RFID-SENSOR FUSION: AN EXPERIENCE AT CLINICAL SESSIONS

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Abstract.- Ami vision proposes a shift in computing from the traditional computer to a whole set of devices placed around us providing users with an intelligent background. For that it is necessary to adapt input technologies to achieve a transparent user interaction. In this work we present a health care scenario in which we have placed RFID readers in order to present information to the users wearing tags through "Mosaics of Information".

1. Introduction

Ambient Intelligence (AmI) is the vision IST Advisory Group (ISTAG) of the European Union in which technology becomes invisible, embedded, present whenever we need it, enabled by simple interactions, attuned to all our senses and adaptive to users and contexts [1]. AmI is based on three key technologies: Ubiquitous Computing integrating microprocessors into everyday objects. Ubiquitous Communication between objects and users with the main goal of getting the information at the moment and the place that user needs it. Finally, natural interfaces make the interaction friendlier and closer to the user. However for this vision to become a reality it is necessary to analyze the concept of context awareness as "context to provide relevant information and/or services to the user, where relevancy depends on the user's task"[2]. Others consider important aspects such as Who, Where, What, When and Why in order to provide the guidelines for context modelling [3]. 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 we have to talk about Albrecht Schmidt and his concept of Implicit Human Computer Interaction (iHCI) [4,5]. It is defined as "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". The following step that this author proposes is that of Embedded Interaction in two terms. The first one embeds technologies into artefacts, devices and environments. The second one, on a conceptual level, is the embedding of interactions in the user's activi-

ties (tasks or actions) [6]. With these ideas in mind, our main goal is to achieve natural interaction, as this author proposes.

Under the next heading we present an approach to embedded technology through RFID tags and readers and sensor fusion in a health care context. Then the applied technology with our experience and the ontology for visualization-based services are presented. In the next point the visualization-based services at clinical session with a scenario, a clinical session room scenario with the adapted technology architecture and a description of formatting information are studied. Finally conclusions and future works close this paper.

2. The applied Technology

In order to create context-aware applications it is necessary to adapt sensorial capabilities providing implicit inputs to the system to achieve natural interfaces closer to the users. Next we present our experience trying to adapt the RFID technology to different contexts and the adaptation to our needs. Then our proposal of the ontology is presented.

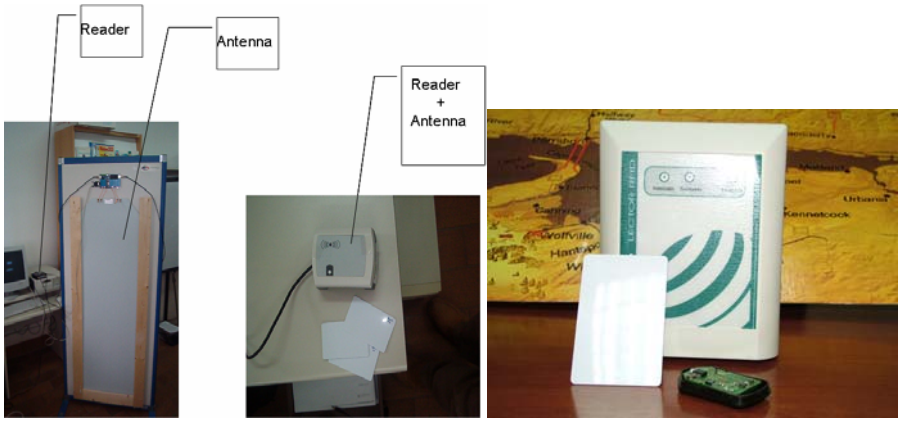

Fig. 1.- RFID sets

2.1. Our RFID experience

In Figure 1, three types of devices that we have placed in different contexts can be seen. The first one on the top left presents a reader and an antenna with a read-and-write capability reaching over 75 cm. This has been specially designed for its location on classroom doors, or near displays [7,8]. It can read several labels simultaneously, when identifying people entering the classroom. It can also identify the teacher or the students who may be approaching the board. The next one is a contact reader includ-

ing 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 use another kind of RFID set, offering more distance between reader and tags (up to 3 meters). In Figure 1, in the third place, a reader and two kinds of tags can be seen. Entry to and exit from each context will also be controlled. This system is has a semi-passive tag using a battery along with 32 Kbytes of EPROM memory for user's data. The reader 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. In addition our prototype uses Bluetooth to transmit signals from the reader to the computer.

2.2 Ontology

In order to use context effectively, designers need to identify certain types of context-aware information as being more relevant than others. The user profile and situation are essential, that is, the identity-awareness. The relative location of people is location-awareness. Time-awareness is another main type of context-aware that will be present. The task which the user carries out and all he wants to do is transformed into Activity-awareness. Finally, is important to think why the user wants to carry out a task in a certain place, here it is Objective-awareness 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 modelling.

To understand all the concept contexts mentioned before it is necessary to develop an ontology for visualization-based services. We define some important concepts:

Entity: Dey defines an entity as "a person, place, or object that is considered relevant to the interaction between a user and an application".

For us all entities have to be identified and located, including, of course, to the user him/herself.

User: It is an active entity requiring and consuming services that interact implicitly with intelligent environments that is aware of its identity, profile, schedule, location, preferences, social situation and activity.

Profile: This is a significant user aspect being important for context-aware information. This concepts define de characteristics of users.

Schedule: This is the calendar representation of predictable activities, contacts, reminders and important user dates. Also it makes it possible to plan the services demanded by users.

Service: This can be said to be a benefit that satisfies some user's needs. Services at different levels of abstraction can be defined.

Identification: It refers to an active and transparent process for recording a single user's identity. In our case study the identification process involves a state of latent awareness waiting to detect new presences near the RIFD readers embedded in the environments.

Location: This is a service to ascertain the relative location of a relevant entity. It is a relative position since, in our case study, the absolute position is not interest and in addition, it is determined by a recognized area

Customized contents: These contents are user information which are structured and adapted according to the profile and situation.

The contents shown through the visualization service can be different for diverse users working at the same time in the vicinity of the visualization devices. It is due to that it is necessary to focus on the contextual information related to the nearby users and also to use techniques to optimize the distribution of, and time for, contents.

Property: priority (main or secondary –> quantified)

Property: Size

Distribution: We need to establish the most opportune situation of the contents, according to the user profiles, contexts, schedules and time.

Work related: To expand, to contract and to move.

Latency (property of contents).- In the visualization service we define latency as the time from when content is published to the moment that it is eliminated and in fact stops being visualized. Those contents that do not adapt to the circumstances or conditions of the moment (the present users' situation) should be deleted.

Structuring: This is the identification and classification of different parts of the contents.

Relationship: It refers to the connection or correspondence of contents with others. Knowing that they can be supplemented allows more direct, precise and concise information.

Adaptability: This is the ability to show contents in a suitable time to the present users, context and schedule.

3 Visualization Services at Clinical Session

We have tried to materialize the implicit output offering information to the users by means of a visualization mosaic. In this, it is desirable that 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 optimum visualization.

In the next points we present a scenario, the clinical session environments and the way that the information is transformed through the mosaics of visualization.

3.1 Scenario

Our scenario is a clinical session in which doctors have an everyday meeting discussing all matters concerning the patients on a hospital plant.

Dr. Fuentes, early in the morning at home, prepares the documentation which will be presented in the clinical session one hour later. Thinking about the problem of a patient, Dr. Fuentes solve that it could be good to show a couple of x-rays and some urine and blood analyses. In addition the last treatment Dr. Fuentes thinks that is important to show and also, he decides to find some similar cases in the hospital.

Finally he writes a few lines to comment doubts, treatments, special cases, etc. for this patient. Once Dr. Fuentes has completed the documentation of all his patients, he passes his key-rings near a device placed next to the computer. Later in the clinical session room, Dr. Fuentes approaches a large display on the wall and when he is within a meter of it, the documentation of his first patient is displayed in a mosaic. He doesn't know how this process is produced but he realizes that every doctor can see the documentation distributed in the display in a clear and concise way. Dr. Fuentes with a movement of his left hand manages the information about his patients easily.

3.2 The Clinical Session

We have placed the RFID devices in two places of the clinical session room: on the door and next to the display. With the first one we can offer services implicit in this technology such as location, access, presence, inventory, routing phone call, etc. The second one is more important for us to the fact that the user can obtain adapted information on the display in a simple and intuitive way: The Mosaic of Visualization.

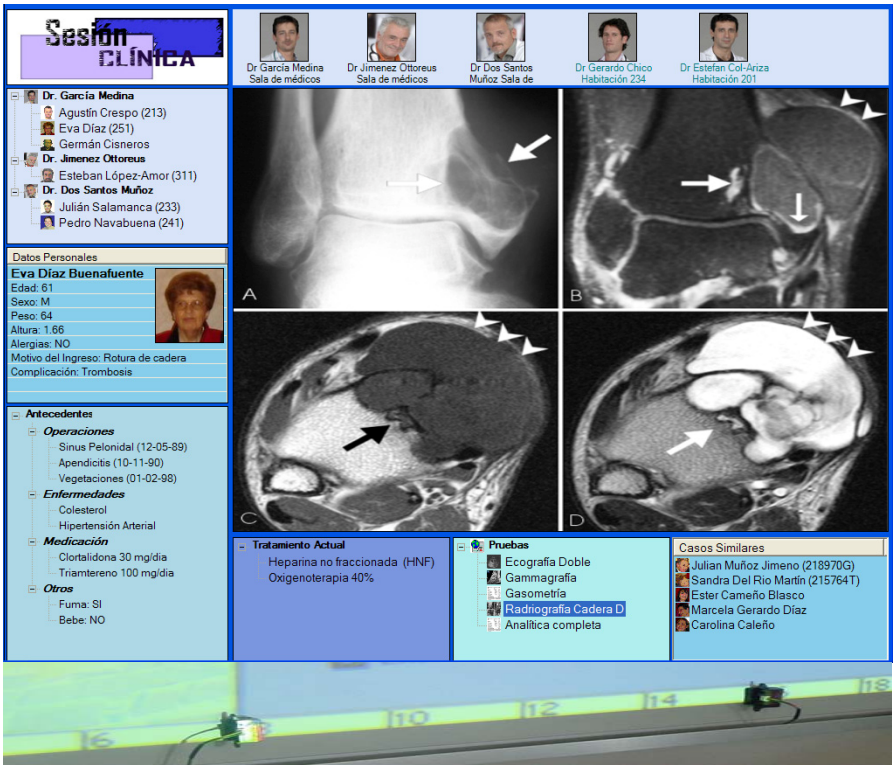

Fig. 2.- Mosaic of Visualization at Clinical Session and a set of sensors.

In the clinical session room we have placed readers on the door and near the Display. When doctors or nurses approach the display, the information stored in their tags is shown in a mosaic generated automatically by the system. In it we can see (Fig. 2) similar information mentioned before in the description of the scenario, that is, a doctor's list, patient affiliation and clinical records, patient proofs (x-ray, scanner, etc.), analysis, treatments and similar cases.

It is obvious that in these implicit inputs and outputs some kind of additional interaction is expected. For this we have placed a number of sensors below the display with different functionalities. By only passing a hand near each sensor the user can obtain answers from the system. So, control of different information for every patient can be managed, see Figure 2 below. The functionality of each sensor is adapted to the user according to their needs of every mosaic. Also it could change dynamically when a part of the mosaic has the focus linking other information. See table 1.

Profile	Sensor #1	Sensor #2	Sensor #	Sensor #4
Dr. Coordinator	Start Session	Next Patient	Prev. Patient	End Session
Dr. Fuentes	Next Screen	Previous Screen	Next Patient	Similar Cases
Dr. Fuentes	Treatments	Proofs	History	Return Control
Nurse	Next Patient	Treatments	Analysis	Comments
Dr. Rueda	Next Screen	Previous Screen	Similar Cases	Treatments

Table 1.- Sensors' Functionalities

3.3 Formatting doctor's information

Doctors handle an application to create their presentations easily. With it doctors control the information that they want to be presented through the mosaics. For that, it is important to highlight the comments for each patient.

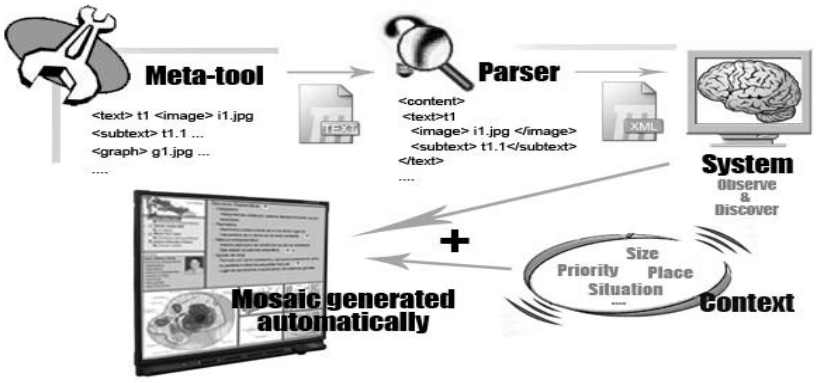

Fig. 3.- Mosaics Generation

Some aspects such as relation to the comments and the clinical history are contemplated. Also, emphasizing information of the clinical history as we have mentioned

before in the ontology can be managed. These actions are performed in the mosaic with the help of the interaction of the sensors.

4. Conclusions and future works

We have adapted the RFID technology in order to improve the interaction between the user and the computer. With these kinds of implicit inputs an extra cost of interaction it not necessary because it is included in the user's daily activities. To complete this application for other hospitals' wards, we are developing meta-application to format the information which will be stored in the doctor's tag placing it automatically in different mosaics of information.

5. References

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