INTEGRAL MULTIMEDIA SYSTEM FOR NON-PRESENTIAL TEACHER-STUDENT ADVISORY THROUGH INTERNET

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Abstract

In the context of e-learning technologies this paper presents E-tutor, a multimedia oriented system that allows students to be remotely in touch with his/her teacher through the Internet. The system is mainly intended to provide a videoconference service which helps the student to accomplish a virtual tutorship. Besides the audio and video interaction, E-tutor is designed to offer a text-based interaction between users, by means of a chat-like module, and a graphical-based interaction, by means of a proprietary blackboard tool that allows us to emulate the usual student-teacher interaction carried out in attendance classroom. The core of E-tutor is basically a specific purpose directory service, through which the student will easily locate and initiate the virtual tutorship. E-tutor is based on the TCP/IP client-server paradigm, and makes use of an administrative server that manages the service in a centralized way and makes it transparent and easy to use for the students and teachers.

1. Introduction

Technology is leading the world to change quickly. A few years ago the number of computers connected to Internet was quite small, whereas nowadays a high percentage of PCs have access to the “net of nets”. Meanwhile, ISPs and telecommunication companies are offering everyday a faster access with innovative technologies. All these achievements have given rise to new applications and services that are changing the human way of live: we spend a lot of time in front of the computer not only for working but also for entertainment by searching for info, playing or chatting with other people, etcetera. The Information Technologies have gained, thus, a very important role in our society.

In this context, a new form of education (that is to say, sharing information) is arising: e-learning. The main benefit of this technology is concerned with tele-education, which offers the paradigm of any-time, any-place training with no temporal or spatial constraints. Hence, the main objective of e-learning systems is to extend the digital culture to the education field. Several and important efforts have been made by different institutions over the world with this purpose [2,3]. Various aspects must be considered to achieve the above goal. Among them it is worth to mention the improvements in networking infrastructure, the need of training teachers on new educational tools and skills, and the need of developing and deploying services. In this sense, a good number of systems have been already developed [1,4,5].

This paper presents a new and improved version of the so called E-tutor system, a useful software tool designed to complement traditional teaching [4]. The main feature of E-tutor is that it offers to the students the possibility of carrying out a videoconference-based advisory session with the instructor to talk with him or her online. The hallmark feature of E-tutor respect to other videoconference tools is that E-tutor is coupled with a specific directory server which manages the session by taking into account the particular subject and the teacher availability.

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That is, the (administrative) server process controls for each subject which trainers are online at each moment, establishing the requested session between the student and the selected lecturer. On this basis, several advanced capacities have been added to the new upgraded version of *E-tutor*. The most remarkable are two additional types of interaction allowed between students and teachers: a text-based and a graphical interaction. The first one lets a textual dialog between the two parties, whilst a specific graphical module has been designed and developed to provide the second of the mentioned new interactions.

After this brief introduction, the structure of the rest of the paper is as follows. Section 2 introduces the overall architecture and functionality of the system. Each of the modules is described in next sections, emphasizing the main differences with the first version of the system. Thus, Section 3 details the database directory manager, Section 4 deals with the administrative server, Section 5 describes the student and teacher modules, and Section 6 discusses the types of interaction provided. Finally, Section 7 summarizes the conclusions of the paper and points out some future work to be done.

### 2. Architecture and functional description of *E-tutor*

*E-tutor* offers a service which allows a student to connect to the instructor and to establish with him or her a multimedia dialog (with audio, video, text, and graphical tools). The system is based on the TCP/IP client-server model and its architecture is designed by the definition of four main modules, as shown in Figure 1:

- **Administrative server.** It is the core of the overall system and is responsible of processing the incoming requests from the users (students) and put them in contact with the desired teacher.

- **Database manager.** For proper management of the service, the administrative server accesses to a database with information regarding degrees, subjects and teachers. The database is controlled by a database manager, through which we can create, query, and maintain the database. Unlike the former version of *E-tutor*, the database can be held in a remote machine different from that of the administrative server. Like the previous version, the database can not be accessed directly by the teacher and student modules (see below), but via the administrative server.

- **Teacher module.** Teachers operate in the service by means of the teacher module, which allows them to log on and out the service through the administrative server. When logged on, the teacher is available for an advisory session request from the student.

- **Student module.** Similar to the previous one, this module is the operating interface between the service and the student. By using it the student can request to the server a multimedia advisory session with the selected teacher.
The service is carried out in a centralized way through the administrative server. First of all, the server must be run in listening mode, after which teachers can log on the service by connecting to the server through the teacher module. This connection is immediately closed and the availability of the teacher in the system is updated into the database by the server. From this point, the service is provided according to the following steps (see Figure 2):

1. If a student wants to connect to a teacher and to establish an advisory session with him or her, first the student module is used to contact with the administrative server.
2. The server provides to the student with the teacher directory (step 2b) after querying the database state at this moment (step 2a).
3. If the desired teacher is available, the student is able to request a session with him or her.
4. At this point, the server will redirect the service request to the corresponding teacher, whose location was recorded in the database when he or she logged on the system.
5. The response given by the teacher, if negative, is returned back to the student by the server. The reason for what the service is not accepted (the teacher is not available, he or she does not explicitly accept the service,...) is signaled to the student, meanwhile the connection with him or her is maintained to allow additional requests.
6. On the contrary, if the session is accepted the server releases the connection with the student, and a session is directly established between the student and the teacher. The interaction between both parties is full-duplex and based on the interchange of audio, video, text and graphical data.

The different modules of the system are detailed in the following sections. As stated in [4], all the modules have been programmed in Java™ to guarantee the service portability to any operating system (Windows™, Linux, UNIX,...). Furthermore, the student module software could be invoked from a web page with a Java applet. For properly working, the requirements of the system are: (a) Java Virtual Machine v1.4.0, or above, must be installed on each machine; (b) for teacher and student modules, Java Media Framework API needs also to be installed; (c) although not mandatory, webcam and microphone devices connected to the computer are recommended for a complete multimedia interaction; and (d) Internet access with a public IP address is necessary.

3. Database manager
This is an elementary module in the whole system. It is intended to create, query and maintain a MySQL database, which is integrated with data concerning teachers’ information. The database maintains for every teacher the following information:

- Name and surname.
- Password for his or her identification in the system.
- Subjects for which he or she is responsible.
- Timetable for which it is assumed the teacher must be logged on the system.
- Actual status in the system: online, busy, momentarily offline, etc.
- IP address from which he or she has currently logged on the system. This field (see Fig. 3(b) with rose background) is automatically assigned and updated by the server.
- Some other useful information such as mail address, phone, etc. is included.

Some differences with the first version of E-tutor should be noticed for this module:

- Teachers are not pre-located on a host, but they can log on the system from any place in Internet. For this, teachers must introduce a password to be properly identified by the server, after which the corresponding IP address (or hostname) will be stored in the database for its use in the course of the current session.
- A more powerful GUI has been developed to manage the information in the database in an easy and intuitive way. Thus, subfigure (a) in Figure 3 shows the main graphical interface for the database manager, and subfigure (b) depicts the window involved in the teachers’ information management –by clicking the button Profesores in subfigure (a)—.

As stated in Section 2, the database is only accessed by the database manager (the user acting as ‘root’) and the administrative server. The student and teacher modules can only retrieve data through a connection with the administrative server.

### 4. Administrative server

This section briefly explains some details concerning the administrative server module. The server is run in passive mode and waits for incoming requests from the clients. To provide the service, this process attends the following requests:

- Connect request: a client (student or teacher) wants to connect to the server, and thus to access to the service.
− Subjects’ list request: the student requires the list of available subjects in the system for a given degree. The degrees’ list is automatically provided by the server when the student requests an advisory session.

− Teachers’ list request: the student is requiring the identity of known instructors for a given subject (i.e., a subject can be taught by more than one teacher).

− Teacher data request: the student is requiring the information regarding to a particular teacher (service schedule, actual state, and so on).

− Change teacher status request: this request can only be sent by a teacher module, and it gives rise to a change in his or her status (online/offline/busy/…).

− Teacher session request: the student is requiring an advisory session with a given teacher.

− Disconnect request: the client (student or teacher) wants to release the connection with the server.

Most of the responses to the above requests are provided by the server after conveniently querying the database engine.

When the student connects to the server and the advisory session is accepted by the selected teacher, the server will indicate this situation to the student and the teacher side connection is released. However, the student connection is maintained to allow him or her to request a subsequent service.

As shown in Figure 4, a specific dialog box at the server side displays its state at each moment, as well as the tasks requested over the time. This information is saved to a configurable log file for monitoring purposes.

5. Student and teacher modules
The student interacts with the system by means of the student module (see Figure 5). The menu Configuración of the module will allow the user to configure and to test all the multimedia input/output devices in the host (option Configuración → Dispositivos de captura), indispensable for videoconference sessions. By using this menu the user can also set up the administrative server name for the service (option Configuración → Conexión).

After connecting to the desired server by clicking the option Servicio → Conectar con servidor, the red icon that appears in the main screen becomes green to indicate the connection establishment. After that, by clicking Tutorías → Solicitar videotutoría a window as depicted in Figure 6 is initiated for helping the student to look for teachers. As shown in this figure, the searching process is carried out in a tree-like structure, where a degree must be selected first (Ingeniería Electrónica, Ingeniería Informática or Ingeniería Técnica Informática de Sistemas in our case), after that, the student must select a subject (Transmisión de Datos y Redes de Computadores I for Ingeniería Informática in Figure 6), and finally, the desired teacher. Once the name of the teacher has been selected (Pedro García Teodoro in our example), the information about him (timetable, status, etc.) is displayed. Thus, now the non-presencial tutorship session can be requested (button Videotutoría in Figure 6).

The advisory session between the teacher and the student will be described in the Section 6. Once it will be finished (option Tutorías → Detener videotutorial in teacher and student modules – see Figure 5–), the student will be able to ask for a new service or simply to exit the program (option Servicio → Salir in Figure 5). It is important to notice that a service request might be rejected by the teacher although he or she is online. This last event happens if: a) the teacher
does not answer within a fixed time interval, or b) the teacher explicitly rejects the request. In any case, the student can actually try it again later on.

Some comments about the student-administrative server interaction by using the graphical window shown in Figure 6 are worth doing. First, the teachers’ state is automatically updated by the server, so that the icons associated to them are conveniently changed at the student side. Second, different information about the teacher is displayed on the window on the right, for example his/her electronic mail address. Regarding this, it must be noticed that the default mail manager configured for the working environment will be automatically executed when the email address is clicked on.

The teacher module is similar to the student module, shown in Figure 5, in several ways. It has identical device configuration menu and administrative server specification unit. However, the teacher module implements client functions as well as server functions. First, it is used by the teacher to connect to the administrative server (client function) to notify his or her status (online/busy/…). When the online status is reached, the teacher module runs automatically the server code in order to listen to incoming requests from the students via the administrative server. At this point a pop-up window will appear to notify the event (see Figure 7). The teacher has the choice to accept or to reject the asked session. Whether accepted, the service is launched and the teacher module tells the administrative server to change its status to busy; otherwise, a message is sent back to the student and the teacher module is ready for new incoming calls. Once the advisory session has finished, the teacher module will notify the administrative server to update the status to online again.

A significant difference between the teacher and the student modules is that through the first one the teacher can modify his or her status in the system by just clicking on the icon on the main screen (see Figure 5) and selecting a new state among those available (having coffee, on phone, …). This event will be automatically notified to the server to update the database.

6. Multimedia teacher-student interaction

A brief description of the modules of E-tutor has been presented in the previous sections. Once the general functioning of the service is known, this section is devoted to analyze the interaction carried out between the student and the teacher during an advisory session. The acceptance of an incoming request by the teacher opens an immediate full-duplex connection with the student. By default, the interchanged data are of three types: text, audio, and video. The first one defines a chat-like interaction through which a written conversation is developed between both parties – see Figure 8(a)–. The audio-based interaction is available only if an audio input/output device is installed in the host machine. In the same way, the video oriented interaction is just possible if a webcam is plugged on the user host. The availability of audio and video devices on the student and teacher hosts will make possible the videoconference session between them –see Figure 8(b)–.
The first version of E-tutor implemented just a videoconference-based interaction. On the contrary, the present version of the system pursues to increase the capacity of the service by adding new functionalities. Thus, besides the incorporation of the mentioned text-based conversation the new version of E-tutor allows a graphical interaction between the final users.

An electronic blackboard tool has been developed with the aim of carrying out a more realistic teaching interaction. The most outstanding feature of this software tool is that it has been designed for operating system independence. Hence, no tools similar to, for instance, Paint for Windows™ have been considered. On the contrary, our blackboard tool is completely based on Java and, therefore, portable to any operating system. It can be executed only by the teacher (option Servicio→Iniciar Pizarra in the teacher module), in which case a similar graphical environment will appear automatically at the student side. The appearance of the graphical tool is shown in Figure 9. Note the white drawing zone on the left and the menubar on the right side. The menubar includes a complete set of elements to draw geometrical figures, text, lines, etc., as well as various icons to save to disk, load from disc or print. Moreover, both the teacher and student have a pointer tool to focus the attention of the other part to a specific zone on the blackboard. However, only the teacher can write on it, which will be reproduced automatically at the student side.

Despite the teacher can use the mouse device to interact with the graphical environment, we have decided to incorporate a drawing tablet to the machines.

Figure 8. Basic teacher-student interactions during an advisory session through E-tutor: (a) text-based window, and (b) videoconference oriented window.
7. Summary and future work

In this paper we present a useful e-learning tool. The designed system, called E-tutor, allows students and teachers to carry out multimedia advisory sessions in a non-presential way through Internet. Although in some sense similar to traditional videoconference services, the main feature of the developed system is the integration of an administrative or directory server that controls the service in a centralized way. The administrative server makes E-tutor easy and convenient for all the users. Furthermore, the new version of E-tutor improves the service performance in several and crucial aspects such as: location independence for database files, as well as any-place, any-time access for teachers and students; E-tutor provides very close to real integral multimedia teacher-student interaction (with audio, video, text and graphics) with identified access. The new added E-tutor features increase, not only quantitatively but also qualitatively, the differences to other similar existing tools.

Although the system is full operative, new minor functionalities still can be added to improve even more the quality of the offered service. First, the system is not completely secure (authenticate) in the sense that anyone can solicit to connect to the server and therefore request a session with a teacher. Definitively, an authentication process should be incorporated in order to restrict server connections only to authorized students. Other issue that must be pointed out is that E-tutor requires a valid public IP address for both ends to communicate, in other words, neither the teacher nor the student hosts are allowed to be behind a proxy.

The above limitations are going to be confronted in future E-tutor versions. In addition, it would be interesting to integrate the service into a more general e-learning system.

8. References

