A Development Of Virtual Learning System For Tertiary Institutions In Nigeria

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ABSTRACT

In this study, a Virtual Learning System that integrates Virtual Classroom and Virtual Laboratory services is presented. The Virtual Classroom represents an interface between the students and a virtual professor and provides personalized learning materials to the users. The Virtual Laboratory offers a possibility to the attendees to share different resources at once and work with them as if they were at the same place where (real) resources are.

In the system design, we use agents as entities that work on different tasks in the system. A set of agents of the same type is responsible for handling different users and their requests. The cooperation among agents is established through the act of exchanging messages.

Virtual Learning System is implemented in Windows 9x/NT environment using Java for the agents' implementation.

Keywords: Web system, Object-oriented design, Distance education systems, Mobile agents, Java, Virtual Learning System (VLS).

1. 0 INTRODUCTION

In this study, a Virtual Learning System that integrates Virtual Classroom (VC) and Virtual Laboratory (VL) services is presented.

The VC service represents the interface between the students and a virtual professor and provides personalized learning materials to the users. Personalized learning materials can be created only if the system adapts to the student needs shown in the student's interaction process. That process is supported with the help of several mobile agents with different specialty, such as an agent responsible for student classification and a set of agents responsible for supporting learning activities such as finding the learning material relevant to student's needs. We consider VC only as a part of Virtual University. Thus, we try to develop a distributed architecture that can be reused for any course that can be activated in the Virtual University.

The VL offers a possibility to the attendees to share different resources at once and work with them as if they were at the same place where (real) resources are. One scenario can be to control remotely a robot system in a chemical laboratory from a PC connected on Internet. The idea of the resource is not limited to some specific laboratory equipment. As with VC, we use agents in the VL design as well. The difference is that they do not expose any mobility behaviour. As it is stated before, the cooperation among agents is established through the act of exchanging messages. In the case of the VL service, we designed several protocols for socket communications between the agents of different levels and different hosts in the system. All protocol definitions are represented using XML (Extensible Markup Language). It proved our choice, providing a great deal of flexibility, which is very important for the service, since it brings many different resources into one standard interface.

Section 2 describes the VC design. Section 3 presents the design of the VL service. The discussion about the implementation is given in section 4. Section 5 concludes the paper.

2. 0 VIRTUAL CLASSROOM OBJECT-ORIENTED DESIGN

VC is defined as an alternative of the "classical classroom". It can be used as an additional source for materials presented in certain courses. The main idea in the VC design is that users can log on from anywhere, and that on the user’s end, the only support necessary, is a Web browser. The whole system is web based and uses Java applets for its implementation [4].

Figure 1 represents an activity diagram of our VC. A user logs on the system through the supporting applet interface. If the user uses the system for the first time, he/she should register by filling in a registration form. Depending on the role in the system, a student or a professor, the user is provided with two different registration forms. The differentiation of the students from the professors is provided with two different login interfaces. After the registration takes place, the corresponding student or professor profile database is updated.

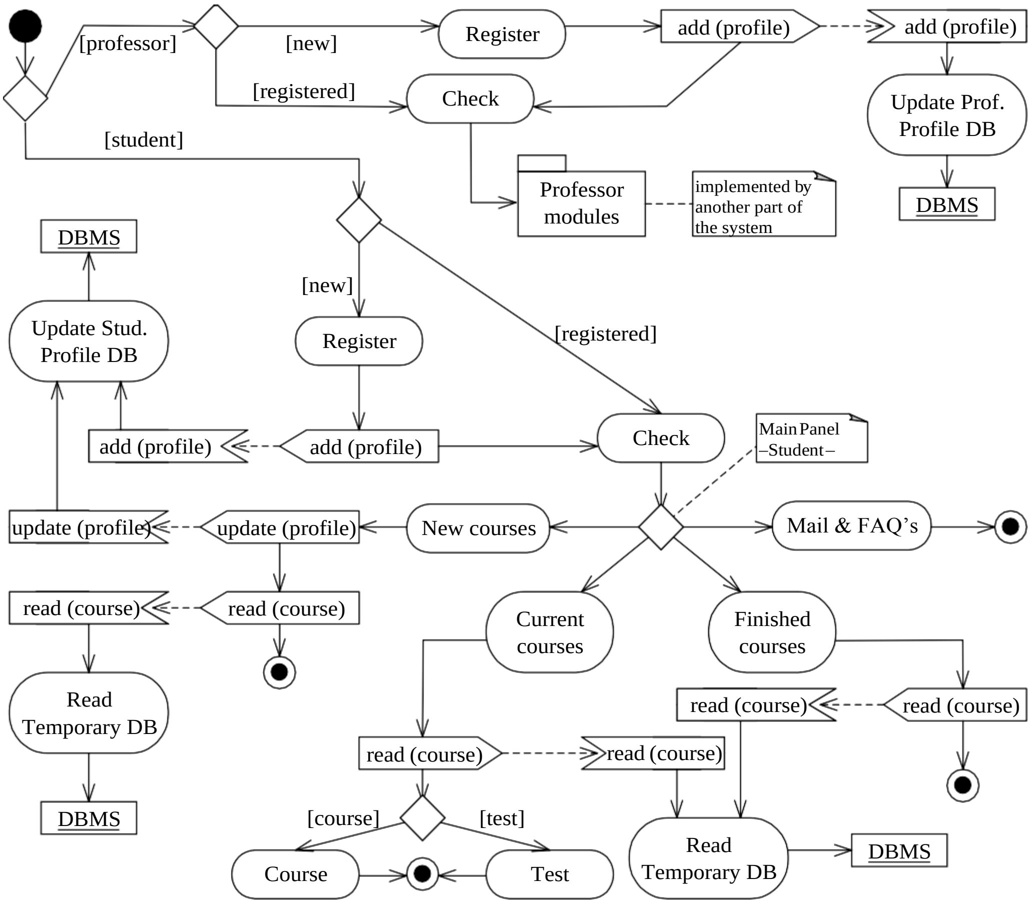


Fig. 1: VC activity diagram

Student registration is done through the Student Registration applet. Once the student logs on, the system opens student Main Panel. This panel allows the student to choose between several options (see Figure 1).

Professors are following the other branch of the diagram that is supported with another module of the system. These modules can be used for updating, posting new courses or previewing information about students attending a certain course. The system contains three groups of classes: agents, applets and query classes.

As an example, on Figure 2 we present two of the most representative classes from the agent group: Virtual Professor and Content Provider classes.

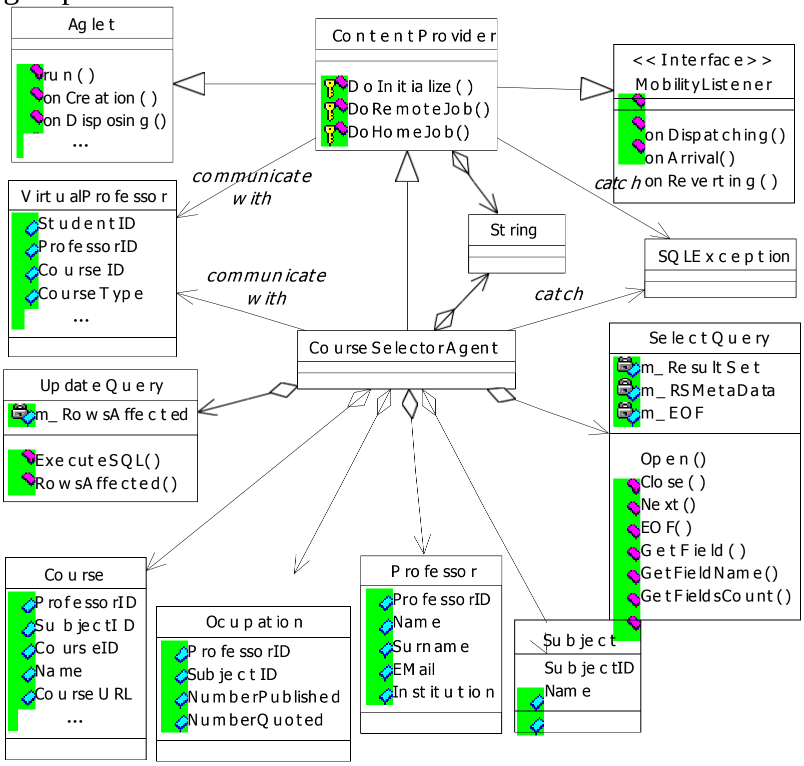


Fig. 2: Class diagram of the Virtual Professor, Content Provider and Course Selector Agent classes

The Virtual Professor class is an interface between applets and agents. It keeps data for the currently logged user and other useful data for the system. The Virtual Professor enables the communication among applets and agents. The Content Provider is a class parent for the rest of the agent classes. It defines agents' behaviour. The Content Provider class inherits its mobility characteristics from its ancestor classes, Aglet and Mobility Listener, which are part of the IBM Aglet agent-supporting platform. For more details about other VC system classes see [1].

3. 0 VIRTUAL LABORATORY OBJECT-ORIENTED DESIGN

The logical architecture of the VL system is given in Figure 3. Every user can work with the system by using a web-based interface. The Container Agent enables different resources, with different implementations of their graphical views, to be placed on the web-based interface. In this way every specific resource can be presented with a graphical interface representing the nature of the resource and can communicate with the users in a manner that is close to the "classical".

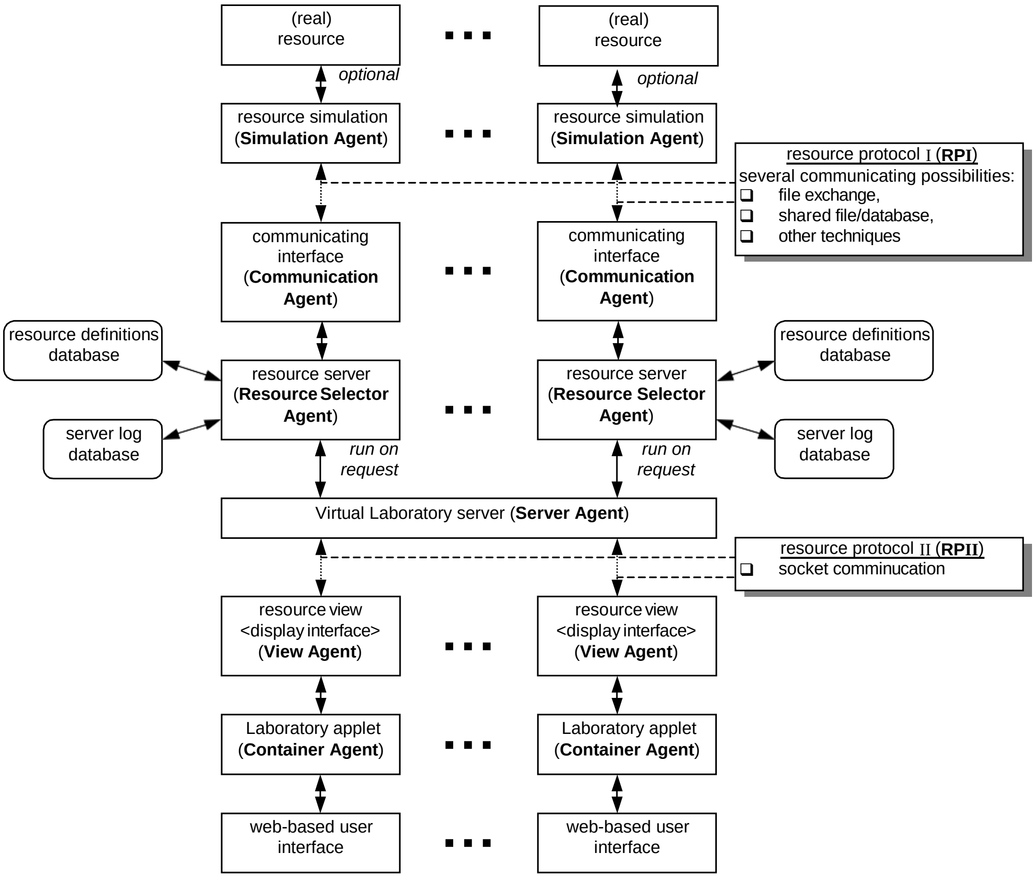

(real) resource
optional
resource simulation (Simulation Agent)
resource protocol I (RPI)
several communicating possibilities:
❑ file exchange,
❑ shared file/database,
❑ other techniques
communicating interface (Communication Agent)
resource definitions database
resource server (Resource Selector Agent)
server log database
run on request
Virtual Laboratory server (Server Agent)
resource protocol II (RPII)
❑ socket comminucation
resource view <display interface> (View Agent)
Laboratory applet (Container Agent)
web-based user interface
. . .

Fig.3: The architecture of the VL

View Agent is the key player on the client side (the web browser that the user is using to view the VL system). The system can hold many definitions of different View Agents, since every different resource or a group of resources should present an interface of its own to the user.

All of the system communication is done through two agents that run on the VL server, the Server Agent and the Resource Selector Agent. Every View Agent in the system communicates with the Server Agent when a connection to the VL server is required in order to communicate with a particular resource. The Server Agent handles different connection requests and runs a Resource Selector Agent as a thread that handles the specific requests and passes back the resource responses to the View Agent.

The Resource Selector Agent's task is to get the request from the View Agent, find the appropriate Communication Agent to communicate with the specific Simulation Agent and the real resource and then pass back and forth the requests/responses between the View Agent and Communication Agent (with possible message translation).

The Communication Agent's task is to enable the message translation and communication in general with the Simulation Agent and the (real) resource. All of the agents mentioned above are stationary agents and implemented as pure Java classes, but the set of Simulation Agents implementation is based on DCOM (Distributed Component Object Model). This enables a distributed computing of the resource requests. The Simulation Agent's task is to wrap around a physical resource in a software entity working in the VL system.

The communication between agents is accomplished via XML defined protocols (see an example of a XML defined protocol on Figure 4) that give a flexible way for agents to exchange common messages.

View Agent	Resource Selector Agent
<CONNECT/>	<ACKNOWLEDGEMENT/>
<ACKNOWLEDGE> <ID>vlClient35</ID> <CODE>VLAB</CODE> </ACKNOWLEDGE>	<ACCEPTED> <ID>vlClient35</ID> <CODE>BALV</CODE> </ACCEPTED>
<RESOURCE> <ID>vlResource_Chem_Robot</ID> </RESOURCE>	<RESOURCE> <ID>vlResource_Chem_Robot</ID> <AVAILABLE>YES</AVAILABLE> </RESOURCE>
<REQUEST> <COUNT>1</COUNT> <ITEM> <TYPE>STRING</TYPE> <NAME>Direction</NAME> <VALUE>LEFT</VALUE> </ITEM> </REQUEST>	<CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE>
<RESPONSE> <COUNT>3</COUNT> <ITEM> <TYPE>NUMBER</TYPE> <NAME>x</NAME> </ITEM> <ITEM> <TYPE>NUMBER</TYPE> <NAME>y</NAME> </ITEM> <ITEM> <TYPE>NUMBER</TYPE> <NAME>z</NAME> </ITEM> </RESPONSE>	<CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE>
<CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE> <CONTINUE>YES</CONTINUE>	<RESPONSE> <ERROR> <NUMBER>0</NUMBER> <DESCRIPTION> No error. </DESCRIPTION> </ERROR> <COUNT>1</COUNT> <ITEM> <TYPE>NUMBER</TYPE> <NAME>x</NAME> <VALUE>135</VALUE> </ITEM> <ITEM> <TYPE>NUMBER</TYPE> <NAME>y</NAME> <VALUE>23</VALUE> </ITEM> <ITEM> <TYPE>NUMBER</TYPE> <NAME>z</NAME> <VALUE>-35</VALUE> </ITEM> </RESPONSE>
<DISCONNECT> <ID>vlClient35</ID> <CODE>BALV</CODE> </DISCONNECT>	<DISCONNECTED> <ID>vlClient35</ID> <CODE>VLAB</CODE> </DISCONNECTED>

Fig.4: XML defined protocol

4. 0 IMPLEMENTATION DETAILS

Virtual Learning System is implemented in Windows 9x/NT environment. All agents are developed in Java, with one exception, the set of Resource Simulation Agents in the VL service, which are based on DCOM technology.

The VC service agents use the mobile agents support platform, IBM Aglets. It is available for free download from http://www.trl.ibm.jp.co/aglets. Aglets are objects that can perform their work on many different hosts (servers). During the transfer from one host to another, they carry their code and internal state. For more details see [1].

The main components of the VC service are shown on Figure 5.

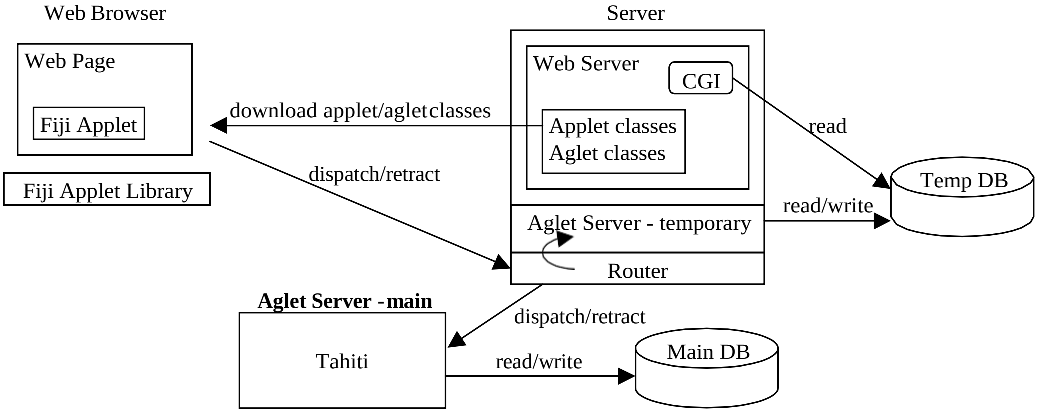
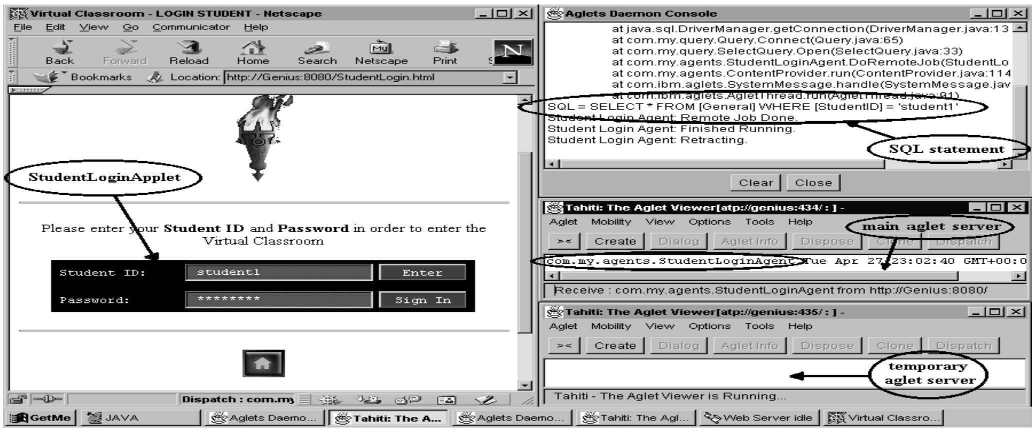


Fig. 5: The main components of the VC service

Figure 6 shows our classroom in action.


Virtual Classroom - LOGIN STUDENT - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print
Bookmarks Location:
StudentLoginApplet
Enter
Sign In
Aglets Daemon Console
SQL statement
Clear Close
Tahiti: The Aglet Viewer[atp://genius:434/ :] -
Aglet Mobility View Options Tools Help
>< Create Dialog Aglet Info Dispose Clone Dispatch
main aglet server
Tahiti: The Aglet Viewer[atp://genius:435/ :] -
Aglet Mobility View Options Tools Help
>< Create Dialog Aglet Info Dispose Clone Dispatch
temporary aglet server
GetMe JAVA Aglets Daemo... Tahiti: The A... Aglets Daemo... Tahiti: The Agl... Web Server idle Virtual Classro...

http://Genius:8080/StudentLogin.html

Please enter your **Student ID** and **Password** in order to enter the Virtual Classroom

Student ID: student1

Password: ********

Dispatch : com.my

```
        at java.sql.DriverManager.getConnection(DriverManager.java:13
        at com.my.query.Query.Connect(Query.java:65)
        at com.my.query.SelectQuery.Open(SelectQuery.java:33)
        at com.my.agents.StudentLoginAgent.DoRemoteJob(StudentLo
        at com.my.agents.ContentProvider.run(ContentProvider.java:114
        at com.ibm.aglets.SystemMessage.handle(SystemMessage.jav
        at com.ibm.aglets.AgletThread.run(AgletThread.java:91)
SQL = SELECT * FROM [General] WHERE [StudentID] = 'student1'
Student Login Agent: Remote Job Done.
Student Login Agent: Finished Running.
Student Login Agent: Retracting.
```

```
com.my.agents.StudentLoginAgent Tue Apr 27 23:02:40 GMT+00:0
```

Receive : com.my.agents.StudentLoginAgent from http://Genius:8080/

Tahiti - The Aglet Viewer is Running...

Fig. 6: VC in action

Being of stationary type, no mobility support platform is required for the VL service agents. Figure 7 shows the component layout of the VL service, which uses similar host architecture as the VC service.

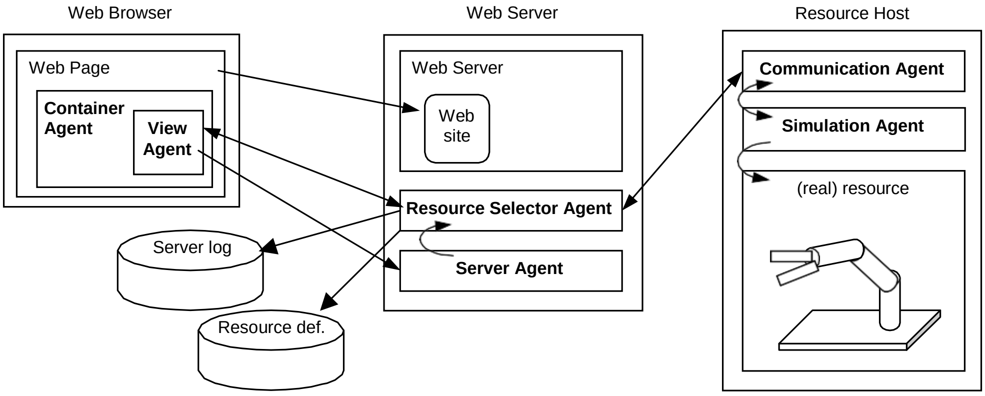
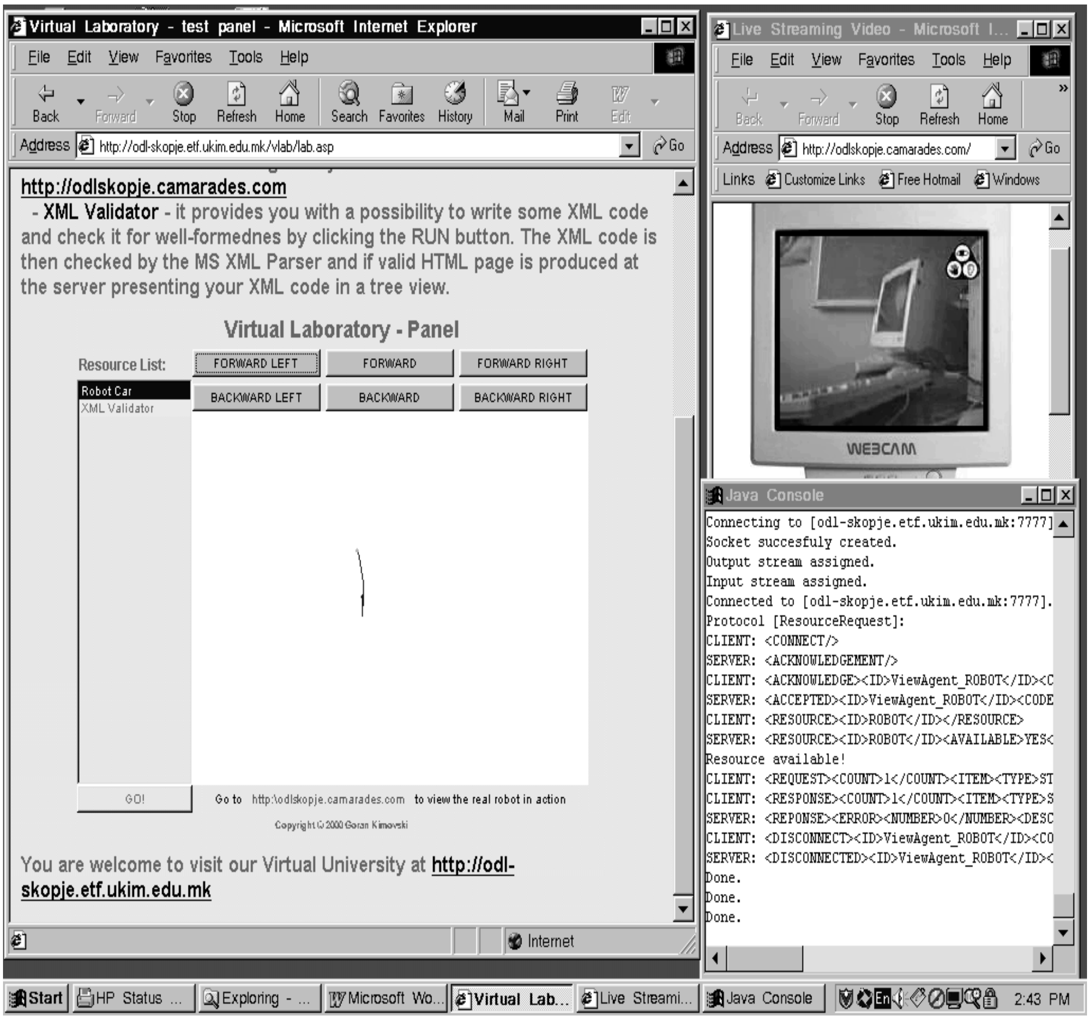


Fig.7: The main components of the VL service

Figure 8 shows the VL service in action. In this case, our resource is a mobile robot. On the left side of the Figure 8, the VL panel provides six control commands for robot movements and the corresponding trajectory. On the right side, we can see the view from the web camera attached on the robot.


Virtual Laboratory - test panel - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit
Address
Go
Resource List:
FORWARD LEFT
FORWARD
FORWARD RIGHT
BACKWARD LEFT
BACKWARD
BACKWARD RIGHT
Robot Car
XML Validator
GO!
Internet
Live Streaming Video - Microsoft I...
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home
Address
Go
Links Customize Links Free Hotmail Windows
WEBCAM
Java Console
Start
HP Status ...
Exploring - ...
Microsoft Wo...
Virtual Lab...
Live Streami...
Java Console
2:43 PM

http://odl-skopje.etf.ukim.edu.mk/vlab/lab.asp

http://odlskopje.camarades.com

- **XML Validator** - it provides you with a possibility to write some XML code and check it for well-formednes by clicking the RUN button. The XML code is then checked by the MS XML Parser and if valid HTML page is produced at the server presenting your XML code in a tree view.

Virtual Laboratory - Panel

Go to http:\odlskopje.camarades.com to view the real robot in action

Copyright © 2000 Goran Kimovski

You are welcome to visit our Virtual University at http://odl-skopje.etf.ukim.edu.mk

http://odlskopje.camarades.com/

```
Connecting to [odl-skopje.etf.ukim.edu.mk:7777]
Socket succesfuly created.
Output stream assigned.
Input stream assigned.
Connected to [odl-skopje.etf.ukim.edu.mk:7777].
Protocol [ResourceRequest]:
CLIENT: <CONNECT/>
SERVER: <ACKNOWLEDGEMENT/>
CLIENT: <ACKNOWLEDGE><ID>ViewAgent_ROBOT</ID><C
SERVER: <ACCEPTED><ID>ViewAgent_ROBOT</ID><CODE
CLIENT: <RESOURCE><ID>ROBOT</ID></RESOURCE>
SERVER: <RESOURCE><ID>ROBOT</ID><AVAILABLE>YES<
Resource available!
CLIENT: <REQUEST><COUNT>1</COUNT><ITEM><TYPE>ST
CLIENT: <RESPONSE><COUNT>1</COUNT><ITEM><TYPE>S
SERVER: <REPONSE><ERROR><NUMBER>0</NUMBER><DESC
CLIENT: <DISCONNECT><ID>ViewAgent_ROBOT</ID><CO
SERVER: <DISCONNECTED><ID>ViewAgent_ROBOT</ID><
Done.
Done.
Done.
```

Fig. 8: VL in action

Implemented Virtual Learning System is modular. Adding the new features to the system can be achieved by defining new classes. Inheritance provides a way for derived classes to reuse all the functionality of ancestor classes with special functionality additionally applied to the derived classes.In the last phase of building the system, a group of 20 students at their last year of graduated studies have been involved in the design process rather than having them participate in a formal usability program. According to the experience of many companies, much can be gained from direct interaction between end users (students) and developers (a group of researchers at the Faculty) [2]. For example, in [3] usability testing is replaced with user dialogue. In our case, the students formulate their own user scenarios, rather than dictating specific test scenarios. From interactivity point of view, they described the system as a convenient tool for a professor - student communication. A lack of certain conferencing tool that can be used by the professor to point out certain important issues was reported. The need for sending files was also noticed. These suggestions will be a part of the next system upgrade (for example, by introducing on line chat facilities). Student groups with different background tested the usability of the system. The results of the test pointed out that the system is most suitable for students from the engineering and computer science department. These results were expected, because in that case the users were more familiar with the working environment. The use of VL services was emphasized as very useful. The system was less suitable for the students in human sciences where student - professor communication is mostly verbal. This weakness will be avoided with introduction of the audio conferencing tool into the system. General opinion about the system interactivity and usability is positive

0 CONCLUSION

In this study, a Virtual Learning System that integrates Virtual Classroom and Virtual Laboratory services was presented.

An important extension of the system is to add a module for knowledge level estimation of the students. We plan to design this module by deriving a new set of classes from the previously developed ones such as a Content Provider Class.

With the usage of software agents, we managed to provide a certain transparency of the physical allocation of the hosts in our system, needed for different types of data manipulation and resource sharing. During the usability testing, students found the system intuitive and easy to use.

References

[1] Vladimir Trajkovic, Danco Davcev, Goran Kimovski, Zaneta Petanceska. "Web - Based Virtual Classroom", In Proc. Of the TOOLS 34, Santa Barbara, California, USA, July 30 - August 4, 2000.

[2] K. H. Madsen, "The Diversity of Usability Practices". Communications of the ACM, Vol. 42, No. 5, 1999, pp. 60- 62.

[3] J. Buur, K. Bagger. "Replacing Usability Testing with User Dialogue", Communications of the ACM, Vol. 42, No. 5, 1999, pp. 63-66.

[4] Abasiama G. Akpan, ‘Influence of Cloud Computing on Virtual Classroom Adoption in Nigerian Universities’. Master Thesis (M.sc), National Open University of Nigeria, Unpublished, 2013.