Touch Interaction through Tagging Context

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Abstract**—**Ambient Intelligence promotes a shift in computing which involves fitting-out the environments with devices to support context-aware applications. One of main objectives is the reduction to a minimum of the user's interactive effort, the diversity and quantity of devices with which people are surrounded with, in existing environments; increase the level of difficulty to achieve this goal. The mobile phones and their amazing global penetration, makes it an excellent device for delivering new services to the user, without requiring a learning effort. The environment will have to be able to perceive all of the interaction techniques. In this paper, we present the PICTAC model (Perceiving touch Interaction through TAgging Context), which similarly delivers service to members of a research group.

Keywords**—**Ambient Intelligence, Tagging Context, Touch Interaction, Touching Services.

I. Introduction

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 by interacting with applications. There are two dimensions to this "disappearing" and they are physical and mental ones [2]. The physical disappearance of computers or applications is possible by absorbing these devices in the environment, as AmI proposes.

One of the first definitions of smart environment arises from Ubiquitous Computing [3]-[5] which "created a new field of computer science, one that speculated on a physical world richly and invisibly interwoven with sensors, actuators, displays and computational elements, embedded seamlessly in the everyday objects of our lives and connected through a continuous network" [6], although Mark Weiser does not define it explicitly.

The vision of Ambient Intelligence (AmI) [7], which is an evolution of Ubiquitous Computing, proposes a new way of thinking about computers, which will disappear in the environment, meaning that this perceiving and responding automatically to the presence of people is creating a smart environment.

The AmI paradigm visualizes environmental management by applications, which will perceive in a continuous way the characteristics of the entities that comprise it and the natural interaction between them, thereby enabling applications to offer services either proactively or with the smallest possible interactive effort. Another characteristic of this type of environment is that, even with a strong technology, it is "invisible" to people; this disappearance can be obtained by embedding it in daily objects in the environment.

The main goal of Ambient Intelligence and Ubiquitous Computing is the creation of smart environments or environments with Ambient Intelligence. A smart environment is defined as an "environment that is capable of acquiring and applying knowledge about the environment and its inhabitants in order to improve their experience in that environment" [8], [9]. An Ambient Intelligence environment is "where people are surrounded by intelligent interfaces supported by computing and networking technology, which are embedded in everyday objects, which are aware of the specific characteristics and personalities of people and not interfere in interactions" [10].

The final objective of a smart environment is to satisfy user needs by providing services that require minimal interactive effort (i.e., the ideal service is one that the user receives without explicitly demanding it).

Our work examines a perception of the touch interaction, which will be used to demand services at the moment of interacting with the environmental elements or entities. To perceive the touch interaction, the "tagging" of the environment's entities will be necessary. We expect that when perceiving this interaction, the program that manages this environment will obtain information on the entities involved and will enable services to be delivered by properly combined with the information in the program's data bases

In this paper we summarize the PICTAC (perceiving touch interaction through tagging context) model [11], the characteristics of research group environment and describe the SeTITaC system's programs, developed to serve at research group members

II. Related Work

Although currently we are focusing our efforts on NFC technology, previously we have developed projects with different sensorial technologies separately [12]-[14] and in combination [15]-[17].

A variety of projects have designed and implemented services through NFC-enabled mobile phones. A common feature of most of these studies is that the tag's content is only one service or one action, a concept known as "one tag, one service". This means that tag memory, which could be used to store the context and several services, is wasted.

Physical browsing is an "interaction paradigm of touching the tag with the device to activate the hyperlink which

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emulates the traditional hyperlink invocation mechanism of clicking" [18]. The key aspect of physical browsing is physical selection, which refers to the way in which the user selects the entity from the environment which it will interact. This physical selection (or interaction technique) can be carried out on TouchMe, PointMe, ScanMe and NotifyMe [19]. The technologies used to carry out physical selection include Infrared, RFID, NFC, WPAN and visual codes.

The MULTITAG project proposes a "touch & interact" interaction technique in which a combination of a conventional touch screen, a NFC-enabled mobile phone and a conventional display that is controlled remotely with a mobile phone provide alternative solutions that can be used to overcome mobile technology's limited visual output capabilities [20].

In the MoreLab Research Group's Touch2 project, three services were developed for NFC-enabled mobile phones, namely, Touch2Open (i.e., electronic door key), Touch2Launch (i.e., virtual post-it) and Touch2Print (i.e., for printing documents) [21]. The services are independent of one another, and each one requires different programs to be installed in the mobile, and so each tag can only contain one of the services. These three services were based on the current NFC application domain taxonomy published by the NFC Forum and summarized as a) service initiation and configuration, b) P2P data sharing and communication and c) payment and ticketing.

III. User Scenario

In the following scenario, we describe some activities at a research group; in these the users obtain services through "touching interaction". This scenario is the support for the application we are developing and testing.

John arrives at the building door, where his office and other workspaces (laboratory, other members' offices, and meeting room) of his research group are located. With his NFC-enabled mobile phone he touches the tag at the side of the main door of the building and the NFC-enabled mobile phone reminds him that he has an important comment for George who is already working at his desk. For this reason John decides to go to the laboratory (where George is). At the moment John touched the tag, all the members of the re-search group, who are working in a computer, receive a message indicating that John has entered the building.

In a corridor, John can observe (on a public display) a summary of the research group's current work, such as deadlines of the congresses in which they will participate, the last versions of the papers being written, the identity and location of each person working in the building, etc.

When John arrives at the door of the laboratory he can observe who is in inside by looking at a little display. He can also see the degree of progress of the different activities (along with notes on projects, programs, articles, etc.) that the members of the group are developing. Before entering he touches the tag of the next door. Inside the laboratory he can observe a reminder of all "notes to comment on", on a public display at the laboratory, which has been stored in his mobile phone. Meanwhile, all users who have "notes to comment on" to John, can see a reminder indicating that John entered the laboratory on their computers.

While John talks to George, John places his mobile phone near the tag on the display of George´s computer to show a file. After commenting on it, they decide to show it to everyone in the laboratory. To this end, John touches the public display with his mobile phone.

Before John leaves the laboratory, George decides to send him a paper for checking, but, due to its large size, it does not fit in the mobile phone's memory. He, therefore, decides to send the file to John so that it can be checked from any computer in the AmI environment.

When John leaves the laboratory, he runs the exit service in his mobile phone to aware the AmI environment that he is coming out of the laboratory. When John arrives at his office and touches the tag in the door, his mobile phone shows the list of people who came to see him while he was out, as well as the messages left for him.

IV. The PICTAC Model

The model we developed would endow an environment with the capability of perceiving the touch interaction between environment entities, which we define as: The intentional approach of two entities in order to obtain a service. This implies that when an entity approaches another one, the touch interaction arises. The objective of this model is limited to the touch interaction, which involves only two elements, of which one is a person. This is the reason why the touch interaction of interest to us is defined as: *a person's deliberate touching of an environmental entity (the latter can be another person) for the purpose of obtaining services.*

The objective of the model that we are proposing is to be able to develop a system that endows the environment with the capacity to perceive the touch interaction using the tagging context.

The model consists of four parts: the entities, the properties that the environment and the entities must have, the tagging context and the services that can be offered.

A. Entities

One of the most popular and referenced context and entities definition is given by Anind K. Dey, who states that "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" [22].

Due to the fact that we are interested only in a specific interaction technique between a person and an environment element or another person, we have adapted Dey's definition so as to define the context limited to touch interaction as: any information on the involved entities that are required to deliver the services offered by the touch interaction.

The PICTAC (it perceives touch interaction through tagging context, in Spanish) objective is to develop a system that manages the touch interactions of an environment in which at least one person takes part. This is the reason why the entity "application" will not be considered by us.

Since the capacity to participate in a touch interaction that is perceived by the environment is not a person's natural ability and so that a system can take into account a person, their data must have been captured previously. If we add these capabilities to the "person" entity, we create the "user" entity (which would be a subset of the entity proposed by Dey), as used in our model.

Dey's "object" entity has proved to be too general for the purpose of the model, since from the standpoint of the service it can provide, we can distinguish two categories of objects: Devices, those whose service can be demanded through a touch interaction (basically electronic or computer equipment), and Objects, those whose service is not "suitable" or cannot be demanded through a "touch" (e.g., a desk, furniture). However, in the case of the latter, through their location and continued use, we can take advantage of them to integrate some in the model we are proposing and offer services. This is the reason why we have broken down the object category into two types of entities: "object" and "device". It must be remembered that an object does not even have the capacity to process and communicate which is the reason why the capacities that it could have will depend on the available computer device that allows it to participate in a touch interaction and on the user's capacities.

"Place" is an entity that will remain and will allow us to represent a part of a smart environment or even the entire environment, since it will have the capacity for self-inclusion, in which the place may contain entities (or even another place). Although, in the first instance, a user has the capacity not to associate the service offered by a place, this could be considered because, on touching the place it will provide the service, entering the smart environment and the user could even obtain the opening of the door. A summary and comparison of PICTAC and Dey entities is shown in Table I.

TABLE I
COMPARISON BETWEEN DEY'S AND OURS ENTITIES

Dey entities	Quantity	PICTAC Model	
		Entities	Description
Person	Only the person or equipment are considered	*User*	Person with the Capacity to participate in a touch interaction
Object	They are divided into two, depending on the form given to the services	*Object*	Those whose service is not "suitable" or cannot be requested through "touch"
		Device	The service can be demanded through a touch interaction
Place	Idem	*Place*	Represents a part of a smart environment or even the entire environment
Application	Not relevant	*Not used*	

Whenever a user touches any of the four entities described above, it will generate one of the four classes of touch interaction managed by PICTAC: user-place, user-device, user-object and user-user, as shown in Fig. 1.

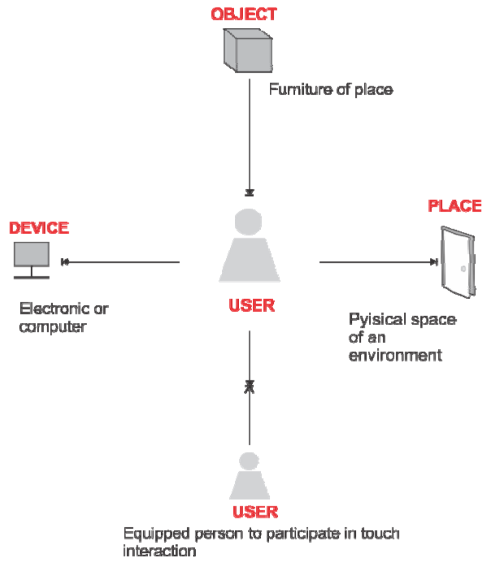

Fig. 1 The four types of the PICTAC Model Touch Interaction

B. Environmental Requirements

The PICTAC Model is designed in such a way that the system developed can easily integrate with other applications in a smart environment or it can be the only one of its type operating in the environment. To develop the system that manages the touch interaction and maximize the use of the information flow generated for the delivery of services, the environment must have two properties or infrastructures:

1) Processing and storage (considered together so that they can be offered by one technology)
2) Communication

Although these properties are essential to the development of the vision of an environment that manages the touch interaction, we believe that they will almost certainly exist in any environment in which an application of this type will need to be developed. Nowadays, most of workplaces have them and the touch interaction is ideal for operating the electronic and computer devices in today's workplaces.

Both infrastructures are the common "technology level", which is shared by all the applications that will make up the ideal smart environment.

C. Tagging Context

If tagging is to put a tag on something and context is any information about entities, tagging context could sound incongruous but the intention of creating this paradox is to give emphasis to the idea.

Tagging will be necessary for two reasons: we will have to indicate the place where the entity must be touched and we must augment the entity with the capacity to perceive another entity's "touch".

The word context is used because we will augment the entities with the data needed to deliver the services originated by the touch interaction.

The tagging context requires generic properties to be developed: perception of touch, containment of information, processing and communication. These capabilities will be provided by different properties, of which all or some of them will be put in the entities. We define the tagging context as:

"Augmentation of the environment's entities with the necessary properties to participate in the touch interaction perceived by a system"

Two properties are necessary for the touch interaction's perception: contact and identification. As it is the user who makes the touch, it must have the contact capability. This is just a way of distinguishing the roles performed by each one of the entities that touch. The identification capability will be given to other entities (non-user) which will be responsible for responding to the touch made by the user. In other words, the entity that is touched is the one which identifies (responds to the touch).

For an entity to contain information, it will require memory capability. Although our model will focus primarily on data, the memory capability is implicit and necessary. The data involve two properties: context and services references.

Context is the information needed to deliver the service and can be of two types: the context limited to the touch interaction, which is the information about the entities involved in the interaction, and the environmental context. The first is saved in the same entities as those involved in interaction and the second in the environmental infrastructure.

In order to deliver a service, some processing of information must be carried out and, because we are not certain where such processing is carried out (in the user, in the environment infrastructure or a device with processing capability), it was decided that, instead of the entity that is touched containing all the necessary instructions for processing the data, it will contain the necessary services references. The services references are all the necessary information to process and deliver the service to the user.

D. Services

The goal of any device or object in the environment is to offer users, as a minimum, an intrinsic service and in order to obtain it the user must interact with the object. The object of PICTAC is to offer services from the environmental elements by means of the touch interaction and, together with these services, to deliver others in an implicit way.

The classification established for the services is based on the manner in which their execution is originated or who has put them. The intrinsic services, which can be natural to the item or established by the system, are the default services that are received by the user who touches it. The implicit services are those that accompany the above and can be received either by the user who touches or other related users. The optional services are those created by the PICTAC system that can be received by any user and put in any entity.

1. Default Services

All the environmental elements with which people are surrounded have at least one function or main use for which they were designed. The model that we propose is designed so that such use or service will be delivered to the user at the touch of the entity. These services are called default services and will be delivered to the user automatically whenever it touches an element.

In a device, the default service is intrinsic to it and is easily identifiable (e.g., the printing of the printer, the display of the monitor, etc.).

In an object, default services do not exist because they are not inherently associated with any services that can be obtained through touch interaction (e.g., the desk). The object will only contain optional services.

In a place entity, the ideal default service, which the user would expect to receive, is to open the door, but its implementation will depend on the available technology; however, touching the place is essential for the user to "enter" or "exit" the application that manages the touch interaction and, should it fail to do so, it will not receive the service.

2. Implicit Services

These services are one of the benefits of implementing a PICTAC system. Sometimes and when the system has just been installed, they may not be easily associated by the user who carries out the touch. In other words, they are services under or attached to the default services.

Implicit services are developed to take advantage of the information flow that is generated when a default service is demanded and, like this one, can be delivered automatically.

All the services that are received either directly or indirectly by the related entities and the entities that participate in the touch interaction and/or are in the place where touch interaction is carried out will be implicit services.

3. Optional Services

These services will be put on entities by the users, depending on their requirements; they were originated to take advantage of the foreseeable and daily use of some environmental entities.

These services allow those elements that do not have an intrinsic service (the objects) to be regarded as part of the PICTAC system and offer services to the touch.

They can also be placed in any type of entity, the use of which can be considered structured. For example, when a user reaches its workplace, it will first touch the door of the building before entering its office; any user that pays a visit to the office must touch the door, etc. Thus, optional services can be placed in the entities that take advantage of such use.

Another example of an optional service is to leave a message to any or a specific user on the door of a building, on its desktop or any entity in respect of which we can be certain that it will be touched by the user to whom we wish to communicate something, or a note for a specific user when visiting the office in our absence, etc.

V. Conclusion

We are currently adapting the system to be used in a graduate division of a faculty with new NFC-enabled cell-phone (Nokia N9, Blackberry 9900, Samsung Galaxy Nexus), which seek deliver services to the administrative staff, academics, researchers and students. The diversity of users and processes is more complex than that of a research group.

In addition the PICTAC model is adapting to monitor from NFC-enabled cell phone data from medical devices as: Blood Pressure, scale and pedometer.

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