

Touching Interaction: An NFC-RFID Combination

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Abstract—AmI proposes a new way of thinking about computers, which follows the ideas of the Ubiquitous Computing vision of Mark Weiser. In these, there is what is known as a Disappearing Computer Initiative, with users immersed in intelligent environments. Hence, technologies need to be adapted so that they are capable of replacing the traditional inputs to the system by embedding these in every-day artifacts. In this work, we present an approach, which uses Radiofrequency Identification (RFID) and Near Field Communication (NFC) technologies. In the latter, a new form of interaction appears by contact. We compare both technologies by analyzing their requirements and advantages. In addition, we propose using a combination of RFID and NFC.

Keywords—Touching interaction, ambient intelligence, NFC, RFID.

I. INTRODUCTION

AmI or Ambient Intelligence [1] (and other approaches like Ubiquitous computing, pervasive computing, proactive computing, ambient computer, etc.) proposes an interaction between user and environment, which requires no devices; these devices must "disappear" and the user should not have to make any effort to interacting with applications. There are two dimensions to this "disappearing"; they are physical and mental [2]. The physical disappearance of computers or applications is possible by absorbing these devices in the environment, as AmI proposes.

The mental dimension of an application or computer is, fundamentally, a conscious interaction with them. To disappear from a mental perspective we should not be aware of that we are interacting with computers [2]. No training or learning should be necessary.

Weiser [3] indicated that if the computer knew who and what was in its surroundings, it could adapt and offer services, without requests being made for those services. Sensorial technologies have a crucial importance in ubiquitous computing and much research focuses on adapting current technology.

Although the objective of AmI is to reduce to a minimum the user's interactive effort, there must be some conscious effort, because it is impossible to eliminate that completely. Many AmI services will require the acceptance of the user, at the very least.

In previous work, we have looked at adapting radiofrequency identification technology (RFID) for receiving implicit inputs (localization and identification) and offering implicit services to the user [4], [5]. We have observed

limitations in some contexts or situations since not all services can be fully delivered implicitly: some need confirmation or acceptance. The present work seeks to provide RFID technology with the advantages offered by Near Field Communication (NFC) protocol.

In this paper we describe the new interaction between the user and the Ambient Intelligence scenarios. We then go on to describe some aspects of RFID and NFC, providing examples of the use of NFC and then compare both systems. We present the concept of "touching interaction" within a conference context scenario. Finally, we show the first test carried out in the development of an application for this scenario and set out our conclusions.

II. TOWARDS HUMAN-AMBIENT INTELLIGENCE INTERACTION

The AmI paradigm represents an evolution in the way people interact with computers. Human-computer interaction (HCI) is absolutely explicit; in it, the computer waits for users' actions. In an ideal AmI vision, this kind of interaction should decrease to a minimum.

In Human-Ambient Intelligent Interaction (HAII), the user can get services by just entering the office. Some of these services are, for instance: reporting location, adapting the temperature of the air conditioning, turning on the computer and displaying the last file the user was working on, etc.

Although Weiser mentioned the importance of knowing who is in the surroundings of the computer, it was not until the mid-nineties that the concept of "context aware" arose [6], [7]. Dey defines this 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 applications themselves" [8]. A fundamental characteristic of context aware systems is not only that they react to the user input, but that they also respond to contextual events that happen in the user's environment [9], [10].

Many studies and definitions of the term "context" have been put into writing. Brooks [11] considers several aspects that we shall now mention as being important: Who (Identity Awareness), Where (Location Awareness), When (Time Awareness), What (Task Awareness) and Why.

In this work we focus on just two aspects: Who and Where. These allow us to offer services to the user from the very moment he comes into AmI, as well as throughout the time he or she remains within it.

III. SENSING TECHNOLOGIES

Sensing technologies are indispensable for perceiving the characteristics of the environment where no user action is required. Sometimes it is not necessary to wait for the

appearance of a new technology. We can adapt existing technologies innovatively, using their advantages, as recommended in Weiser's vision [3].

In our research, we propose the combination of "old" technology such as RFID, with a "new" one, namely NFC, in an attempt to cover three important elements in an Aml: Localization, Identification and Ubiquitous services to the user. In the following sub-sections we explain these:

A. Radiofrequency Identification (RFID)

This technology, which appeared at the end of the forties, is used to identify objects, but its characteristics make possible to adapt it for Aml uses. RFID technology allows us to capture information from the environment in an implicit way without

any user effort and to offer services in an implicit way [12]-[14].

In RFID systems [15] there are basically two elements (Fig. 1):

- Tags or transponders, which consist of a microchip that stores data, and antenna (coupling element). They are packaged in such a way that they can be placed in any object and they each have a unique serial number.
- Readers or interrogators have one or more antennas, which emit radio waves and receive signals back from the tag. The "interrogation" signal activates all the tags that are within its reach.

A characteristic that defines the RFID area is the computer-reader connection, which is carried out physically.

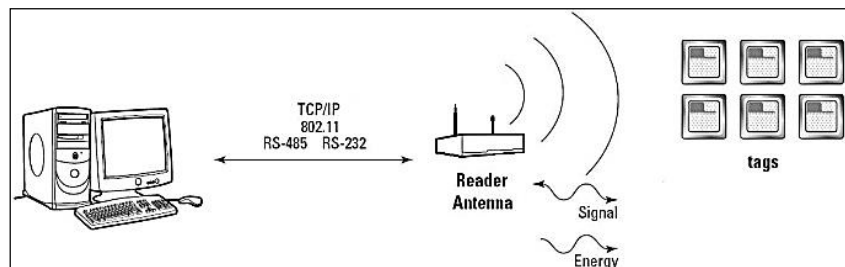


Fig. 1 Elements of RFID system

B. Near Field Communication (NFC)

This technology was developed by Philips and Sony in 2002. It is a short range wireless connectivity technology which combines RFID and interconnection technologies.

NFC systems consist of two elements:

- The Initiator; as its name indicates, it begins and controls the information exchange (the reader in RFID system); and
- The Target, which is the device that responds to the requirement of the initiator (tag).

In an NFC system there are two modes of operation: Active and Passive (Fig. 2). In the active, both devices generate their own field of radio frequency to convey 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.

It is important to mention that, although the NFC protocol can be installed in any electronic device, our interest will be focused on NFC-enabled cell phones.

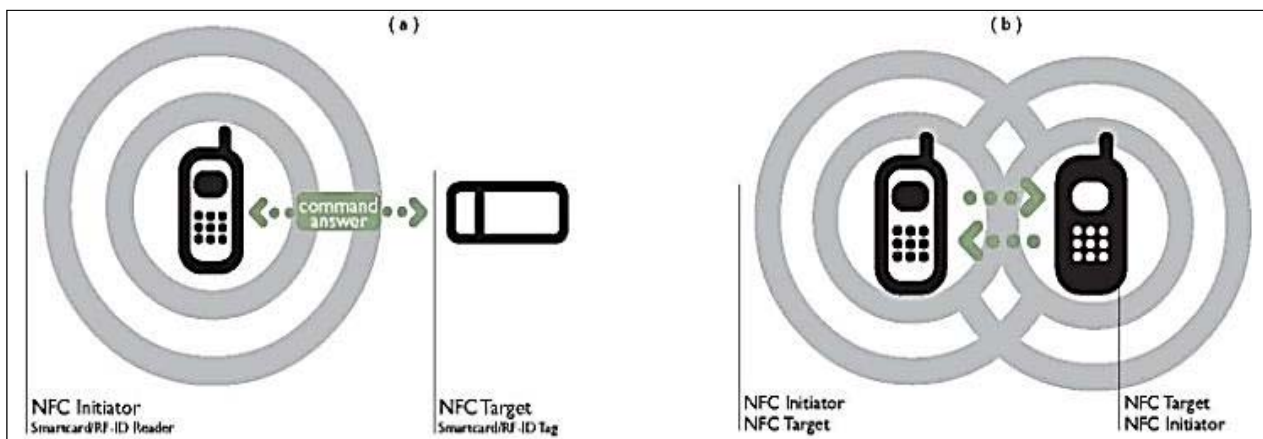


Fig. 2 (a) NFC device emits an RF signal to activate a target (b) Two NFC devices establish an active communication between them [16]

IV. NFC vs. RFID

There are two characteristics that distinguish NFC from RFID:

- NFC devices can work as Initiators or Targets.

- Two NFC devices are recognized automatically at just a short distance from each other (contactless).

The distance required to detect a NFC device (target or initiator) is quite small compared to an active tag of RFID but, at the same time, this in itself is a security factor. It ensures

that we can always be aware of our proximity to a device and that the signal cannot be intercepted without us realizing it.

An RFID system can detect tags that enter the reader's field of action, which we call Reader-fixed vs. Label-mobile (Fig. 3 (a)). The reader is "fixed" so it requires a physical connection to the computer that contains the application. That limits its possible change of position.

In the NFC systems, the initiator and the target can be mobile. We refer to that as Initiator-mobile vs. Target-mobile (Fig. 3.b). In the case of this technology, the application can be contained inside the same initiator or, in the case of a cell phone, it can be accessed through cell phone signals.

An RFID system without NFC has a series of limitations that can be satisfied by NFC. RFID technology allows us to capture two important aspects of the user: localization and

identification. This is done well and clearly, but there are three limitations:

- Cost of spreading the readers;
- Localization; at the moment, this is given within a quite a large area, and
- Memory capacity of the tags.

These limitations can be solved by NFC technology:

- An NFC initiator device can move to any place.
- The localization will be exact because of the need to bring the target and the initiator very close together.
- The initiator can make use of the memory of the device, associating it with the memory of the objective.

We consider that, in some circumstances, an application combining RFID and NFC will mean a step towards invisible interaction.

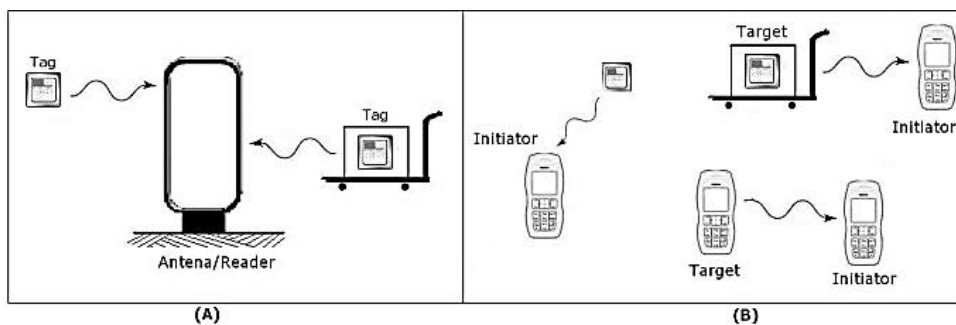


Fig. 3 Comparison of mobility of NFC and RFID

V. AMBIENT INTELLIGENT PROCESSES

AmI is a sensitive environment that responds to the presence of individuals according to their characteristics and preferences, in an easy, intuitive way that does not require a learning process [17], [18]. In processes carried out in AmI, our work will focus on two groups: a) Perceiving/Locating users, and b) Offering services to the user.

Our proposal is to provide sensitivity to the environment by means of a combination of RFID-active and NFC. For this we will equip users with RFID active tags and NFC-enabled cell phones. In Section IV we have explained the advantages offered when RFID and NFC systems complement each other. The operation modes of these technologies generate two different forms of perceiving: RFID perceives users and NFC locates them.

The operation/workings of a RFID tag and NFC device are such that when either one is detected by the reader, the first information that is sent is the Id, which will be unique to each user. This process of identifying is implicit in perceiving or locating of users. We can conclude that there are two processes being carried out: Perceive (and identify) and Locate (and identify).

A. Perceive and Locate

An RFID active system has an approximate range of up to 80 m. By using it we can define the "service or sensitive area" as a function of the reader position, but we may know only which users are within this area and not their exact location.

That is, we *perceive* the user within the "service area" without knowing their exact position.

NFC's operating range is just 10 cm. This allows us to provide services when the initiator and target are close to each other. We are more interested in bringing two devices together in order to obtain services, than in ascertaining a geographical position. By using NFC we have *located* the user "at a service point", where the services may be delivered. So, with RFID technology we *perceive* users in a service area; and with NFC, we *locate* them at a service point.

The combination of both technologies does not limit the use of NFC to only an intelligent environment. We can establish a point of service outside the RFID-defined area.

B. Services

Although there is a great diversity of services in an intelligent environment, our interest focuses on those produced by identification from RFID and NFC technologies. Each one generates a particular type of services: RFID generates "Services in the area" and NFC brings "services at a point".

1) Area Services

The user will be able to receive a series of services when inside the area of the RFID reader's reach (service area) depending on his or her characteristics and preferences, as well as on the availability of devices. We can now mention some of these services (Table I): Visualization, Attendance, Location, and Note to comment.

TABLE I
IMPLICIT SERVICE BY RFID

Services in area service	Data necessary
Visualization The mosaics show information according to the characteristics and preferences of the users.	- Id User
Attendance The system registers the time of entering or leaving the service area.	- Id User
Location The system knows who is in the service area.	- Id User
Note to comment The user carries notes that he/she wants to comment on with somebody when they meet. The system then also detects the user and their notes in a service area.	- Id User looked - Note

2) Services in a Point

When a user brings his NFC device near to another, it will be for the purpose of obtaining services. This service point can be fixed (if it is part of the infrastructure of AmI) or mobile (if it is carried by another user). The different services at a point are (Table II): Explicit sure identification, Presentation Card, Scheduling appointment/meeting, Carry files.

TABLE II
EXPLICIT SERVICE BY NFC

Services in point services	Data necessary
Business/Presentation card Bringing cell phones near each other in order to exchange a presentation card.	- Id User - Name - Address - e-mail - Tel & cell, - Id User
Scheduling date The user selects the option which will look for a meeting with another. By just putting the cell phones of both users close to each other, the system searches for and selects a suitable meeting arrangement.	- Id User - Cell phone agenda
Explicit sure identification The secure user identification at a "point of service". Example: When opening a door.	- Id User
Carry files Take files into the tag or cell phone memory so as to exchange data	- Id User -File destination - File

VI. TOUCHING INTERACTION

The use of NFC involves at least one explicit action: "touch" on the part of two NFC devices. Sometimes more is involved in confirming the fulfilment process, such as pressing a button on the initiator. This interaction, that may contain one or two steps, is being called: "touching interaction", which we can define as "*The deliberate bringing together of two devices, for the purpose of obtaining services*".

Although "touch" is an explicit task that produces the "touching interaction" – that does take away from the ideal of implicit or invisible interaction. At the same time, it generates a saving of effort, compared with the traditional way of interacting with electronic devices.

At the moment, the NFC-enabled cell phone is beginning to be distributed and its applications focus on two categories: Pay and Smart poster. As it is a device of widespread use however, the challenge is to provide more implicit services within the same device.

In NFC-enabled cell phones, "touching interaction" will mean the substitution of more than one explicit action (at

present) by just one single explicit action -bringing the NFC-enabled devices next to each other and sometimes pressing the button to confirm the service. For example: If two users exchange their business card, when they arrive at their office they will type all that information into their computer, while, with the proposed system, they will simply bring their cell phones close together and then press a button.

A. Touching Interaction in a Conference Scenario

We have developed the first stage of an application for using the NFC-enabled cell phone to obtain services in a conference scenario. We made a test to find out the user's reactions during one Workshop.

Days before the workshop, we asked the authors for their presentation files and assigned each a number. This number was stored on NFC tags, which were in turn added to the accreditation badge of all the attendees and collaborators of the workshop. When each person picked up their documentation we explained what they were to do for presentation. In addition, all the coordinators were equipped with an NFC-enabled cell phone.

The main display of the conference room, where the workshop takes place, shows a series of announcements before and during the session. In the opening ceremony, the coordinator of the workshop places his cell phone on his accreditation badge and after the sound is heard, which indicates that the reading was correct, the presentation begins on the display. Then, in the same way, the chair of the first session passes his cell phone by his tag and the information about the session and the first paper are displayed. Next, when the first speaker approaches the presentation board, one of the workshop assistants (Fig. 4) passes his cell phone by the speaker's accreditation badge and the presentation starts.

It is important to mention that the system is not affected if, at any given point, some user wishes to use his own computer to offer his presentation. The next user can give his presentation in the usual way.

To deploy the presentations, the tag contains a URL that includes the number assigned to the coordinator or speaker of the presentation. On pressing the "OK" key, the cell phone modifies a database by means of this link; the application that controls the display detects the change and starts the presentation.



Fig. 4 Reading the NFC target with the NFC-enabled cell phone

Before the workshop, a survey is carried out amongst attendees to find out their opinion and level of knowledge of NFC. We should highlight that more than 90% of the attendees considered it excellent. All of them thought that the application was very simple and more than 80% considered it meant a reduction of interaction effort.

VII. CONCLUSIONS

We propose the concept of "touching interaction" as the name for the process of bringing two devices close together in order to obtain services in an ambient intelligence environment. This process will mean the substitution of more than one explicit action (as we do at present) by just one single explicit action -bringing the NFC-enabled devices next to each other and sometimes pressing the button to confirm the service. In this paper we describe a scenario where this can be observed and have evaluated a real case.

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