

Distributed Learning Environment using Advanced Services over the Internet

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Abstract

Multimedia and hypermedia had and still have a tremendous impact on the evolution of educational software. In this paper we propose an Integrated Distributed Learning Environment (IDLE) for the implementation of the services of an educational network over TCP/IP networks such as the Internet. Our proposal aims at providing an integrated communicational environment, which supplies the communicative needs of an educational community, using the latest telecommunication and multimedia information processing technology. The environment that we implemented can be used for virtual lectures, virtual conferences, collaborative work on projects, which are shared among institutions, exchange of useful material and experiences among teachers, and creation of educational material.

Keywords: Distributed Multimedia Systems, Distance Learning, Collaborative Systems.

1. Introduction

Today we can register a growing public interest in the Internet and especially in the World Wide Web. At the same time, the computer networks are becoming increasingly fast with the use of new technologies. Furthermore Asynchronous Transfer Mode (ATM) based networks, which offer speed up to 155 Mbps, are installed and new technologies are proposed for the infrastructure of the computer networks. Moreover new Internet protocols like the RTP/RTCP (Real-time Transport Protocol / Real-time Transport Control Protocol), which have characteristics like payload type, time-stamping and numbering of data packets, make possible the transmission, over the Internet, of real time multimedia information offering Quality of Services (QoS). These

achievements make possible the implementation of tools that offer teleteaching capabilities over the Internet with QoS characteristics. All the above described achievements make the implementation of tools that offer synchronous learning, asynchronous learning and Computer Support Collaborative Work for Learning (CSCW/L) capabilities over the Internet possible.

The advent of the World Wide Web has seen a tremendous expansion in use of the Internet teaching and learning. This paper addresses the role of synchronous and asynchronous Internet communication in distributed teaching and learning and also presents an Integrated Distributed Learning Environment (IDLE). IDLEs are client/server applications using standard Internet protocols. Previously, most IDLEs had proprietary client-side applications which constrained the users to load special software onto their home or business computers. However, almost all IDLEs now have enabled their software to be accessible via common World Wide Web browsers, such as Netscape Navigator and Internet Explorer. The subject of distant learning and collaboration has engaged researches all over the world. Many solutions have been proposed for distant learning and collaboration over the Internet [1].

The main feature of our tool is its fully integrated environment, which is flexible and adaptive to many possible requirements. In other words, our proposal aims at covering a wide range of related applications instead of limiting its capabilities to a specific operation, which is the case with other existing tools. For instance, the model that we propose can be used for virtual lectures, virtual conferences, collaborative work on projects which are shared among institutions, exchange of useful material, experiences among teachers, research results and conclusions as well as versatile and more attractive

presentations of the subjects taught. Our proposal is based on the needs of an educational network as they are described in the next section. This paper presents the motivation factors that motivate us to implement that tool, describes the model and the architecture of the system, the functionalities of the IDLE, some implementation issues and finally presents the usage scenarios.

2. Motivation

Open and Distance Learning (ODL) could be regarded as the process of learning with the use of Telematics that is the combination of telecommunication, information and multimedia technology and its services [2,3]. In such a scenario: All the interactions among trainees, trainers and instructional material, which are essential for the instructional process, can be implemented. The information and the knowledge, which are essential for the instructional process are accessible and readable. The place, time and the pace of learning are flexible.

The ODL has the following main goals: The development of learning environments and methods suitable for the use of information technology to different learning environments. The improvement of the organization environment, in which these new methods are applied, and the quality and manageability of the multimedia applications and the real time services. The encouragement achieved is recognizing the quality characteristics obtained through teaching with the use of new ODL technologies and services. The encouragement of the recognition of the quality characteristics which are gained from learning with the use of new ODL technologies and services.

The target of the ODL is the development and promotion of special methods and techniques for the increase of the quality, the effectiveness and the suppleness of the learning. The ODL has two main results: The educational: The improvement of the existing learning methods and the development of new learning methods and the technological: The provision with new distance learning methods with the use of Information and Communication Technologies (ICT). An ODL environment combines various instructional scenarios such as collaborative learning and education with or without the live presentation of the Professor.

The Integrated Distributed Learning Environments provide a common environment for the implementation of all the above scenarios and the way to success in specific educational targets such as: The renewal of the pedagogical methods and environments in the Educational Institutes. The incentives for the diffusion of information among the Educational Institutes in the World. The encouragement for the collaboration. The motivation of the trainees with the use of effective and modern equipment for the lesson. The effective transmission and distribution of the instructional material to the trainees

Our IDLE is the result of our assay to upgrade and integrate two others tools [4,5]. The IDLE that proposed in this paper has the following goals: To meet the communication needs of a group, such as e-mail, discussion lists, chat and videoconference. To fulfil the educational and instructional needs of the University of Patras, such as synchronous and asynchronous multimedia (audio, video, text and graphics) lessons. To provide a common and familiar user interface via common World Wide Web browsers, such as Netscape and Internet Explorer

3. Model and Architecture Description

In order to achieve the above goals our proposal is based on the following concepts: An integrated communication environment that covers the communicational needs of a group of participants. A client-server model. We propose a model that has one server and multiple participant clients. An open platform architecture in order to support different operating platforms. International accepted standards. Access through Web pages. Object oriented design and implementation. Modular design to achieve the goal of easy extension

The proposed architecture is based on the concept of Session. One session is composed from the Participants of the session and the information that the session contains. The participant who creates a session has full permissions on that session and manages that session. We call this participant, Leader participant. The other participants (the participants except the leader participant) have the permissions that the leader participant has given to them. The information, which a session can contain, includes data file (in many different MIME types), hyperlinks, notes and meetings-lessons.

Figure 1 displays the general architecture of the IDLE. The IDLE follows the client – server architecture. The IDLE server consists of the WWW server, the Teleteaching server, the Media Server and the Database of the system. The clients access the capabilities of the IDLE server through the WWW server. In addition the WWW server is used to store the educational materials in form of HTML pages. The Teleteaching server is responsible for the management of the educational process. With the use of the media server, the participants have the capability to transmit and receive real time video and audio, which can be used for synchronous and asynchronous learning. The IDLE server is using one Database schema to store information about the different session and the users of the system.

The participant client consists of a Java enabled Web browser. If the participant wants to receive video and audio information, he must have installed on his computer the Real Player [6] application. If the participant wants to transmit video and audio information he must have installed on his computer the Real Encoder [6]

application. The advantage of Web browsers as the interface for distributed learning environments is that they are popular, easy to use, and require no additional proprietary software on a user's computer. Moreover, they provide access through different computer platforms like Windows, Mac and UNIX.

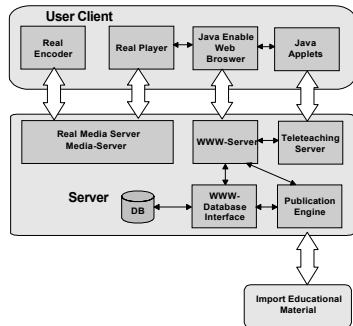


Figure 1: General architecture

4. Functionalities

Due to various kinds of communication in a classic situation of learning or collaboration, different mechanisms must be established for sufficing the needs of an educational community over the Internet by our tool. Our tool will attempt to broaden the horizons of learning and collaboration. Thereby, optimized integration with simple operation mechanisms is an essential necessity. In order to create a complete learning system, which is able to satisfy the needs of an educational network, our tool is designed as a simulation of a real situation.

The relation between the services for the integration of the distributed learning environment is shown in Figure 2

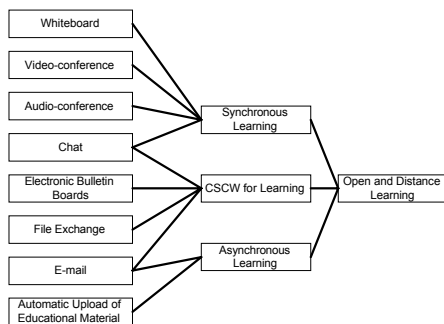


Figure 2: Services of the ODL

As it has been already stated, our tool follows the client - server architecture and has two environments, the server environment and the participant environment. In the following sections we describe separately the functionalities of each environment.

4.1. Functionalities of the server environment

The server acts like a meeting point for the participants. The server is saddled with the functions of

management of educational material, session creation, session announcement, session registration and authentication control. The participants can be informed of the several sessions, register to one session, join one session or create their sessions through the server. The functionalities for the server are the following:

- Management of educational material: The server with the association of the web server, where the educational material is stored as hypermedia, offers the participants the capability to access the educational material of the educational network.
- Session creation: One participant can create one session and become leader participant of that session. Through the session creation procedure the leader participant gives the necessary information for the announcement of the session in the electronic bulletin board.
- Electronic bulletin board for session's announcement: The server has an electronic bulletin board in order to inform the participants the different sessions and for questions and replies for topics which are relevant to the specific session.
- Session registration: When a participant finds a session that interests him, he can register for it through the session registration procedure. Session registration procedure gives the leader participant the ability to know the other participants that register to his session.
- Authentication control for a session: A participant has to pass the authentication control in order to join a session. After the authentication control the participant can access the pages of the session that he has joined. With the authentication control the server can recognize the leader participant and enable his session management module. The server handles the authentication control. This functionality differences the participants and gives them a different user interface with different functionalities that are described in the following paragraphs.

4.2. Functionalities of the participant client environment

Students and teachers access the capabilities of the educational network through the participant client. The client environment is the same for all the participants except the leader participant of a specific session. The difference between the leader participant and the other participants is that the session management module is active in the leader participant client. This approach is followed because a simple participant, in a session, can be leader participant in another session and the reverse. The participant client environment is friendly for the user and provides the following functionalities:

- Video/Audio conferencing: A participant can have visual contact with the other participants through video windows, if the necessary bandwidth is available. Through this capability the participants can

communicate as if they were in the same physical place.

- **Whiteboard:** One participant can broadcast information to other participants, like slides, shapes, etc by using the whiteboard. With the whiteboard the participants can exchange ideas. More specifically whiteboard is an effective way for communication.
- **Chat:** The chat function can work together with the audio capability or solely when the audio communication is not feasible. The chat function gives us a flexible solution for communication when the available bandwidth is limited.
- **Ability for bi-directional and multi-directional independent communication:** A participant has the authority to select the participants that he is addressing.
- **File exchange:** The ability to exchange files between the participants who contribute to the learning procedure.
- **E-mail:** The ability of the tool to support typical e-mail functions (sending and receiving e-mails) helps the creation of the integrated communication environment that we want to provide.
- **Asynchronous learning:** A participant can view an asynchronous lesson which consists of two main parts: the professor's video window and the window with the instructional material. The video is synchronized with the instructional material.

In addition the leader participant client environment offers the following functionalities:

- **Session management:** Through this capability the leader participant can manage the session and determine the permissions of each participant.
- **Automatic upload of the material for the asynchronous lessons:** The leader participant can send his synchronized video and instructional material to create an asynchronous lesson.

The Figure 3 displays the GUI (Graphical User Interface) of the leader participant client.

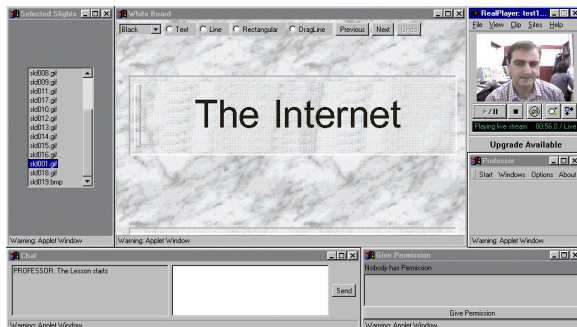


Figure 3: The GUI of the leader participant client

5. Implementation Issues

In this section, we present some implementation issues, including the technical design and the programming languages that are used.

As already we have stated our proposal is accessed with the use of a Java enabled web browsers. The user interface of the IDLE consists of web pages. For the development of the web pages, we use HTML 3.2. Many functionalities of the IDLE (like session management, the discussion lists, etc.) were developed with CGI programming and particularly with the use of Perl 5.0 language. Perl is a programming language which is very popular for CGI programming. Moreover Perl is available on many platforms including Unix based machines and Windows NT. We choose Perl for CGI programming because it is a wide used language for this scope, supporting many operating platforms and we are familiar with it. The WWW server that is used is the Apache WWW server. Apache is one of the most popular WWW servers, which offers increased reliability, flexibility and security.

In order to ensure the independence of the operating platform, we use Java, which is a programming language independent of operating platforms. With the use of Java, our proposal can be accessed by different machines like Windows based or Unix based machines. In addition, Java is an object-oriented language, which facilitates the design of systems with the use of objects. For the implementation of the Teleteaching server we use Java. The Teleteaching server, as a servlet, cooperates with the WWW server and manages the live educational procedure. The Teleteaching server consists of four (4) modules: the session control module, the whiteboard module, the chat and the lesson control module. Each module operates independently, and it is responsible for one particular part of the educational process. Each part of the Teleteaching server communicates with the corresponding Java applets of the participants clients, in order to accomplish the educational process. The communication between the Teleteaching server and the Java applets of the participants' clients is based on the TCP sockets network communication model. With the above-described design we achieve the goals of modular design, easy maintenance and easy extension of the Teletraining server. For security reasons both the Teleteaching server and the WWW server must be installed at the same physical computer.

As media server we use the Real Media Server [6]. Real Media Server offers a variety of codecs for the compression of the audio and the video and it is one of the most ubiquitous streaming media servers. In addition Real Media Server provides the capability of multicasting transmission of the audio and video, which is used by our IDLE. With this approach, we deal with the Quality of Service (QoS) and the network traffic with the best manner.

6. Usage Scenarios

Our tool is well suited for the communication needs of an educational community for various situations. In this section we describe usage scenarios, of our tool, for

synchronous and asynchronous learning and collaborative work for a project.

6.1. Synchronous learning

In the scenario of synchronous learning we have a teacher and his students who want to participate in a synchronous lesson. Before the lecture the teacher has to create a session through the session creation capability and become the leader participant for that session. The new session and the information for it (like theme, teacher, day and time) is announced in the electronic bulletin board of the server. The students can register to the session through the register procedure of the server. After the registration procedure, students become participants of the session. The teacher and the students join the session through the authentication control, at the arranged day and time of the lecture. With the authentication control the server recognizes the leader participant, in this case the teacher. The teacher as the leader participant can determine, through the session management, the authorities of each student. The teacher can make his lecture with the video/audio applications and use the whiteboard, which simulates the blackboard of a traditional classroom. The teacher may project educational material on the whiteboard, which is available on all the students. The students can annotate the educational material during his lecture. The other functionalities of the client can help the learning process. Apart from a teacher's lecture, students can access the educational material on their own without the need of teachers being present (asynchronous learning scenario).

6.2. Asynchronous learning

In the scenario of asynchronous learning the leader participant is the teacher and the other participants are his students who want to attend the asynchronous lesson. Before the lecture the teacher has to create a session through the session creation capability and become the leader participant for that session or to create the lecture in a session in which he is the leader participant. The creation procedure consists of three steps: the creation of the instructional material (docs, slides, etc.), the creation of the video, the synchronization of the video and instructional material and the transmission of the synchronized instructional material to the server. In the case that he creates a new session this session and the information for it (like theme, teacher, day and time) are announced on the electronic bulletin board of the server. The students can register to the session through the registration procedure of the server. In this scenario the participant gains the access to information resources and he can attend the lesson at the space, time and pace that he wants. Multimedia technologies such as RealMedia are used in this scenario and the participant can attend and review the lesson as many times as he wants.

6.3. Collaborative work

In the scenario of collaborative work for a project we have a group of participants who want to communicate through the distance collaborative work. One participant creates a session and becomes the leader participant of that session. The other participants register to that session. All the participants join the session through the authentication procedure. The leader participant determines the permissions of each participant. The participants can work and collaborate through the capabilities of the participant client. The participants can communicate through both the chat and e-mail capability, release solutions to a problem or put a question in the electronic bulletin board.

7. Conclusion - Future Work

The implementation of our tool suffices the needs for collaborative work and for ODL in asynchronous and synchronous mode. Although no one can expect that educational networks will totally replace the traditional lecture and traditional collaborative work, it is likely that such applications will obtain more and more positive ground in the future. In addition to this, the IDLE which was implemented, should be more friendly and functional. According to this our next steps are the implementation of a VRML interface and the implementation of the T.120 protocol. The VRML interface will give a friendlier user interface, which will enable the students to feel that they are in a traditional lecture or collaborative work. The implementation of the T.120 protocol will provide the application sharing functionality, which will help the instructional, and the collaborative work procedure to be more functional.

In addition the evaluation and the usage of our tool is essential for its future extension.

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