Enhancing Collaborative Learning and Management Tasks through Pervasive Computing Technologies

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***Abstract*— We are examining in this paper how ubiquitous technology enhanced classrooms can foster opportunities for enhancing teaching and learning. Our concept of Smart Classroom is shaped upon an ambient intelligent environment which supports three major objectives of the educational process: assisting course creation and presentation, classroom management and student assessment and collaboration. Distance learning poses additional requirements on smart classrooms since both local and remote students should have an equal educational experience. This paper describes a Smart Classroom prototype, which combines a number of pervasive computing technologies such as RFId, Microsoft Kinect, magnetic cards and Android applications. The main contribution of our work is combining such different technologies to support classroom attendance management, lecture presentation handling through physical interaction and student collaboration through android applications. Finally, this work includes a survey on related systems and their contribution on strengthening the educational procedure.**

Keywords- Smart Classroom; collaborative learning; pervasive computing; physical interaction.

I. INTRODUCTION

Traditional classrooms have a simple structure as the instructor is the only responsible person for planning, management and guidance of all activities in the classroom as well as for the presentation of the educational content. On the other hand, smart classrooms (SC) provide a complex structure that allows innovative ways of learning. A SC is a physical classroom in which information and communications technologies have been integrated. The technological infrastructure of a typical SC includes equipment for multimedia content rendering, projectors, large screens for video projection, computers, smart boards and desks, data centers, etc. This infrastructure facilitates students to watch a lecture without concerning on keeping detailed notes, since after the lecture they can have access to the teaching material including notes and annotations. In such an environment students can interact with the material, the instructor and the other students in new ways.

The deployment of a SC has many advantages such as enabling active learning (students become active inventors of knowledge rather than passive recipients), enhancing content and presentation, harnessing the wealth of the Internet, bringing in experts with videoconferencing, allowing lecture and notes capturing and enhancing distance learning (instructing remote and local students). As an example, students can use SC resources (e.g., interactive desks that are connected to the smart board) and under the supervision of their instructor can work educational activities in teams as part of a course. Afterwards, each team can present their solutions, compare them, discuss under the guidance of the instructor, and as a consequence create joint knowledge (complementing one another).

Hellenic Open University (HOU) has a mission to offer university level education using distance learning methodology and to develop the appropriate material and teaching methods. Currently, HOU offers 31 undergraduate and postgraduate Study Programmes with a total of approximately 30,000 students, coached by 1,700 tutors in 1,550 groups (20 students per group on average). Students of the HOU usually live in disparate locations all over the country. Besides being students they usually have families and working obligations so they have pressing time constraints for studying. Once per month students of a particular group meet face-to-face with their tutor.

In this paper, we describe a SC prototype developed in the HOU. The prototype enhances a typical SC with pervasive computing technology components in order to accelerate management services and to support an enhanced learning experience by providing services that enhance student-tutor interaction. A critical objective of the HOUs SC is to decrease the gap between a traditional classroom and a virtual classroom regarding the educational experience acquired by students. A basic approach to achieve this is to move the user interface from the static computer environment of a typical virtual class software system to the 3D space of the SC so that the instructor can interact with the remote students with multiple natural ways, in equal terms as with the local students.

The remaining of the paper is organized as follows. Section II gives an overview of the SC prototype and the enabling platforms used for developing a number of services. Section III describes how user authentication and status update is performed in the context of the SC using a combination of pervasive computing components. The management of the educational content presentation through gesturing movements using the Kinect technology is presented in Section IV. The importance of enhancing collaborative learning through suitable collaboration tools is discussed in Section V. The results of a preliminary evaluation of the SC prototype are discussed in Section VI. Related work is presented in Section VII followed by our conclusions in the final section.

II. System Overview

The SC model that was developed incorporates computational intelligence in such a way to be invisible to the audience and its final goal is the improvement of learning experience both for the local students and the remote students. It constitutes a mixture of a classroom with traditional characteristics but as well as a web-based learning system which provides both synchronous and asynchronous communications services. The classroom that is used has a total coverage of 66 m2. It includes bearings for the students, a Student Board and a Course Board connected with a projector. The SC incorporates audiovisual content recording and processing system (server, sound processing and video processing software), digital content distribution / streaming, a sensor package to measure environmental parameters (sound, temperature, light, etc.), a location tracking system based on the commercial Ubisense system, Radio Frequency Identification-based (RFId) applications, biometric devices, a voice recognition and text rendering system and an eyetracking system for building affect sensitive intelligent tutoring systems. A basic setup of the SC is shown in Fig. 1.

When possible, open source technologies are used for the enhancement of the learning process considering that the system must be inexpensive so that it can be easily adopted by the educational institutions. On the other hand, commercially available software is necessary to cover the needs that the open source software cannot. A characteristic example is the Saba Centra Teleconference software, which the HOU employs for synchronous communication in the context of virtual classrooms.

The features of the SC that were developed apply to different stages of a lecture. The first stage refers to the authentication of the user either the local one or the remote one. For the authentication task there are various available technologies that can be used such as the RFId technology in combination with single board computers and magnetic cards technology which are used by students attending a face-to-face meeting with the instructor in the SC. Remote students authentication is accomplished through JSP pages. Regarding the educational process stage, the aim is to be enhanced with various technological means. Thus, the students will have in their disposal tablets with android operating as an enabling platform. Alternatively, students can bring their personal laptops. There are a lot of reasons why tablets are used in the educational process. Some of them are concerning their low cost, their storage capacity and their ease of use. Finally, a primary factor is that these devices have peer-to-peer connection capabilities but also broad network capabilities through various communication protocols such as Wi-Fi, Bluetooth or NFC. Thereby, in the context of the SC the learners are given the chance to have access to the educational content as well as to operate cooperatively in groups. In the educational process stage, another parameter that is taken into account is the enhancement of the students' participation in the process. Students are no longer passive viewers but they are able to be active, to ask questions and to handle the educational content. Via the Android applications they can intervene to the discussion and handle the content, which is projected to the Course Board remotely. Hence, the student from her place can be connected to a central computer and can use the input/output capabilities of her tablet to interact with material of an educational task collaboratively with other students. Finally, in this prototype the instructor can move around in the SC and interact with educational material in a natural manner without being static in front of a computer. For example, she is able to manage her lecture and navigate the presentation slides projected on the board via gesturing movements. This can be accomplished by using Microsoft Kinect technology which can recognize the tutors' movements through infrared rays.

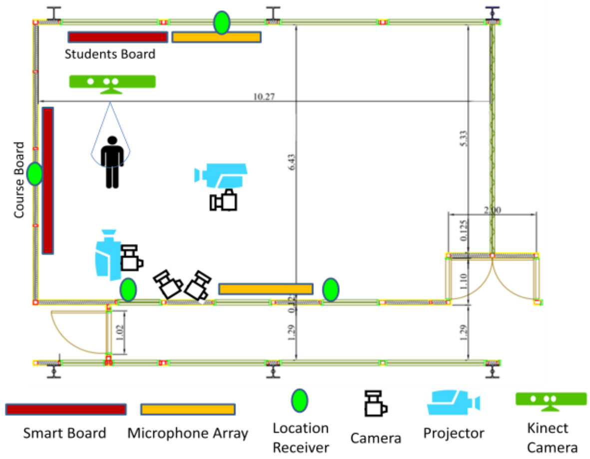

Fig. 1. Smart Classroom setup.

In this prototype, we aim to use devices and objects which have embedded computational capabilities that can be accessible by the student in a non-intrusive manner. This prototype continues to develop with new applications and services which enhance even more the concept of ubiquitous computing and improve the educational process both for the local and remote students. Each one service that was developed is analyzed below.

III. Ubiquitous User Authentication and Status Update

One of the offered services in the SC prototype is the user authentication module serving both the local and remote students and the recording of their status (e.g., present, absent) for every lecture/meeting taking place. In this particular implementation a combination of technologies are used, such as microcontrollers (RFId), Web development and magnetic cards. This combination came out through the analysis of the users' requirements as different needs have emerged by the different user categories of the system. Thus, the developed service constitutes a combination of three modules. Two modules are responsible for the physical authentication of the user and the recording of her status. In this case, both RFId sensors and magnetic card technology are used (Fig. 2, 3).

The RFId represents a major change in how applications handle object identification and tracking. RFId uses radio waves and allows the automatic identification of the data which are transferred into smart RFId "tags". The RFId tags can be automatically monitored by stationary or mobile devices without the need of being serially scanned.

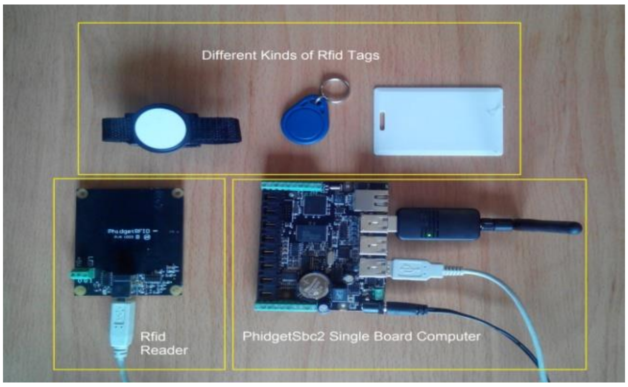

Fig. 2. Phidget SBC – RFId Technology.

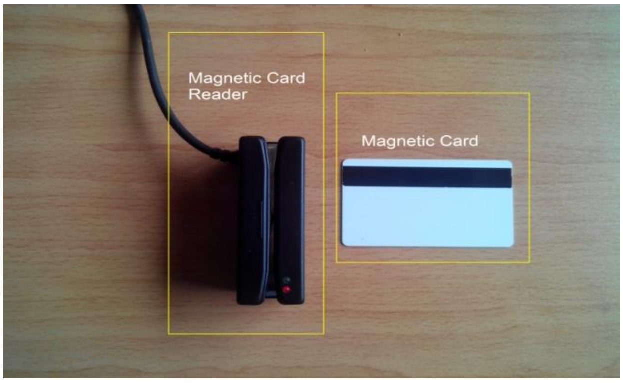

Fig. 3. Magnetic Card Technology.

Using this way of gathering information the university can dramatically reduce the time and the cost of management tasks such as the management of the status of its human resources. For instance, the instructor is not anymore required to inform the status of the students who attended a face-to-face meeting (this is a mandatory task according to HOUs management procedures) as this is achieved in an automatic manner.

The user needs to pass the RFId tag through the RFId reader which is placed in the classroom's entrance. Alternatively, the user can carry a magnetic card. A magnetic card is provided to every student of the HOU integrating in its magnetic tracks information that uniquely identifies each one of them. This card is also used in a number of other activities such as using library services or joining university's social network. If the user is a member of the group that has assigned a meeting at that time in the classroom she will be granted entrance in the classroom. Simultaneously, the user's attendance status will be updated. If the user is not a member of that group he/she will be informed with an appropriate message on the screen.

Additionally, in the context of the authentication process a web interface was developed. This interface gives the user the capability to be connected and authenticated remotely. The remote student provides her personal details (e.g., email and id number) via a web interface and is authenticated by the system. When the user is connected she can watch information regarding the lecture that is taking place (e.g., location, opening time, number of participants) as well as information concerning her status both to this particular lecture and those preceding. The authentication does not mean the automatic participation in the meeting in which she has been connected. This procedure is accomplished through the Centra platform, a teleconference service (implementing virtual classes) which provides both the instructors and students the capability of attaining meetings and seminars regardless the place of their physical presence.

Status update refers to the recording of the users' status with respect to the authentication time and mode. The potential user states are the following: *present*, *late*, *in distance* present, *in distance late*, *absent*. User's status recording allows continuous statistical analysis with respect to the HOU's students' attendance profile with an ultimate aim to provide improvements and/or adjustments of the offered services towards them.

A. *RFId-based Authentication*

For the development of this module PhidgetSBC2 Single Board Computers are used serving the execution of independent and autonomous applications without the need of a host computer on which they must be connected. A PhidgetSBC2 node is running a light version of a Debian GNU/ Linux operating system. Development services like the creation of a new application running on the board or its network management features are managed through a Web interface. Its advanced features can be accessed through an embedded SSH server. The identification process is performed through PhidgetSBC2 wireless connection with the Central Server on which the system database is running.

Those boards are placed in the entrance hall of every classroom. The PhidgetRFId Reader reads the RFId tags which are attached to the reader instantly and returns the unique authentication number that identifies each tag. This requires that each participant in the meeting has her own tag which is provided to her during the registration process. The tag's unique authentication number is recorded in the specific field in the corresponding database table. The software, which runs on PhidgetSBC2 board, is responsible for identifying the tag, establishing a connection to the database if the user is authenticated successfully and updating the status of the tag holder with the proper indication. Finally, it is responsible for the system's output to the user giving a short beep after successful identification from the user or a longer beep with a different pitch after unsuccessful identification.

B. *Web-based Authentication*

For the development of the user interface for the remote students' authentication the JSP technology (JavaServer Pages) is used. This technology helps software developers to create dynamically generated web pages based on HTML, XML, or other document types. The core of the developed application uses also the Java programming language. Specifically two JavaBeans components have been created (Fig. 4). The first is responsible for the storage of data variables entered by the student (username, email) through the interface and the second is responsible for establishing a connection with the database and performing SQL queries. After the successful

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user validation the same procedure as in the RFId module is applied and the status update of the user is performed. Then, the student who successfully entered the credentials can retrieve information about the lecture attending and other relevant information. Finally, the application enables the student either to disconnect or to connect remotely to the lecture which is carried through the teleconference system.

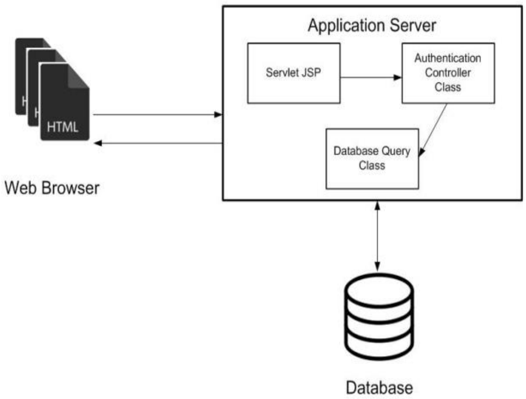

Fig. 4. Web Authentication Architecture

C. *Magnetic Card-Based Authentication*

In this module, the JSP technology is used in conjunction with the magnetic cards technology. The Web interface developed in the previous module is modified so that instead of username and email it receives a string which is a unique identifier for each student. Specifically this identifier consists of three parts. The first part is a 66 characters length secret key that uniquely identifies each user. The second part is the user’s password. Finally, the third part is the user's name in ASCII encoding. Each part has a starting character and an ending character. In the first part the starting character is "%", in the second part is the character "#" and in the third part is the "+" character. In all three parts the terminating character is ";". The string is stored in the three tracks of the magnetic card. So when the magnetic card is passed through the card reader, authentication is performed by a series of SQL queries to the database including the students’ status update. Simultaneously, on a screen, which is positioned at the entrance of the SC, the user can also retrieve information about the lecture to attend. After a few seconds the display returns to the original home screen for next student authentication. The software architectural design follows the pattern of the previous module making use of Java beans in the same way. Here the major difference is the credentials that must be managed by the application. Another difference with the previous module is the number of users that it handles. This module must give the ability to a number of users to enter their credentials in a short period of time. So it is designed in a way that every single user can be validated and disconnected after a while so the next user can be authenticated.

IV. GESTURE-BASED PHYSICAL INTERACTION

A second service that was developed in the context of the SC prototype is the management of the educational content presentation through gesturing movements using the Kinect technology. Microsoft Kinect [10] is a motion sensing device that enables physical interaction with the computer. Gesturing movements replace the standard human-computer interaction which is achieved with the mouse and the keyboard. The innovative technology behind Kinect is a combination of hardware and software contained within the Kinect sensor accessory that can be added to any computer device running Windows, Linux or Mac OS. Kinect cameras use three hardware innovations working together. The first one is a Color VGA video camera, which is called RGB camera, referring to the color components it detects. The second one is a depth sensor. It’s a combination of an infrared projector and a monochrome complimentary metal-oxide semiconductor (CMOS) sensor working together to "see" the room in 3-D regardless of the lighting conditions. Finally, there is a multi-array microphone which is an array of four microphones that can isolate the voices of the users from the noise in the room. This allows the users to be a few feet away from the microphone and still use voice controls. This camera was positioned to the area where the instructor moves between the smartboard and the bearings of the students and within the distance of 5 feet from him (Fig. 1). The reason for this distance is the optimal performance of the camera, which ranges from 4 feet to 6 feet.

The tutor by using gesturing movements can change slides which are projected to the Course Board. Specifically pointing the Kinect camera at her direction and standing at least five feet away she can extend her right arm to activate the "right" or "forward" gesture. If she extends her left arm she activates the "left" or "back" gesture. These gestures will send a right or left arrow key signal to the foreground application, respectively. The up and down movement can be added if necessary. These two movements can be used to create a gesturing handled document reader with which the user will be able to move smoothly to the next page (not instantaneously as in the slides presentation). Additionally, one can mark on the document or ‘printscreen’ the document.

It should be noted that this application is independent of any slideshow software architecture (such as PowerPoint or Adobe Reader) which means that basic movements like *Next_Slide()*, *Previous_Slide()* can be easily applied to any of them. The way this is achieved is that the application uses *Window.Topmost* property of Windows Presentation Foundation (WPF) windows, which is a graphical subsystem for rendering user, interfaces in Windows-based applications by Microsoft. This property defines how in a group of windows, the window that has set the *Topmost* property to true is currently activated as the topmost window. Likewise for the group of windows that has set *Topmost* property to false are currently deactivated. The only thing the instructor has to do is to run the slides presentation software with the lecture’s slides loaded to it. Since the slides presentation software has the *this.Topmost* value set to true this means that the window is not overlapped by any other window and the instructor can use the gesturing movements *Next_Slide()*, *Previous_Slide()* and change slides back and forth in a natural interaction manner using a pervasive computing infrastructure.

The HOU teleconferencing platform for virtual classrooms provides tutors and students with the ability to participate in meetings and seminars regardless of their physical location by organizing and monitoring "electronic events". A typical teleconference session (event) consists of a central leader - presenter who is usually the tutor, and the other participants/guests who are usually the students. HOU uses the Saba Centra system which enables learners to connect remotely and watch lectures in real time. One of its main functions, inter alia, is the lectures slides presentations. This enables remote students to see on their screen the lecture's slides and listen to the sound from the classroom in real time. The developed Kinect-based application has been adapted to the needs of the Centra system (Fig. 5) providing the teacher with the ability to handle slides of lectures by using gesturing movements.

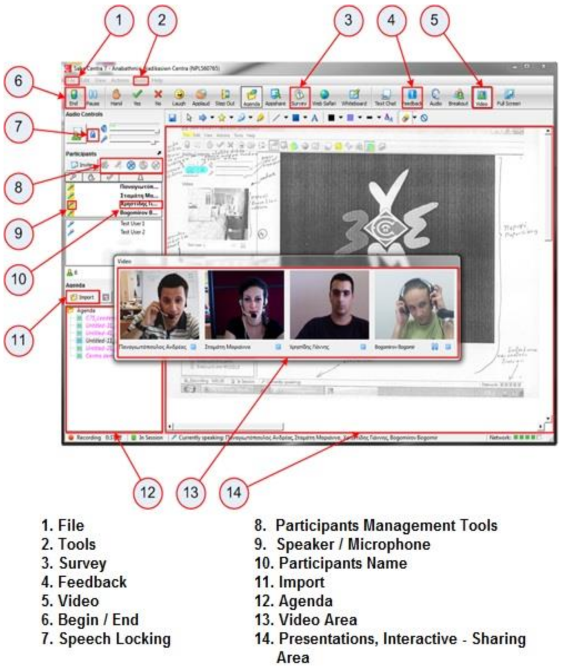

Fig. 5. The HOU's teleconference system.

The modification needed to be done in the existing software consisted of the operation of the movements that the tutor could accomplish. The loaded slides at Centra are converted to images independent of each other. To move to the previous/next image the user has to move with the up/down arrow keys and therefore two new gesturing movements which send a down or up arrow key signal to the foreground application were developed.

V. ENHANCING COLLABORATIVE LEARNING

The need for an active involvement of the students in the educational process led us to the design of an application which gives the student the capability to perform and share their thinking and understanding using annotation techniques. The aim of this application is particular classroom resources, such as the Course Board, to become available to the students in order to unfold their thoughts or to annotate comments to the content that is under discussion. In the context of a traditional lecture this seems difficult due to the fact that the student in order to be able to have access to the Smart Board must move from her seat and stand in front of the computer in which the operation software of the smart board is installed. Then she can handle smart board operations and eventually put forward her views. With this particular application the student is given the chance to interact with and handle this specific resource remotely, without moving from her place.

The rationale is that the student, given the permission of the instructor, is able to connect remotely with the smart board and handle its content either through the provided tablet or through her own Android device (Fig. 6). This specific application makes use of an android application which gives the ability to the android device to operate like a wireless mouse and keyboard for a specific computer. Thus, when the student is given the permission by the instructor to interact, she is connected remotely and gains access to the resource making use of the mouse and keypad in distance from her place. The application gives the instructor the ability to determine who is connected remotely each time as well to terminate the connection.

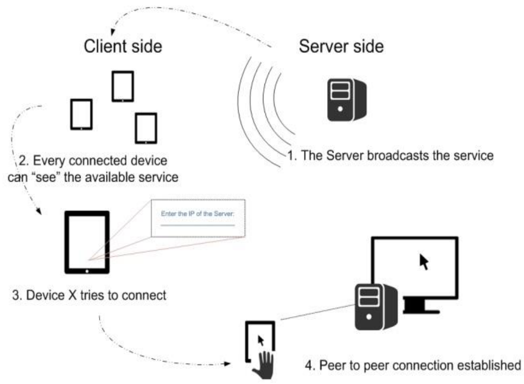

Fig. 6. Collaborative Tools

The architecture of this particular application is based on the client-server model in which the role of the client is played by the android devices and the role of server is played by the computer on which are connected and in our case is the same to that which runs the smart board software. On the server side special software is installed as a windows remote service which gives the capability to set the correct IP as well the TCP port in which the service will start. Once the windows remote service is started, every android device which belongs to the same network can search for its tracking. When the android device tracks the remote service it can be connected through the connect command with the server and have access to the handle of the mouse and the keyboard and therefore to the content of the lecture which is projected on the smart board. On the server side the tutor can monitor the interactions in the log section, to see which device is connected each time and terminate the connection when this is necessary.

VI. EVALUATION

The proposed authentication model was evaluated in a pilot setting including five trial meetings allocated to three groups of 20 students. Both the students and the tutors were provided with magnetic cards and RFId tags for their authentication as well as codes for their remote connection. From the data collected, 53% of the students on average participated physically to the meetings, 31% participated remotely and 16% were not attending. Regarding the technology preference, there was a clear preference to the magnetic cards (87%) versus to RFId (13%), which is easily explained, as the former is a technology familiar to most of the students due to other services provided to them through it. Another reason for this preference was the additional feedback that the magnetic card based module provides to the students as it informs them not only about their successful authentication but also for their participations to the preceding sessions. Regarding the use of RFId technology we noted an increase on its usage meeting after meeting due to the fact that students were more familiarized to the new technology. The 100% of the tutors agreed that the automated way of recording the status of the students no matter the technology employed was time saving in relation to the traditional status recording.

On the other hand, it was noticed that alongside with the ubiquitous mode of authentication the traditional way of recording should be maintained as there were cases in which the students had forgotten to bring either their RFId tag or their magnetic card. In technological level, after the use of the system it was found out that the specific system was operating robustly within the failure margins given by the RFId/magnetic tag/card manufacturer (2%).

The gesture based physical interaction service was also evaluated. At the end of each session both tutors and students who participated in the meeting were asked to answer a questionnaire stating their view on the use of the particular application during the educational process. Regarding tutors who are the ones that are directly involved with the new service as well as being the main operators of the system, at first they found the application very difficult to handle as they were not familiar with this way of interaction with the system. Alongside they found it difficult to memorize the various combinations of gesturing movements that the application requires for handling slides. They reported that their concentration was focused on combining the movements with their hands to cause an action (e.g., next slide) which made them lose their sequence of thoughts. However, after the first two sessions the tutors got familiar with the handling of the application which led them to the conclusion that the use of gesturing movements increased their performance giving them the ability to interact in a more physical manner with the material and the students. The Kinect technology gives them the capability to navigate through the slides of the lecture along with their verbal communication without being forced to stop the lecture, approach the computer, change the slide from the keyboard and then continue their discussion. It should also be pointed out that one of the objectives of the SC prototype is the recording of the training material and the online streaming as a service to students. This application therefore helps achieving a better quality of the produced material since the video recording of lectures contains material which is more natural.

On the other hand, students, mainly those who are remotely connected to the SC accepted very well the use of this technology as their access to the classroom is achieved through the Centra teleconference system so using such an application gives them the illusion of even more physical presence in the classroom. Regarding the technical part there is one point in which the application should be improved in the future. That is the gesturing movement combinations which should be simplified so that the system can be used with greater ease.

Finally, students who participated in the meetings were provided with network capability to their laptops. The remote desktop application, which was mentioned in section V, was distributed to students via the network. Alongside all students were informed about the use of the application in the teaching process. In conclusion the use of the application strengthened the participation of students in the educational process something which is particularly difficult in traditional classrooms. Students were asked to rate the use of the application at a five point likert scale questionnaire. The result revealed the positive attitude shown by the students in the adoption of the application as a tool that enhances the involvement in the learning process.

VII. RELATED WORK

In this section, we present research efforts that attempt to convert simple classrooms to smart ones by using pervasive computing technologies.

In 2003, researchers at Tsinghua University of China proposed a smart classroom standard for enhancing the traditional classroom with pervasive computing technologies and supporting remotely connected students [5][6]. The classroom is equipped with two wall-size projector screens, one in the front wall called Mediaboard and another called Studentboard. In the first board, which is touch sensitive, the teacher can present his slides and notes, while in the Student screen, images of the remote students and information about them are displayed. The smart classroom supports user authentication services via face and voice recognition also. A multiagent software platform coordinates multiple processes which are hosted in any computer of the classroom.

The George Maison University presented in 2005 Network EducationWare (NEW) an open source and distance learning education system [4]. Students via the NEW have the ability to hear instructor’s voice and view lecture’s presentation material, on their screen. They are also given the opportunity to intervene in the process and make questions either asynchronously or synchronously via instant messaging (chat) during the lecture. Finally, the system supports recording and playing back recorded lectures whenever the student wants in a later time. An important advantage over other commercially available systems in this domain, such as Saba Centra and Microsoft LiveMeeting, is the low cost of purchase and maintenance for educational institutions.

The CyLab laboratory of the Carnegie Mellon University in Japan proposed its own version regarding the Smart Classroom topic [9]. The main aim of this project is to link two or more classrooms through the internet. For this purpose a set of technologies are used such as the BlackBoard system, which provides online learning opportunities and recording lectures, the Lecture On Demand system (LOD), which enables students to have access to all previous lectures and material, and finally the VTE system (Virtual Training Environment), which is a library of educational tools and learning objects such as demonstrations, lectures slides, videos, hands-on labs.

In 2009, the University of Tsinghua in collaboration with the University of Kyoto in Japan developed the Open

Smart Classroom [7] model based on Smart Classroom project [5]. The developing model proposes the interaction among several Classrooms which are geographically dispersed. Two Smart Classrooms have been used, one at Tsinghua University and another one at the University of Kyoto. All processes that (are used), run on a software infrastructure called Open Smart Platform, which is based on the software platform of Smart Classroom that was developed at the university Tsinghua and consists of Agents, Containers and Directory Services. To optimize performance in the interconnection of the two classrooms the platform adopted services such as instant messaging, live data streaming and transferring large amounts of data (bulk data transfer).

The LOCAL project (Location and Context Aware Learning) is based on the principles of pervasive computing [1]. This project utilizes location and contextual information of learners aiming to promote the learning process. The model uses description learner's standard called PAPI to describe the user profiles [2]. The services that have been developed and are being supported are: sending messages to specific trainee who has been authenticated by the system; sending messages to a specific group of learners; and massive messaging. The messages addressed to students represent learning objects and are correlated to the goals set by the students themselves.

In 2010 the University of Cairo developed its own Smart Classroom standard which is named iClass [8]. This project uses a classroom equipped with various types of sensors such as light, temperature and humidity sensors and a weather station. All of those sensors are being interconnected via Lonworks, a building automation protocol, commercially available which provides HTML interfaces to users and which interfaces with the IP network infrastructure. RFId technology is also used, for user authentication. Specifically when the teacher enters the room a Smart Agent recognizes him and automatically opens the smart board. Then students can be authenticated by the Smart Agent too. Finally, using voice recognition in the classroom the instructor is allowed to interact with the devices of the classroom through voice commands.

Researchers at the Taipei University have developed a Smart Classroom standard [3] in which the teaching table agent has several modules for classroom management. One module takes care of the power supply and lighting system and another module is responsible for managing entrance issues since the classroom has digital locks and smart user authentication system. A third module manages the smart blackboard system and is responsible for controlling the projector. This model beyond the management capabilities focuses on providing a smart timetable system which enables the instructor to interact with it. The application has several levels of interaction which are defined according to the distance of the user from the screen and the gesturing movements he uses.

VIII. Conclusions

In this paper, we introduced services deployed in a SC for enhancing collaborative learning and management tasks through pervasive computing technologies. The specification and the development of such services require an understanding of the needs and characteristics of all the involved educational stakeholders. The proposed system is a first prototype which makes use of tracking technologies such as RFId and natural interaction modalities with the system to support a collaborative learning methodology. The objective is the proposed model to be enriched with new technologies and services that will enable the students to participate in the educational process through contemporary and interactive distance learning environments.

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