Enabling NFC Technology for Supporting Chronic Diseases: A Proposal for Alzheimer Caregivers

Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

*MAmI Research Lab
Universidad de Castilla La Mancha, Ciudad Real, SPAIN
**General Hospital of Ciudad Real, SPAIN
**Facultad de Ingeniería (ESIDE), Universidad de Deusto, Avda. Universidades 24, 48007, Bilbao, SPAIN
Jose.Bravo@uclm.es, dipina@eside.deusto.es

Abstract. Alzheimer's disease makes great demands on care by caregivers, since they cannot distract their attention from patients while they are managing records at the same time. For this reason, technologies to complement this process need to be considered. In this work we propose to adapt Near Field Communications (NFC), applying it to an Alzheimer's day centre. With a simple interaction, which involves touching tags with mobile phones, it is possible to manage the information easily. In addition, a complement for Alzheimer care visualization activities at home and monitoring is presented.

Keywords: NFC, Ambient Assisted Living, Context-Ontology, DTT.

1 Introduction

AmI promotes environments where humans will be surrounded by intelligent interfaces, supported by computing and networking technology that is embedded in everyday objects. These environments will adapt to the needs of users and will be capable of responding intelligently to any human form of communication. [1]. This is an evolution from Ubiquitous Computing, a vision originating in Mark Weiser [2], where computers disappear, being embedded into the background. Weiser's vision has to do with Ubiquitous Communication, which takes place between objects and users and whose main goal is to get the information at the time and place that users need it. This vision is also related to Natural Interfaces, which make the interaction friendlier and closer to the user. Basically, users are focused on the task and not on the tool, so that the technology should disappear. Using a computer to support daily activities is not yet a reality nowadays. The reason for that may be related to the interaction required. In healthcare contexts, workers do not have time to manage daily routines. Moreover, they complain about the difficulties of using healthcare applications [3]. Another important aspect is the great percentage of time that workers in a care-giving environment consume in managing patients' information [4]. This time should be invested in care activities rather than in using computers.

2   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

Care of elderly people and the increasing occurrence of chronic conditions among the ageing population are major social and economic challenges for the European society and its healthcare systems. Thus, the AAL Joint Programme [5] aims to find out innovative Information and Communication technologies for elderly people with identified risk factors and/or chronic conditions. The economic aspect for caring elderly people in Europe also has to be considered. For example, one year's stay of an Alzheimer patient in a nursing home costs $64,000, while staying at home costs only $20,000. This fact, added to the estimation that the number of elderly people will double by 2050, is a basic one in finding appropriate AAL solutions

This work presents a solution which aims to improve and complement Alzheimer's care based on the use of two technologies NFC (Near Field Communications) [13] and DTT (Digital Terrestrial Television). The main idea behind it is that care givers interact trough NFC enabled mobile phones by touching tags attached to equipment or patients with their mobile phones, i.e. through a very natural and easy to use touch computing paradigm [14]. Additionally, Alzheimer's therapy through the use of DTT is also suggested.

The structure of the paper is as follows. Section 2 gives an introduction to two application scenarios; a day centre environment and a home-based setting is given. Besides, a description of the technology used in each case is offered. Section 3 describes an ontology which allows us to model the context gathered on the Alzheimer scenarios considered upon which aiding services are offered. Section 4 presents the actual prototypes we have carried out applying NFC technologies in day-care centres and DTT for home-based monitoring and therapy. Finally, section 5 draws some conclusions and suggests further work.

2   The Context

The technological contributions proposed by this work address issues on Alzheimer care in two kinds of environments: day centres and homes. In the former one, patients go to a day centre every day from 9 am to 4 pm in order to receive some therapy that reinforces their memory. The aid received in the day centre is often complemented by other in-house based therapy exercises. Besides, it is important to be in contact, during the whole caring process, with family members in order to have better knowledge about the patients' behaviour in both places. In the next section we describe these activities and the related exchange of information.

2.1 Day Centre

These care environments relieve families from the continuous daily care of an Alzheimer patient. In the care centre we have studied for this work, namely Alzheimer Day Centre of Ciudad Real (Centre II), patients are divided into several groups, of about seven people, where they develop their activities in different rooms. Once the patients arrive to the centre, by using the daily transport service, they eat breakfast together. Then, the different therapy activities are started:

- *Rehabilitation / Physiotherapy*. The objective of this therapy is to observe patients behavior and to promote activities which will delay their loss of movement and agility. For that, patients have several exercises for their hands, arms, legs, feet and torso. In this activity, caregivers need to know about recent injuries caused by falls or domestic accidents. In addition, information about patient profiles and the physician's recommendations are also relevant.
- *Therapy*. This is the main activity that seeks to reinforce the patient's memory through the recognition of relatives and objects. Patients are asked details about their families, e.g. names of children, wife or husband, parents they have and so on. In the object recognition exercises, patients are asked to recognize pictures with the aid of their assistants. Also, a few games to reinforce memory are included in this activity.
- *Handwork (Occupational Therapy)*. Here patients do some handwork, cutting out drawings painted on cardboard, sticking different parts together and finally creating figures. In this activity, the place where each patient sits down is particularly important, as well as whom they are sitting next to, because affinities are crucial for proper development.
- *Visual*. Once a week, patients watch films and documentaries in the projection room. Meanwhile, the staff manages the weekly information in order to draw recommendations for the families in their weekend care. This can be done because this activity does not require great deal of attention. Two people are enough to monitor about twenty patients.
- *Lunch*. Finally, lunch is considered another important activity as it includes the patient's behaviour when eating. Patient attitudes and reactions at lunch time, such as rejection of food, have to be monitored by care-assistants. Facts such as menu acceptance, refusal to eat, affinities with other patients or fights are important aspects in the centre's daily life.

The information collected from these activities and the occurring incidents are currently written in a patient notebook. In addition, assistants record the corresponding recommendations in that very book, which is handed to the patient's family at the weekend. Noticeably, many incidents are also transmitted informally just by speaking. This means that some things are often forgotten since there is no corresponding annotation in the notebook.

2.2 Home

At the moment, therapy activities are managed by relatives or home care staff in collaboration with the day centre's caregivers. Daily, relatives provide care assistants with information concerning the behaviour of the patient at home, receiving, at the same time, information of the patient's activities in the day centre. In addition, families provide information concerning the patients' memory in order to build personalized exercises to reinforce their minds. Finally, families receive recommendations from the caregivers towards safety for patients at home or with suggestions regarding possible therapies to apply at home.

4   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

2.3 Technologies for Alzheimer care support

In our work we have experimented with four core technologies which we deem can aid in the Alzheimer care giving process. Taking into account the two contexts of Alzheimer care considered: a) day centre and b) home, the technologies regarded are as follows. As far as the home is concerned the only realistic approach is to consider a minimal introduction of new technologies. In this regard, we think that the adoption of DTT-based interactive services through which therapy to Alzheimer patients can be provided are a good option. Additionally, both at home and in a day centre the adoption of patient wandering systems with lowering prices such as the Agotek's Gerotek [15] product with which we have experimented is a very good option. However, the work described in this paper has focused on two key technologies:

- **Context Modelling through Ontology**. As it has been described in the previous two sections in order to provide a personalised and valuable service to Alzheimer patients it is paramount to know as much information as possible about their current status and daily therapy exercises and reactions to them. A common current approach is to adopt semantic technologies to model such knowledge given the flexibility such technologies offer in terms of new knowledge inference and reasoning.
- **Context Sensing and Phone-mediated natural interaction with NFC**. If there is a truly pervasive device, this is the mobile phone. Therefore, if there is a device that a care giver is ready to use is a mobile phone. The integration of NFC technology into the latest mobile phones eases the pairing between users and surrounding tagged devices. Based on this promise we have carried out some experiments for improving the care given in a day centre, which are described in the following sections. However, before concluding this section we offer a brief overview of this technology and its capabilities.

In order to create applications for supporting daily activities in an assisted environment, it is necessary to adapt sensorial capabilities. Our approach on this regard has always considered identification technologies. Initially, we used Radio Frequency Identification technology (RFID). By placing readers and antennas appropriately in the environment, it is possible to be closer to Weiser's vision, as this system offers an easy method for interacting with the environment [6], establishing bindings between users and tagged objects. By just wearing tags, people can obtain services relevant to the context in which they are living. However, some disadvantages have to be considered. Firstly, even a single interaction requires the patient to pass near an antenna. The fixed nature of such antennas and readers carries associated infrastructure costs. On the other hand, the NFC technology changes the model (see Fig. 1). While in the first case both readers and antennas are fixed, in the second one, they are mobile. In addition, in the first case, tags are mobile, while in the second one, they are either mobile or fixed [7]. Thus, we deem that a key technology to support Alzheimer caregiver's work in day centres is NFC.
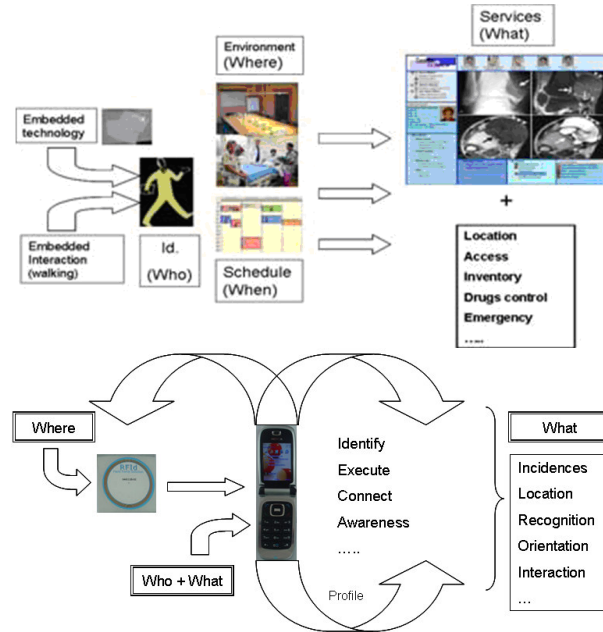
Fig. 1. RFID vs. NFC models.

NFC [13] is a short-range technology using a frequency of 13.56 MHz. The system consists of two elements: the Initiator, which controls the information exchange (called reader in RFID); and the Target, which responds to the promptings of the Initiator (called tag in RFID). Furthermore, two operation modes are available: Active and Passive. In the Active one, both devices generate their own field of radio frequency to transmit data (peer to peer). In the Passive one, only one of these devices generates the radiofrequency field, while the other is used to load modulation for data transfers. Fig. 2 shows the three types of NFC devices: mobile phone, tag and reader. It also shows the Active and Passive interaction modes.

A very interesting feature of NFC in Java ME devices is that by just bringing a mobile phone near a tag, the information contained in the tag can activate the execution of the corresponding mobile phone application automatically. This is due to the PushRegistry of the JSR 257 API of NFC. Registration for mobile application or service enacting start-up is based on the record type name and format of the NFC Data Exchange Format (NDEF) record. There can be one application for each record type name and format pair registered for start-up at a time. If the data on the target contain more than one NDEF record, the start-up is based on the record type name and format of the first matching record in the data. When a target is discovered, the application management software checks the PushRegistry entries. If there is an entry for the NDEF record type name and format in the target, the application having that entry is started. An example NDEF record would be the following: `MIDlet-Push-`

6   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

```
1:ndef:mime?name=App/Therapy,Presentation.VisualMIDlet_IN
CIDENCES,*.
```


Fig. 2. NFC devices and operation modes.

3   Ontology-based Context Modelling for Alzheimer Care

As mentioned in the previous section a key requirement to offer a better Alzheimer care support is to gather, model and process patient related information, i.e. their current and past context. According to A. Dey, 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*" [8].

   This definition, together with Dogac's idea about the creation of context ontology to achieve a better scenario understanding in Ambient Intelligence [9] made us consider the division of a caring setting (day centre or home) in four important aspects defined as follows:

- *User***.** The user is an active entity requiring and consuming services that interact implicitly with an intelligent environment, which is aware of the user's identity, profile, schedule, location, preferences, social situation and activity.
- *Services***.** When we talk about services, we are referring to all the activities that the system might offer users to satisfy their needs.
- *Environment***.** The environment is everything surrounding the user; that is, all the physical entities that could be found.
- *Device***.** Mechanisms capable of modifying the context, by the explicit or implicit interaction of the user, or collecting information about the context or users.

Each and every one of these aspects or concepts is, in turn, composed of a set of entities or instances that depend on the scenario, thus distinguishing between the day centre and home.

3.1 User

The number of users taking part in a day centre is considerably higher than that in a home and, what is more, there are some entities in the day centre ontology that are not considered in the home ontology. We will start by defining the entities shared by both scenarios.

- *Dependant person***.** A user with a degree of dependency who requires special care. These will be those favoured by the services available.
- *Visitor*. A user who gets in contact with the system temporarily.

  Now we indicate the entities bound, specifically, to the day centre ontology.
- *Assistant*. A user who helps in particular tasks related to patient care.
- *Physician*. A doctor entrusted with the monitoring of the dependant person's state of health.
- *Nurse***.** A user with enough professional training to take specialized care of the dependant person.
- *Relative.* A user who belongs to the family or caring circle of the dependant person. This user receives specific information from the incidence service.
- *System administrator.* A user who maintains and operates a computer system.

  The entities described above are not included in the home ontology; however, the home ontology has its own two entities:
- *Primary physician.* Refers to someone with a medical degree who visits the dependant person daily.
- *Caregiver.* A user who takes care of the dependant person. This person related to the patient or not, is in charge of carrying out the exchange of information with the day centre staff (when the dependant person arrives or leaves the centre).

3.2 Services

At first glance, the two scenarios present the same classification on the service ontology. All the services defined can be included in one of the following three general services:

- *Information management.* This means processing and filtering context information so that it can be visualized and understood for later decision making. Most of the users would benefit from this service. Services of this type offered in the day centre differ from the ones offered at home. In the day centre there is more information to manipulate and some of the activities do not exist at home. The *activity support* service is especially important, as it tries to avoid the advance of the disease. *Incidence management* is also a key term. Both concepts will be explained in depth further on in this document.

8   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

- *Monitoring.* To understand what is happening in the environment, it is necessary to know the origin of the information, using sensors. Users, as well as the environment, need to be monitored, and this is done by taking their life signals (*patient tele-monitorization* service) and by controlling their location.
- *Decision making.* Reactive care in AAL environments implies that actions should be taken based on the information available at the exact moment an incident happens.

3.3 Environment

In the environment ontology, there are slight differences between both scenarios, at least at first sight. The main entities that take part in this ontology are now listed.
- *Door.* In a place like a day centre, it is necessary to control doors to avoid the possibility of patients escaping (or intruders entering).
- *Outside area.* Places outside the building.
- *Room.* The day centre is composed of a group of rooms. Each of them would have certain attributes to differentiate them from each other.

   The room types we can find in a day centre differ from the ones found at home. As shown in Fig. 3, at the day centre there are specific rooms for the activities carried out (emphasized with a green square), while at home, the rooms correspond to the common places of a simple house. Another difference is the orientation panel used to facilitate the movement of the dependant person between the different rooms (see home diagram in Fig. 3).

3.4 Devices

The types of devices used to modify the home context are more than those deployed in the day centre. This is due to the fact that not only NFC technology has been introduced, but also RFID, so as to know where the dependant person is at every single moment so that incidents related to the person can be avoided. Once the differences have been explained, we can begin defining the devices found in both scenarios:
- *Tag.* It is a near field RFID tag that contains information about the place, object or person it is attached to. Depending on the kind of tag (for place, object or person) the information stored in it and its structure will vary.
- *NFC Mobile Phone.* Device capable of reading near RFID tags. It is a special type of mobile phone that contains an NFC reader and allows information exchange between two mobile phones, as well as reading and writing of information stored in RFID tags.
- *Sensor.* Bluetooth-enabled devices recording the dependent person's state of health.
- *Visualization system.* System used to show the information needed by the user. In the home ontology there is a specialization of this entity used to visualize exercises that slow down the Alzheimer's disease.

- *Door actuator*. Its function is related to the *Door control* service. This service will send an opening signal to the device, so that it executes the order.

An additional entity is defined in the day centre ontology: the *server*, which is similar to the *computer* entity defined in the home ontology with the only difference being its central role as information gatherer. Further entities only included in the home ontology are listed below:

- *Reader*. Device capable of reading RFID tags. It is useful for finding where the dependant person is. This device is used in the orientation and location services.
- *RFID tag*. It is a device similar to the one called *tags*. They differ in their reading distance range.
- *Tele-Alarm.* Mechanism used for help requests. It is associated with the telephone and works by pressing a button that immediately contacts with an emergency service.
- *Alarm.* It is a composition of an alarm and an RFID tag. The alarm starts ringing when a danger is detected.

3.5   Context Ontology

Our context ontology results from merging the four types of concepts mentioned. The *User* (physician, dependent person, assistant, etc.) is in the *Day centre*, being able to use the active *Devices* and, at the same time, to benefit from the *Services* offered. The most significant part of the resulted context ontology is shown in Fig. 4.The figure shows where the activities take place (*Activity Support* is developed in a *Room)* and how the incidences are linked with the activity being done. In addition, we can observe that the door is linked with the services containing the name.

4   An Approach to Home and Day Centre Services

Next, we detail some of the main services defined which make use of the knowledge modelled by our context ontology. Prototype versions of all these services for Alzheimer care support have been developed.

4.1   Simple Interaction

Elderly people are not familiar with new technology. Thus, interaction methods as simple and natural as possible are highly desirable. This is also applicable to caregivers or relatives, whose hard work taking care of the patient does not allow them to waste their time with annoying common interactions. Stopping their work to write records in a PC is not an option. They (both patients and caregivers) must interact with the system in a transparent way, with the simplest possible actions. Technology should be at the service of the users and not the other way around.
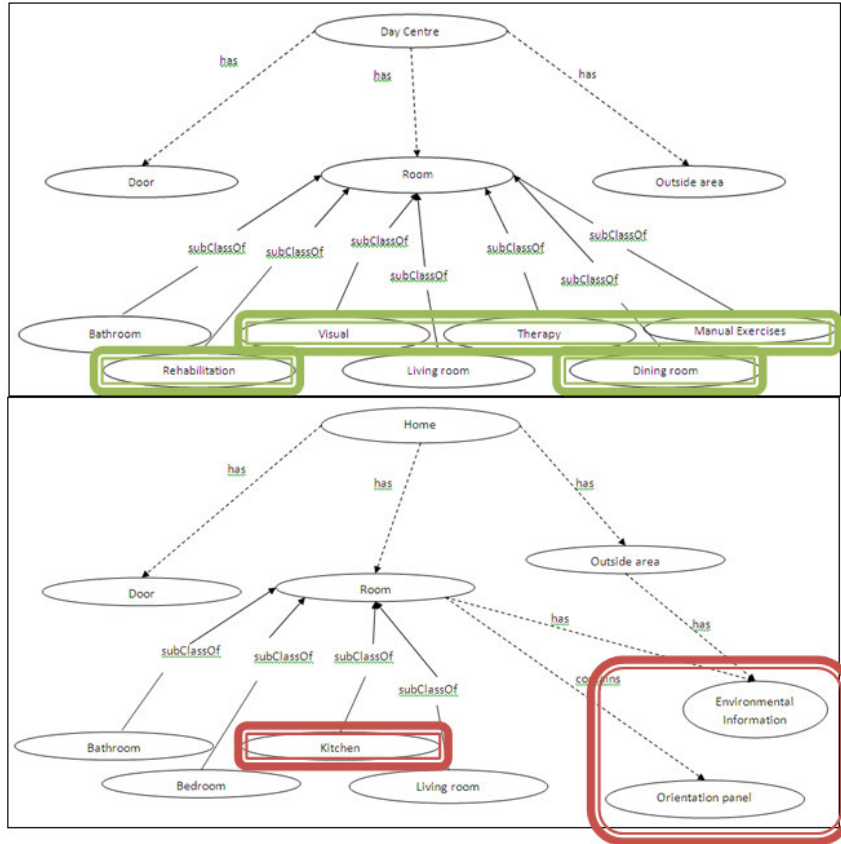
10   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

Fig.3. Ontology entities for the day centre (top diagram) and the home environment (bottom diagram). The differences between both diagrams are marked with green boxes in the day centre ontology and with red boxes in the home ontology.

We can achieve this objective by using a Bluetooth-enabled NFC mobile phone. The interaction is as simple as bringing the mobile phone close to the device or person that will take part in the action: life signal monitoring devices, displays, computers to store data or, even, the patients. Examples will be detailed in next sections.

In order to use a device or to get the information of a patient, a person has to touch the corresponding NFC tag with the phone in order to launch the needed mobile phone application, as it was explained in §2.3.
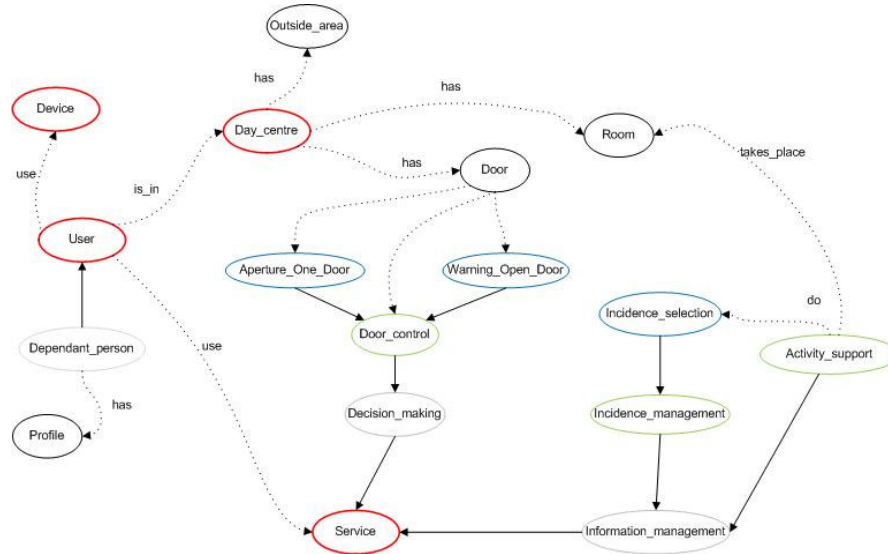
Fig. 4. Resulting context ontology.

4.2   Incident Management

The management of patient incidents is a key service to be offered by an Alzheimer care support system, because it facilitates the inherently difficult job of the caregivers.

At present, when a patient incident is noticed, caregivers have to stop doing their job, leaving their patients with another caregiver and writing the incidence in a notebook manually. There are many clinics and centres that follow this protocol, which causes numerous problems, such as the interruption of daily work, lack of formalism and the impossibility of searching for the information and generating accurate reports for physicians at a later date.

This problem has to be addressed in a way that will help caregivers with the simplest possible interaction, without making their job even harder. Reaching this objective is discussed in the following three stages.

The first step in accomplishing our task successfully is to formalize the type of incidence a patient may have. It is not a good idea for each member of the staff to record the same incident in a different way. Therefore, a long list of all possible incidents and issues has been devised. In this list, we have separated each area of the day centre into a separate category (see Fig. 5). In addition, each centre could add its own incidents through a common server interface or even a website. This is a concept that we have called *meta-incidents*.

With the incidents already formalized, a form is offered to the user to fill in a consistent way. NFC technology is used to simplify this task. In combination with a mobile phone, NFC technology allows a user to "insert" the incidence about the

12   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

patient via the NFC tag. This can be then accessed easily by others caregivers, assistants or relatives.
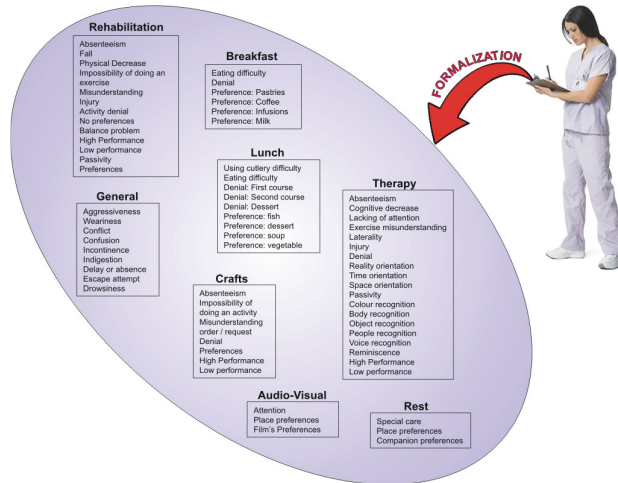

Fig. 5. Incidents by area captured after the formalization process.

On the other hand, users should receive the personalized data needed to avoid the extra effort of reading incidents that may not be related to their job. Physicians would receive clinical information, while assistants and caregivers would obtain just the behavioural incidents. Moreover, this information should be shown as clearly as possible, trying to summarize all related incidences and put them together. In a further step, these summaries should be mixed with the patient's clinical information and previous reports, so that professionals could receive valuable recommendations. Fig. 6 describes the proposed idea.
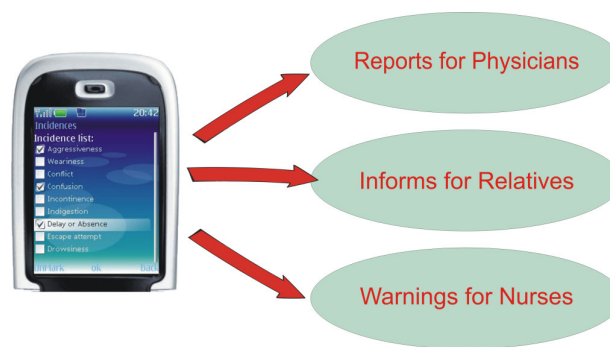

Fig. 6. Different information is displayed depending on the interest of each person.

4.3   Therapy Activity Support

Day centres use different services to help their patients. One of the most important services is occupational therapy. Therapy activities are focused on stimulating the patient's memory, orientation, calculation, language, and so forth.

Normally, there are general games that help the dependant person without the interaction of a caregiver. However, if we want to make personalized games or activities, we need to keep the patient's personal knowledge in mind as well as an assistant who knows all this data, in order to ask the correct questions with their corresponding clues (e.g., "What is your wife's name?", "It starts with M…"). This knowledge is, in fact, the most helpful when we want to improve the capacities of the patient.

At day centres, all of these activities could be carried out under a general concept; referring to all the patients staff look after, as well as to the particular patients themselves. In other words, the recognition of objects, people and places, as well as other activities, may be valid for every patient, as they could be done about general knowledge. On the other hand, referring to the home context, these activities would be mostly centred on questions for the specific individual because, at home, there would be just a few patients to take care of, as it was mentioned in the ontology previously presented.

For each activity, the system will then ask its corresponding question and wait for the answer of the patient. In case the patient does not know the answer (the patient may become a bit nervous for that), the system will offer the possibility of visualizing some clues composed of text, video, audio or images, or even, the correct answer to stimulate the patient's learning.

Therefore, caregivers or relatives should be able to define different kinds of activities from their work places or homes, through a Web environment. They could make it through predefined formularies or by building their own ones. To achieve this, server applications used to get data for therapy activities must provide enough mechanisms to allow the introduction of different kinds of information, whether it is personal or general.

As an example, they could introduce into the system information related to some patient's relatives, along with some clues to help the patient's memory when remembering them. Here is where an activity plan could be taken into consideration, avoiding the patient's disconnection from their closest environment. This will stimulate their identity as well as their self-esteem.

They can also create general questions that will be useful for every patient; for instance, information about celebrities, books, TV series, etc. A patient could thus watch a piece of a film or listen to an animal sound to recognize it. In case the predefined activities may not be enough for caregivers, they could use an open form to enter any question they want, defining the question itself, its answer, and its clues.

Moreover, assistants could build their own activity through meta-forms, defining tags and contents, which correspond to the custom activities considered by each centre. These meta-forms will help them to create forms that could be filled in by anyone with the personal data of each patient.

14   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

In accordance with the rest of services, we propose a simple interaction to get activities displayed in any screen from the server. It is possible to visualize an exercise on any public display knowing just the activity and the patient tag. The exercise, contained within the server, is sent to a display, thanks to a wireless video sender. Those taking part in the exercise wear some tags, which makes the interaction possible. This device can show different data, such as video, voice, text, etc. In addition, the corresponding navigation through an exercise structure is given by just touching tags.

Regarding the home case, this device could be a common television with DTT enabled. This complement to therapy could be managed at the patient's own home too. For this reason we have implemented some applications through DTT. These have been developed with the MHP [11][12] language and their content is automatically generated from the information provided by the day centre server using the XML markup language. Hence, relatives wishing to help patients only have to interact with a television set, using the remote control.

The device used to send the application to the DTT television is a DVB-T (Digital Video Broadcasting – Terrestrial) decoder with MHP technology. This device will decode the interactive application distributed in a television channel and will offer the interactivity demanded by our activity plan. This technology provides the possibility of developing applications in which the user could interact using a simple remote control. The system, of course, allows us to show multimedia content (video, audio or images) to the user. As an example, Fig. 7 shows an object recognition activity, where a user can watch clues, answer or, even the user's own experiences with this object, just by touching the colour buttons on the remote control.

Fig 7. Object recognition activity through DTT.

The MHP application reads from the served XML file and, through an MHP decoder, shows on the television screen an interactive activity played by the patient or his/her companion via a remote control. They can navigate across the therapy

activities, while the patient will be practicing with the corresponding exercises. This kind of system offers us a technological environment at minimum cost, just a DVB-T decoder ready to understand MHP code, and a display or television, which joins multimedia content with an easy interaction.

4.4 Patient Tele-Monitoring

In order to keep control the patients' health when they are at home or at the day centres, it is necessary to monitor their vital signs, which are measurements of the basic functions of the body.

There are several available Bluetooth enabled devices that support monitoring of vital signs in the market. For instance, the electrical activity of the heart can be controlled with a Bluetooth ECG device. To monitor the Peak Expiratory Flow Rate (PEFR) and for diagnosing lung conditions like asthma, a Bluetooth Spirometer can be used. The oxygen saturation in the blood (SpO2) can be measured with a Bluetooth Pulse Oximeter, in the same way that blood pressure can be measured with a Bluetooth Blood Pressure Monitor. People with diabetes can check their blood sugar with a Bluetooth Glucose Meter. The weight can also be daily controlled with a Bluetooth Weight Meter.

Communicating with these devices should not involve a complex interaction with common personal computers. To use a monitoring device, a person (the patient or assistant) should be able of just touching its NFC tag with the phone, in order to launch the mobile phone application. As a result, the monitoring device should be activated and the measurement sent to the mobile phone through a Bluetooth connection. When the mobile phone obtained the measurements, it could make recommendations and send the corresponding alert messages, if necessary. Hopefully, this king of Bluetooth- and NFC-enabled vital sign devices will emerge soon.

According to the patient medical records and other data, like age or measurement limits are set. When the mobile phone gets a measure from a monitoring device, it checks the limits and performs an action. When the measurements are inside the patient's predefined thresholds, the mobile phone will play a voice message telling the patient that everything is all right. However, when the measurements are over the limits it means that something is going wrong and, therefore, it is very important to calm the patient, mainly when he or she is alone at home. When this happens, the mobile phone tells the patient what to do. The patient will hear a voice message with the recommendation of the mobile phone. This recommendation will depend on the patient's medical record. A recommendation example would be "your pulse rate is very high, you must rest" or "your glucose levels have increased, you should go for a walk for about 30 minutes". However, the most common scenario when dealing with Alzheimer's patients is the one in which their companion (a relative or a caregiver) is near them, so that they will receive such recommendations as well. In addition, since they can understand our offered data better, these recommendations could be more complete than those provided to the patient alone.

When the measurements are dangerous, the mobile phone will send a message to the primary doctor. The doctor will see in her computer the patient's medical record and the dangerous measurement, assessing the incident and deciding what treatment

of special care the patient should receive. Moreover, the doctor can give a simple recommendation to the patient via the mobile phone. The physician can also prescribe some pills to the patient and the prescription will be saved on the mobile phone. If needed, the doctor can also send an ambulance. Fig. 8 summarizes this process.
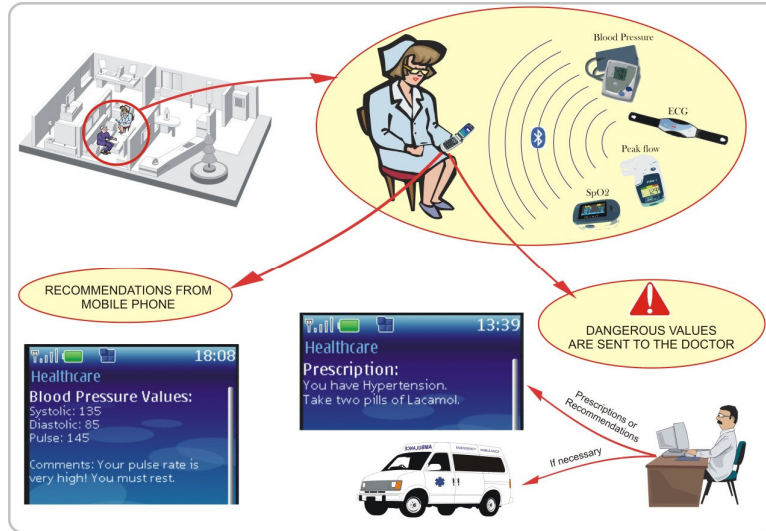

Fig. 8. Patient Tele-monitoring Process.

Finally, all the information is always included in the patient medical record and saved into the mobile phone. This is very important because in this way patients (or their caregivers) will always carry medical records updated in the mobile phone. When the patient (or caregiver) goes to the chemist or to the doctor, the authorized professionals can see the patient's medical information just by touching a NFC reader with the patient's mobile phone.

Hence, in our proposal, the only devices needed are the mobile phone and monitoring devices. Home computers are not necessary because the mobile phone can manage all the data and communicate with the health assistance centre when required. However, in the day centre case, an additional server is very convenient since it could store every patient measurement in order to make logs and statistics for future consulting.

5   Conclusions and Future Work

This work has described how the application of NFC technology to Alzheimer care can significantly improve both the caring services received by patients and the daily activities of caregivers, both at day centres (nurses, doctors and so on) and homes (relatives or home caregivers). Only the adoption of natural interaction mechanisms can encourage the use of technology by the very busy caregivers. The services suggested by this work are a clear sample of the capabilities of NFC technology to improve Alzheimer patient care. In addition, all the information gathered both from caregivers' mobile devices and vital sign devices has to be modelled and analyzed to offer even better services to patients. Thus, the use of data modelling instruments such as the context ontology describe are required. The application of semantic modelling techniques enables a very flexible and evolutionary knowledge repository upon which incident management, patient tele-monitoring or therapy support services can be provided. Referring to this last type of services, we have described our experiences applying DTT technology to transfer and continue part of the therapy process from day centres to homes. Future work will assemble our current prototypes into an NFC-enabled chronic disease support framework which we aim to deploy for evaluation in local care giving centres. Thus, we will be able of assessing the suitability of the mechanisms proposed and to add further improvements.

Acknowledgments

References

1. ISTAG, Scenarios for Ambient Intelligence in 2010. Feb. 2001. http://www.cordis.lu/ist/istag.htm.
2. Weiser, M., The Computer for the 21st. Century. Scientific American, 1991. 265(3): p. 94-104.
3. Roy Want, "People First, Computers Second," IEEE Pervasive Computing, vol. 6, no. 1, 2007, pp. 4-6.
4. J. Favela, M. Tentori, L. Castro, V. Gonzalez, E. Moran, and A. I. Martinez (2006). "Estimating Hospital Workers' Activities and its use in Context-Aware Hospital Applications". Pervasive Healthcare, Innsbruck, Austria.
5. Ambient Assisted Living. http://www.aal169.org/

18   Jose Bravo*, Diego López-de-Ipiña**, Carmen Fuentes*, Ramón Hervás*, Rocío Peña*, Marcos Vergara* & Gregorio Casero*

6. Bravo, J., R. Hervás, I. Sánchez, G. Chavira & S. Nava, (2006). "Visualization Services in a Conference Context: An approach by RFID Technology". Journal of Universal Computer Science. Vol. 12-3. pp. 270-283.
7. Bravo, J., Hervás, R., Chavira, G., Nava, S. & Villarreal, V. (2008). "From Implicit to Touching Interaction: RFID and NFC Approaches". Human System Interaction Conference (HSI'08). Krakow (Poland).
8. Dey, A. (2001). "Understanding and Using Context". Personal and Ubiquitous Computing 5(1), 2001, pp. 4-7.
9. Dogac, A., Laleci, G., Kabak, Y. "Context Frameworks for Ambient Intelligence". eChallenges 2003, October 2003, Bologna, Italy.
10. Fridman, N., Musen, M. "An Algorithm for Merging and Aligning Ontologies: Automation and Tool Support". Stanford 1999.
11. DVB Multimedia Home Platform tutorials and information for interactive TV developers. http://www.tvwithoutborders.com/
12. MHProject v.2.0. Universidad Pública de Navarra. http://www.mhproject.org/
13. NFC Forum (2008). http://www.nfc-forum.org/aboutnfc/
14. The Touch Computing Project. (2008), http://www.nearfield.org/about/
15. http://www.agotek.com/web/PDF/triptico%20Gerotek%20web.pdf