Chapter 13

TOWARDS THE EVERYDAY COMPUTING IN THE CLASSROOM THROUGH RFID

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Abstract: Many educational scenarios are based on the learning process itself using computers as a tool to aid teachers and students. However new forms of interaction arise making possible to solve daily activities in the classroom. In this work we present a tool to support a cooperative work scenario through the identification process by Radio Frequency Identification technology (RFID). With this technology, the environment identifies users and reacts properly showing information through that we called "Mosaic of Visualization". This process requires only the natural interaction embedded in the users' activities.

Key words: Ubiquitous Computing, Ambient Intelligence, RFID, Context-Awareness.

1. INTRODUCTION

Ambient Intelligence (AmI) is a vision from the ISTAG in the six Framework Program of the European Community (ISTAG 2001). In it a detailed document expresses the guidelines in all areas of society in terms of intelligent environments and how to serve the users. This vision promotes the learning paradigm based on the active learning approach (to learn by doing) with all the senses (eyes, ears, hand, etc.), with all methods (at school, on the network) and access to knowledge anywhere and anytime. So, it is obvious that the learning process becomes more flexible in an ubiquitous learning environment.

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However, for this vision to become a reality it is necessary to handle the context-aware information. There are some definitions of context: "*Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves*" (Dey 2001). This author defines a context awareness system as "*a context to provide relevant information and/or services to the user, where relevancy depends on the user's task*". In order to use context effectively, designers need to identify certain types of context-aware information as being more relevant than others (Brooks 2003). The user profile and situation are essential.

Once the context and their important features are defined, it is time to study new interaction forms proposing the approach to the user by means of more natural interfaces. At this point Albrecht Schmidt proposes a definition of Implicit Human Interaction (iHCI): "*iHCI is the interaction of a human with the environment and with artifacts, which is aimed at accomplishing a goal. Within this process the system acquires implicit input from the user and may present implicit output to the user*" (Scmidt, 2000, 2005). Schmidt also defines implicit input as user perceptions interacting with the physical environment. At this moment, the system can anticipate the user, offering services with explicit output. In addition this author defines embedded interaction in two terms. The first one embeds technologies into artifacts, devices and environments. The second one, on a conceptual level, is the embedding of interactions in user activities (tasks or actions) (Schmidh 2005b). These concepts allow users to concentrate on the task and not on the tool, according to the principles of the Ubiquitous Computing paradigm. If our main goal is to achieve a natural interaction as the implicit interaction concept proposes, we should complement system inputs with sensorial capability.

In this work we focus on the search of context awareness situations, allowing users to obtain system outputs through implicit and natural interactions. We try to solve daily activities in the classroom particularly in a cooperative work activity. In it, students in groups transmit information to each other in a simple and natural way by an intelligent meeting scenario. For that we apply the Radio Frequency Identification technology (RFID). With this it is possible to identify users wearing little devices called tags, offering visualization services without any explicit interaction. The system reacts properly showing the presentation according to the summary made by every student.

Under the next heading a proposal with new challenges, a scenario and the "who model" is presented. In section three a proposal for context-awareness by identification architecture in the classroom is studied. The next point a cooperative work real experience with the format of the information and visualization mosaics is presented. Finally, conclusions are set out.

2. NEW CHALLENGES

New forms of interaction are important to solve daily activities in the classroom. As researchers mentioned before argue about implicit or embedded interaction it is possible to talk about disappearing interaction. In this sense it is a complement to the disappearing computers initiative.

As we have mentioned before, in order to improve the user-interaction, we have adapted the RFID technology by embedding it in different objects such as credit cards, watches, key rings, etc. The simple action of walking near an antenna allows the system to read and write information contained in the tags. We have focused the context aspects mentioned before on the identification process (Bravo et al, 2005a, 2005b, 2006a, 2006b). We are therefore placing these concepts strategically in order to obtain services for the user as is shown in figure 1. We aim to make the interaction transparent, non-intrusive and included it in everyday activities for the user. Thus, a user wearing tags and walking through a building can interact with the environment without any explicit interaction. The user can also obtain typical identification services such as location, access, presence, inventory, phone call routing, etc. All of these are obtained with a combination of "who", "where" and "when" concepts of context. We have called it the "who model". Through this it is possible to handle non-intrusive services without any interaction.

With this model we try to solve the matching between these kinds of inputs and outputs. Both of them in a non-intrusive way allow the user to concentrate on the task, not on the tool.

To understand ambient intelligent environments it is important to illustrate different context scenarios and processes which are going to occur. Next we describe a cooperative scenario to discuss the effort made by the members of a group of students.

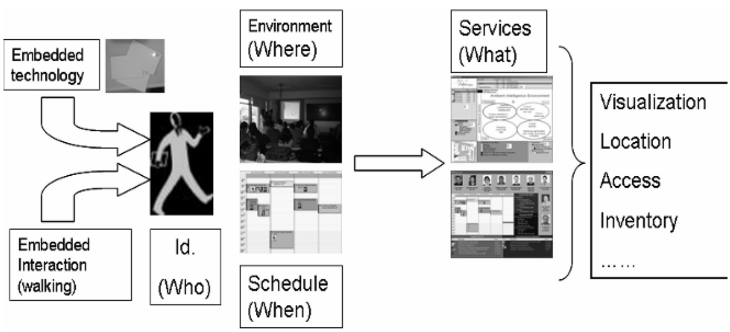

Figure 1. The "who" model

2.1 A scenario

Ruth is preparing the Geology cooperative work at home. For that she uses a single tool in order to prepare a summary that will be presented to other members of her group. With this tool Ruth formats the information according to the advice that the teacher gave her some days ago. She introduces, in a structured manner, with main and secondary texts what she will present to her colleagues, connecting contents to graphics and pictures trying to make her presentation comprehensible. When Ruth has finished she passes her tag near a device (reader) placed next to the computer to store this summary in it. To do this she uses a contact RFID set. Once in the group meeting, Cristina approaches the board and automatically her summary appears on it as in a mosaic format. Also, a plan for this session can be seen. It is surprising to her that only by passing near an antenna it is possible to identify her and start her presentation in a good form of visualization. All the students enclose these summaries using the same method trying to explain their piece of the group work.

3. THE ARCHITECTURE

3.1 RFID Technology

We have adapted RFID technology with the purpose of identifying people. In this technology three kinds of objects are clearly differentiated: the reader (reader or transceiver) connected to the computer, the antenna and the label (tag or transponder). The last one is a small device containing a transponder circuit that takes, in the case of the passive tags, the wave energy that the reader continually emits and reads and writes the information that these may include. Figure 2 shows two RFID sets. The one on the top right presents a reader and an antenna with a read-and-write capability reach of over 75 cm. This has been specially designed for its location on room doors, or near boards. The one on the top left is a contact reader including an antenna with a reach of only 10 cm. A model of the tag is also shown. This identification system is ideal for individual use.

We are trying another kind of RFID set, offering more distance between reader and tags (2 or 3 meters) see Figure 2 bottom. Entry to and exit from each environment will also be controlled. This system is called HFKE (Hands Free Keyless Entry) and has a semi-passive tag using a battery along with 32 Kbytes of EPROM memory for the user's data. The reader

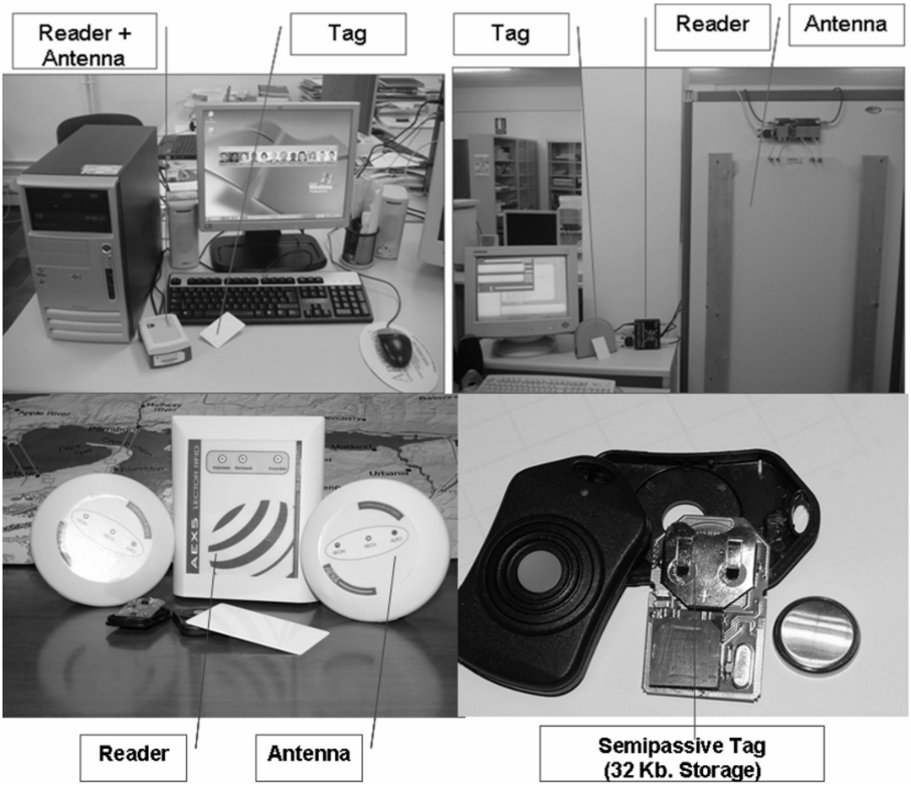

Figure 2. RFID devices

(HFRDR) transmits waves of low frequency, 125 Khz, continuously. When a tag detects this wave it activates the microcontroller sending the required information in UHF frequency. The communication between reader and computer is by Bluetooth.

3.2 The Classroom

The classroom is equipped with readers, a computer and antennas. These antennas are placed on the door and next to the board. In the classroom, teachers and students wearing tags mean they can be identified and located, thus allowing them access to the system and to services, all in an implicit way.

When teachers and students enter the classroom the location (attendance) and access control services are automatically activated. These are typical services that RFID technology offers. In addition to this, the visualization service comes up on the board. It is a mosaic of information which varies according to the context (classroom) and time (schedule). This mosaic is different for each attendance profile. In the time between classes the information is about news and announcements to students. In the actual class-time, the mosaic is transformed and presents information prepared by the teacher for the session see Figure 3.

The second activity in the classroom is to get information onto the board by means of proximity of a person to its surface. When the teacher approaches the board, his lesson presentation, the problems proposed, solutions, documentation, etc. are shown. In order to control the order of these activities, the teacher has a plan for each class. If the student is the one approaching the board, the answer he has given to the problem posed previously can be displayed. On the other hand, some presentation, or any other kind of information may be shown,

The third activity consists of the storage of information on the content of the lesson or lecture in tags. Teachers and students have this information when they go through the door as they leave the classroom.

These activities are completed by work at home. Teachers and students, helped by a contact reader, are able to read the information included in tags and/or rewrite more for the next class. All transactions are managed by the classroom server.

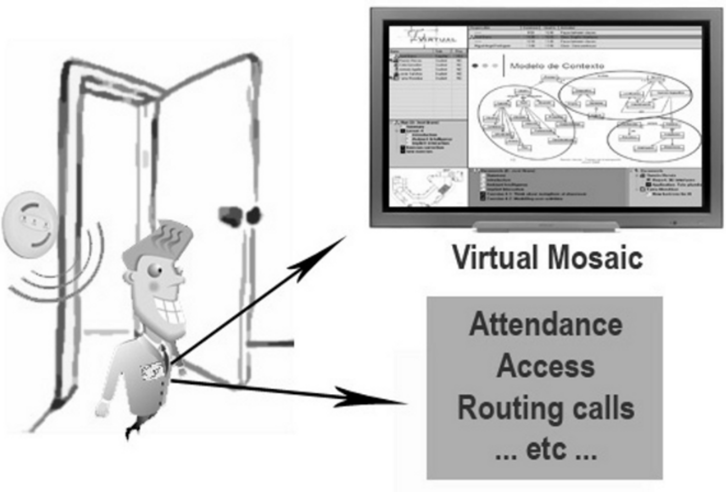

Figure 3. Identification at Classroom

4. A COOPERATIVE WORK EXPERIENCE

This experience is based on the new paradigm mentioned before. On the one hand keep in mind the disappearing computers initiative and, on the other hand, with the new forms of interaction that some researchers propose. With these perspectives we have experimented with two different groups of students that have to do a cooperative work. The first ones uses the computer tool to prepare the presentations and, the second ones, with the traditional cooperative way without computers but evaluating this experience as external evaluators.

In figure 4 the evaluation process can be seen. The first one, on the left, the student actually present passes near an antenna and his presentation appears automatically on the board. The picture in the middle shows the audience for this evaluation process. Finally, the third picture on the right shows the presentation itself with the mosaic that the system generates automatically starting from the student's summary arranged before the session.

It is obvious that some kind of additional interaction is expected. For that we have placed a number of sensors below the display with different functionalities (next slide, previous slide, finish, etc.). By only passing a hand near each sensor the user can obtain answers from the system. The interaction required for each hand movement is a combination of identification and sensors. So, control of different information for each student and the functionality of each sensor can be adapted to them according to their needs in every mosaic.

Figure 4. A cooperative work experience

4.1 Formatting the Information

The subject for this experience has been Geology. The requirement for the initial information is simple. We have built a tool for students with the purpose of doing the summaries. With this tool, see figure 5 left, the students can introduce main and secondary texts. They can also attach pictures and graphics. In addition, the control of slides is considered.

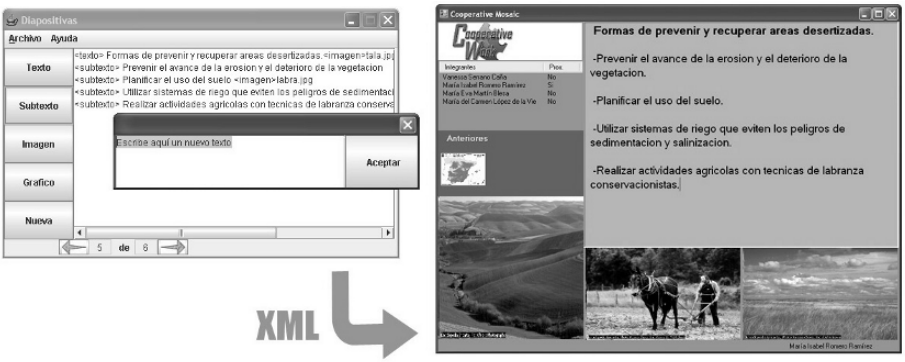

Figure 5. Formatting students' information

When the student has finished the summary, this tool converts it to an XML-based language. Then, the system generates the mosaic for every student's summary automatically. See Figure 5 on the right. Every main or secondary text can be shown with a picture or graphics attached.

4.2 The Visualization Mosaics

The presentation of information is important without needing the user's request. This presentation and the independence of the display device are important factors to be considered. We are trying to regard every visualization component as a puzzle piece. For that, the visualization service is structured as a mosaic of information. For the representation of each mosaic, we have applied a XML-based language. In it, the pieces of the mosaic, the size and the kind of each element are considered. In Figure 6 the XML representation of a mosaic is shown.

Every mosaic is generated automatically from the students' summaries. Some aspects such as size, situation, distribution, etc are contemplated. All of these concepts have been grouped in the corresponding ontology. It is important to keep in mind that to every main and secondary text some pictures and graphics can be attaches, so the concept of slide is significant. The distribution of the space and the link between texts and figures has to be optimized.

The visualization service involves three modules which are clearly differentiated: The Analysis Context Module, responsible for the changes of the context and the managing of a Data Base. The Mosaic Generation Module which obtains data that will be presented in the selected mosaic. Finally, the Mosaic-Composer Module that executes the mosaic and generates the user interface automatically.

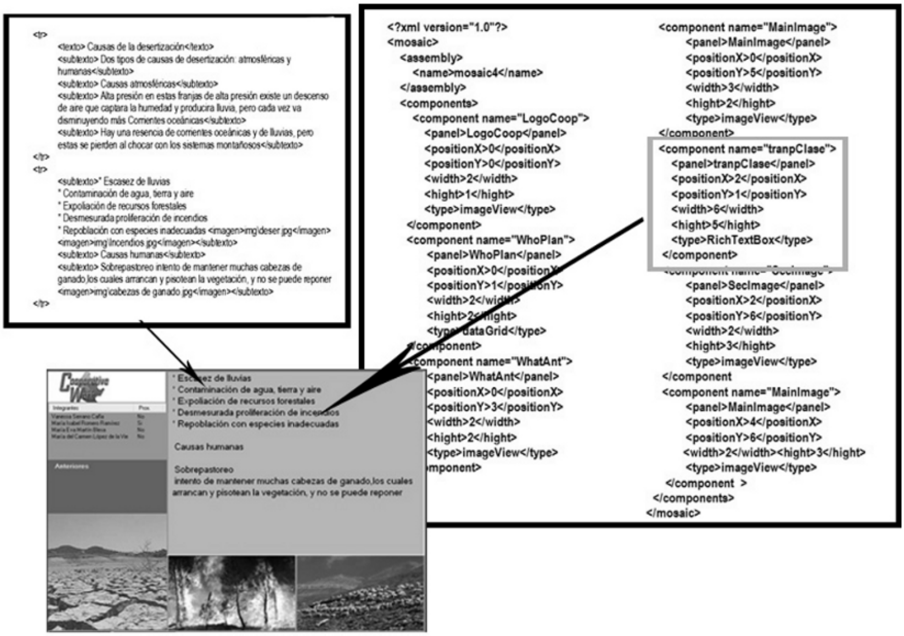

Figure 6. Mosaic XML Structure

4.3 The evaluation

In order to make this experience more real, the students, at the beginning, only know the tool to format the information. Later, in the meeting room, everyone understands the effect of the mosaic and the functionality of sensors below the board. We think this impact is important and this gave us a clearer idea about the acceptance of the new computational situation.

We have evaluated this experience with the students of the School of Education at the University. In it, two groups of students are clearly differentiated. The first one, at the top of Table 1, corresponds to the groups taking part actively in the experience. The second one, at the bottom of the table, is the data from students that have carried out the usually experience of collaborative work of this school.

In this evaluation different features have been clearly contemplated. In a general aspect of the experience, that is, the interest in the experience and the global evaluation, have a good result (33% excellent, 71% and 66% good, 28% average). In the interaction aspects, the results are good by proximity (85% and 66% excellent, 14% and 33% good) and average and by sensors (28% and 44% good, 43% and 44% average, 28% and 11% fair). It is obvious that the last aspect should be improved.

Table 1. Cooperative Experience Evaluation

Aspect	**Excellent**	**Good**	**Average**	**Fair**	**Poor**
Interest in the experience		71%	28%		
Interaction by proximity	85%	14%			
Interacting with sensors		28%	43%	28%	
Appropriateness of the mosaic	28%	56%	14%		
Global evaluation of the experience	42%	56%			
Aspect	**Excellent**	**Good**	**Average**	**Fair**	**Poor**
Interest in the experience	33%	66%			
Interaction by proximity	66%	33%			
Interacting with sensors		44%	44%	11%	
Appropriateness of the mosaic	33%	55%			
Global evaluation of the experience	44%	44%			

Globally the experience was satisfactory and it encourages us to continue with our investigations in this field.

5. CONCLUSIONS

We have put into practice the ideas of the Ambient Intelligence vision trying to create an environment in which computers and interactions disappear. With this vision it is possible for users to concentrate on the task not on the tool.

This real experience has been possible to connect implicit inputs and outputs trough RFID technology and visualization mosaics. In this sense we need to move towards real intelligent environments that serve users without any extra interaction, just carrying out daily activities.

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