Modeling Contexts by RFID-Sensor Fusion

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Abstract

Once devices have been distributed around us, it is essential to model the context in which we interact on a daily basis in an appropriate way. In this sense, we should ensure that the devices chosen should be completely suited to needs. Our aim is to create applications to facilitate the user's daily activities, without any extra effort in terms of interaction, if possible. In this work we present an approach to the modeling of contexts through RFID technology, identifying users as implicit inputs to the system and offering services as implicit outputs. The particular contexts studied are the classroom and the conference site.

1. Introduction

Nowadays, more and more people are working towards achieving natural interfaces by making the use of the computer easier. New forms of computing are appearing, trying to distribute the computer in artefacts which are placed in the environment around us. New computational moments, whose aim is to make our daily activities easier, will thus be an increasing focus of study. In relation to this, concepts such as context are very important if we want to achieve these kinds of applications. A. Dey defines context as "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." [1].This author also defines a context-aware 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. [2] The user profile and situation are essential, that is,the identity-awareness (IAw). The relative location of people is location-awareness (LAw). Time-awareness (TAw) is another main type of context-awareness that will be present. The task which the user carries out and all he wants to do is transformed into Activity-awareness (AAw). Finally, it is important to think why the user wants to carry out a task in a certain place; here it is Objective-awareness (OAw) we are talking about. All these types of awareness answer the five basic questions (Who, Where, What, When and Why) that provide the guidelines for context modeling.

If we want to perform daily computational activities, these tasks should be carried out without any extra user interaction. We aim to use new artefacts placed around us and to complement traditional explicit interaction. New forms of interaction, which are more natural and closer to the user, need to be available. Albrecht Schmidt [3][4] proposes a definition of Implicit Human Interaction (iHCI):

"iHCI is the interaction of a human with the environment and with artefacts, which is aimed to accomplish a goal. Within this process the system acquires implicit input from the user and may present implicit output to the user"

Schmidt defines implicit input as user perceptions interacting with the physical environment, allowing the system to anticipate the user by offering explicit outputs. This agrees with the idea of users concentrating on the task and not on the tool. In this sense our main goal is to achieve natural interaction, as the implicit interaction concept proposes. The present work sets out the identification process as an implicit input to the system, perceiving the user's identity, his profile and other kinds of dynamic data. This information, complemented by the context in which the user is found, as well as by the schedule and time, makes it possible to anticipate the user's needs. In addition, we complement system inputs with sensorial capabilities.

Other authors have used mechanisms for identifying and locating users in different contexts. Want and Hopper did research into active badges which transmit signals that are picked up by sensors situated in the building [5]. Others propose location by means of

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sensors embedded in everyday objects [6], as in the MediaCups experiment. Other experiments like Blueboard, developed at IBM, consist in a display which is designed for the purpose of collaboration by user groups and which incorporates an RFID tag reader [7]. Lastly, the IntelliBadge project gives services to those attending academic conferences [8].

The present work focuses on the search for context-aware situations, allowing users to obtain system outputs through implicit and natural interactions in two different contexts: the classroom and the conference site.

Under the next heading we present the identification process with RFID technology and the way that we applied context-concepts. In section three architectures for both of the contexts mentioned before are described. Section 4 presents services by identification- those offered by RFID technology itself and our contribution of Context-Aware Visualization-Based Services, named “Mosaics”. In the section following that, a proposal to complement the implicit interaction by id-sensor fusion is shown. Finally, conclusions and future work are set out.

2. The identification process

People identification is an good input to the computer that has come from RFID technology. The user doesn’t need a dialog with the computer; he/she only has to wear a small device called a tag. With this, simple actions like entering a room or approaching a board allow the system to detect who is in the room, making it possible to offer services to the user.

The following point presents the RFID technology and the elements needed to read and write tags. The distribution of devices mentioned above focuses on the “who” concept.

2.1 The RFID technology

This technology allows the system to identify people within any kind of explicit interaction. Users and objects have to be captured by the antenna placed near them. In this technology three kinds of objects are clearly differentiated: the reader or transceiver has the job of handling all readings and writings, the antenna supplements these processes, making it possible to read and write at a distance and finally, the tag or transponder (smart label) is carried by the users and objects to be identified. This small device contains a circuit that reflects the electromagnetic energy emitted continuously by the reader, reading and writing the information contained in them. There are passive tags which don’t need a battery We use tag with EEPROM of 64 bytes, of which: 8 are for serial number, 4 for the write access condition, 4 for Electronic Article Surveillance (EAS) and QUIT mode, 2 to family code and/or application identifiers and finally 46 free bytes that we will use in different ways in each approach. Also we use readers and antennas with read-and-write capability of over 75 cm. in reach. Actually, we use two types: Short and Long Range. Each one has 4 ports, input and output function, ,RS232-RS285 communications ports,. The long range can work with one (TX/RX) or two (TX-RX) antennas whereas short range use built-in antenna and printed circuit format. In our context, these have been good for location on doors or near boards. They can read several labels simultaneously when identifying people entering the room. As well as these, the technology presents contact readers which incorporate antennas of only a 10 cm. reach. This last identification system is especially for individual use.

The RFID technology has important advantages over bar codes. We could mention that they do not have to be visible to be read, the reader manages the information at a distance of a meter (in passive tags) and a speed over 30 tags per second and finally, security is guaranteed by transmitting encrypted information.

2.2 Context Concepts by Identification

Identification is an interesting implicit input to the computer. By someone walking near the antenna, wearing a tag, it is possible to read and write information included in this. It can store data such as Id. Numbers and other information like profiles and specifications for subsequent tasks.

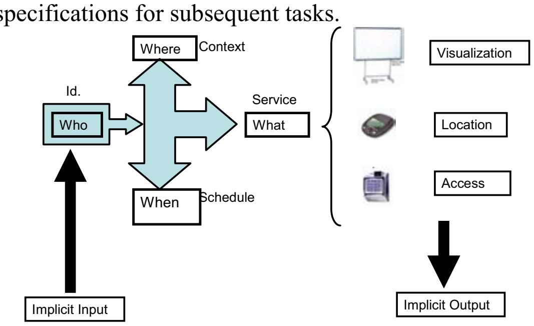


Fig. 1.- Context Aspect by Identification

The concepts of context mentioned above focus on the “who” concept through identification [9][10][11]. At this point we place these concepts strategically in order to obtain services (what) by a function of identification with other concepts as parameters. This structure is shown in figure 1.

Via RFID technology we get the implicit input to the system that we have described. This kind of input, combined properly with the context and schedule, makes it possible to obtain implicit output which is natural and closer to the user.

The main service offered to users is the visualization of information. This depends on profile, context and schedule. The second service is people location, adding other kinds of services like phone-call routing, the number of those present at meetings, readiness of rooms, etc. Finally, access control is achieved by allowing only authorized users to enter the previously- planned context

3. Our Contexts

We have studied two contexts with similar characteristics: the classroom and the conference site. The following points present their architectures for obtaining services by identification.

3.1 The classroom

The Identification Architecture for classroom support is shown in figure 2. 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. The classroom is equipped with readers, a computer and antennas. These antennas are placed on the door and next to the board.

When teachers and students enter the classroom, wearing tags, 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 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.

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 in 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.

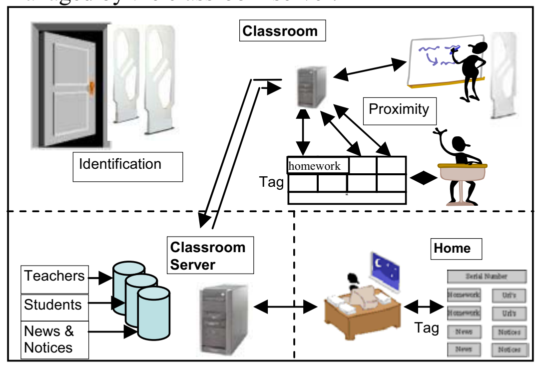


Fig. 2.- The Classroom-RFID Architecture

3.2 The conference site

This is a good scenario for modeling context-applications through identification. In this setting, there are different areas, as we can see in figure 3. The first one is reception, which is very important because those attending are identified as they take their tags .It is at this moment that the location service is activated. At the same time the information of the profile, session and work will be presented (the spikier information) and put into the tag. The second area is the common area where people can observe news and announcements on the board or at kiosks. The news appears when people enter the common area, or when an attendee approaches a kiosk. In this area a social aspect could be highlighted, with data from the tags appearing, such as lines of work, preferences or a person's particular topic of interest. This is when the system could inform those around about people with similar interests to themselves. Another feature is that notices appear on boards and kiosks by means of proximity to them. In this area, depending on the schedule, posters and demos for a particular session can be presented by means of the board and poster identification service. The last area is the session room. Here, the process of entering the room and approaching the board are central activities. In the first case, location and spikier control are produced. These are important for obtaining the attendance statistics and this in turn assists the session's chairperson. In the second case, proximity causes the appropriate presentation to be shown when the holder of the relevant spikier data approaches the board. This process is complemented by the schedule of the session. Evidently, Schedule (Conference Program), Room Session and Time are aspects which are very important in the management of these processes.

All of these areas are equipped with the RFID technology: reader, antenna and tags. All elements are controlled by a server, which manages the whole set of id-transaction, schedule, rooms and time.

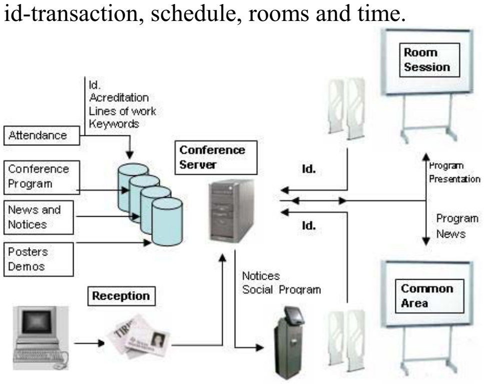


Fig. 3.- Conference-RFID Architecture

4. Services (what)

In this section we describe all the services commented on before in more detail. All of them possess RFID technology like identification, location, presence and access, as we can see in Figure 4 where a data distribution on tag is proposed. The services offered by proximity or by going through the door are shown. In both cases, the visualization services (Mosaics) are offered.

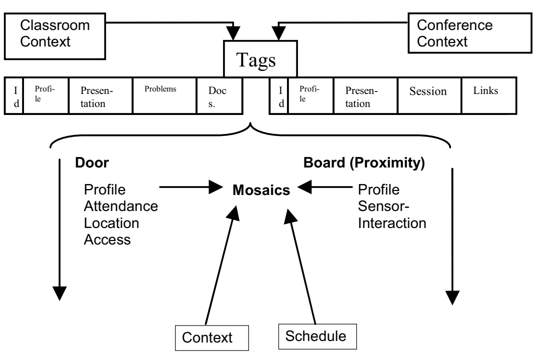


Fig. 4.- Identification-based Services

Our next task here is to present visualization services and the characteristics which are similar in both contexts.

4.1 Visualization mosaics

We have tried to materialize the implicit output to the system by means of a visualization mosaic. In this, the information appears automatically when identification has been produced. Thus, in accord with the concept of "who" mentioned before, knows how to display mosaics, placing different kinds of information in each pane the mosaic is made up of. Some aspects such as pane size, location in the mosaic, priority according to profile, latency of information, etc. are critical features in achieving an optimal visualization.

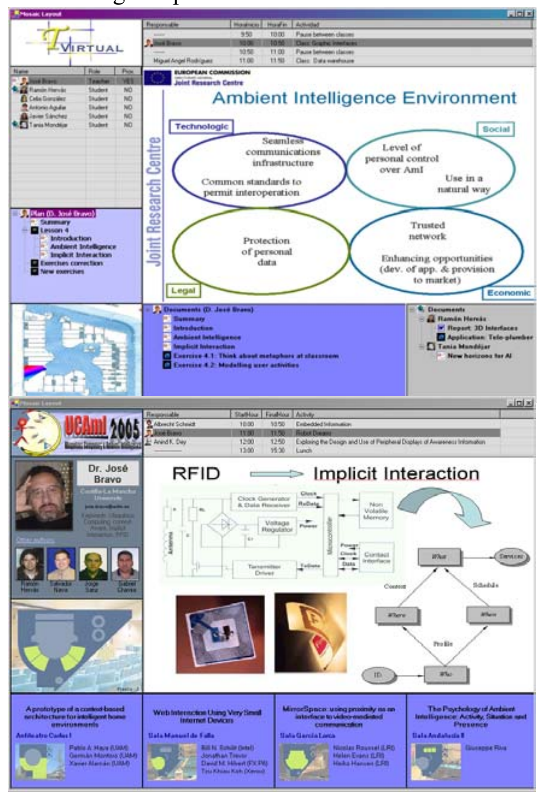


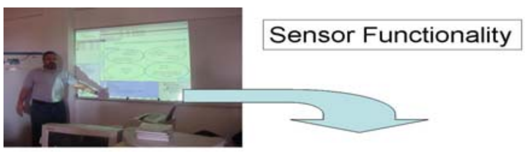
Fig 5.- Classroom and Session Mosaics

In figure 5 we can observe two types of mosaics. The first one is the classroom mosaic and the right one corresponds to the session room in a conference site. In both of them, in the main area, on the right, teachers or speakers present their work. The teacher's plan or the session program is also shown. Other panes in the classroom mosaic present information about class attendance, the teacher's documentation, problems he or she has proposed for answering, etc.. The author's affiliation, session program, information regarding other rooms, etc are in the session room mosaic.

These mosaics are adaptable and the main area could take up other different pane areas. This change would contribute to the spectator's increased attention to the main area. Added to this, mosaics change automatically to show information about news and announcements when classes or sessions finish. The news appears when there is anyone in the room and it is repeated in a continuous cycle. Individual announcements are shown when the attendees approach the board (proximity).

5. Id-Sensor fusion: A complement to Implicit Interaction

It is obvious that implicit interaction is more natural than an explicit one. There are some situations, however, where a slight interaction is necessary. To this end we have placed some sensors below the visualization devices to meet these needs. To be precise, we have four sensors which, with just a movement of the hand, provide some extra functionality, according to the user who is identified. These functions may include, for example, passing a slide, changing tasks, finishing a presentation, etc. With this method there is no need to handle the computer in performing the whole range of simple tasks seen in our two given contexts.



Profile	Action	Action	Action	Action
Speaker	Next Slide	Prev. Slide	End	Control
Chair	Next Job	Prev. Job	Start Session	End Session

Fig. 6.- ID-Sensor fusion.

Fig. 6 shows our scenario. A board with an antenna on the left to read tags and sensors placed below the board. We again highlight the fact that the user's profile, combined with context, schedule and different hand movements near the sensor (such as passing one's hand by the sensor, or holding it steady there for a few seconds, etc), make it possible to obtain some extra functionality. Note too, that in this figure, below, a proposal for sensor functionality is shown.

6. Conclusions and future

In this work we have presented an approach to Implicit Interaction through identification process which is as natural and as close to the user as possible. To see this in operation, we have dealt with two contexts which possess similar characteristics, offering users visualization services with a combination of RFID technology and sensors as implicit inputs to the system. A complement to Implicit Interaction has thus been set out.

We are looking towards new forms of interaction which combine inputs from different sensors and RFID technology.

7. Acknowledgements

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