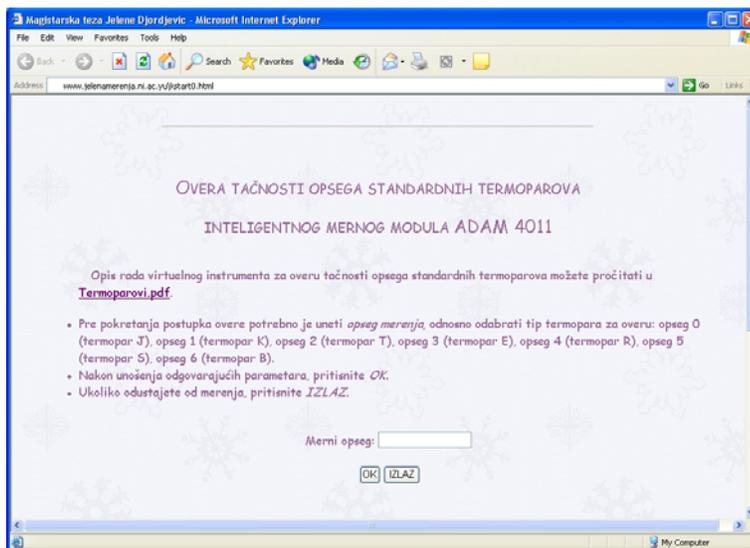

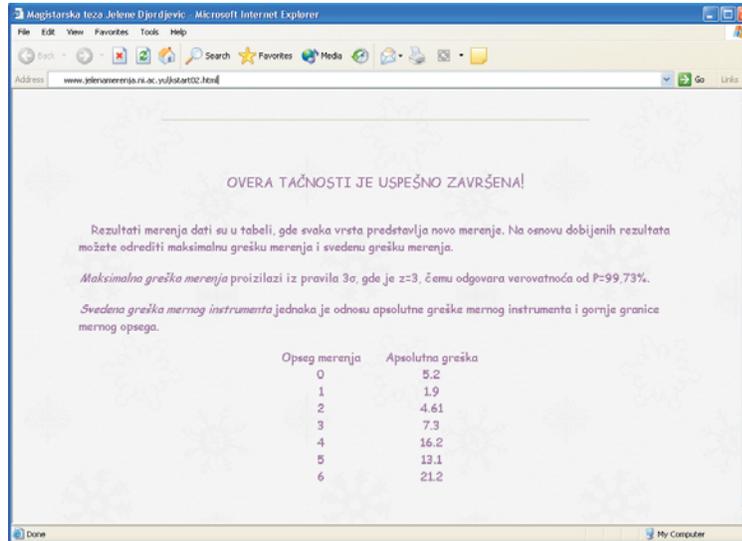Fig. 8. Page view for parameter determination.

Fig. 9. Report which student gets on the end of the measurement.

5   Conclusion

The advance of the information and telecommunication technologies opened a number of solutions in remote virtual laboratories development. Within a remote measurement laboratory, students can use all laboratory resources, even they are on geographicaly distant places. On the other side, it decreases the charges for laboratory technicians and equipment

Suggested system is based on client-server architecture, it is easy to expand as well as it makes possibilities for distant students to access the laboratory. System expanding can be shown with the increasing number of laboratories, which are connected to the system. Every laboratory needs a different LabVIEW virtual instrument, and it will be necessary to develop a virtual instrument for each laboratory. Templates used in communication between the virtual laboratory and the web based application make it easy extensible. New virtual instrument can be added with slight changes in the source code.

Also, it will be necessary to make the program, which will enable the selection of available laboratory and prevent of student's concurrence, if the number of laboratories increases. At the same time, the application has good bases for further development, related to easy handling, the possibility of easy upgrading and interface changing.

References

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