Context Management for RFID-Based Distributed Interaction Spaces

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Abstract. Information system management in distributed interaction spaces is not an easy task because the information should be contextualized in the space it is being manipulated in order to keep it consistent and coherent to the users. For instance, museum visitors usually have difficulties to associate the information provided by an electronic guide while they are moving inside the building. The association/contextualization of the information to a physical space is not an easy task. This article presents the system of management of contextual information CAIM to solve this problem from the management point of view, allowing managing virtual contexts, and from the point of view of the end user. CAIM assures that the information is provided with coherent and consistent manner in the different contexts from distributed interaction spaces. The article shows a case of use study and an evaluation of CAIM system implemented by means of technology RFID.

Keywords: HCI, Virtual Contexts, Evaluation.

1 Introduction

Every day the scenarios are more common where several users participate simultaneously to make tasks in common, with great variety of personal devices and interactive screens. This tendency does that the use of the new paradigm of distributed interaction scenarios is becoming increasingly important and is moving to the traditional interaction scenarios.

There are a great variety of distributed interaction scenarios. Next, some of them are enumerated like for example the work meetings scenarios: WallShare [1], i-Land [2], Connectable [3]; e-learning scenarios: MPrinceTool [4], Co-Interactive Table [5]; tourist and cultural scenarios: Interactive EcoPanels RFID [6], etc. This work is centered in a concrete type of scenarios, the scenarios where through interactive panels, provided with technology RFID, certain contextual information referring to these panels or referring to the environment is shown to the users.

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The paradigm of the distributed interaction spaces entails a series of problems. One of them is that these spaces consume or generally make use of information that must be available in a set of devices that lodge the user interfaces. In addition, a typical problem that we can be found in this type of scenarios is to detect the change between contexts, so that the information shown the user is coherent with the context.

Some problems also affect the administrators of the resources, for example when it must associate the objects with the RFID tag that are made generally on a plane of the surroundings, instead of in this way making it in-situ on the own objects, causing possible errors at the time of associating them. Another problem with the administrators is at the time of making the maintenance of the labels. Until now we worked with the identifier of label RFID, therefore whenever a label was replaced, the data base had to be updated in the server and offline devices have to be updated.

System CAIM puts solution to these problems from the point of view of the management and from the point of view of the end user, allowing the management and consumption of contextualized information.

The document is structured of the following way. In this section an introduction to the problem is made and the proposal appears briefly, later is made a review by some related works. In section 3 the proposed system is described, next in section 4 considers a case of study that is evaluated in section 5, in the section 6 we present a discussion, concluding finally with results in section 7.

2 Related Work

In this section we will see some works related to the system that we propose. We have identified a series of works that they have in common the RFID technology and interactive panels for the provision of services, and works designed to computerize the cultural spaces offering multimedia information to users. Finally, a concept that we consider is slightly related to context management such as Content Management Systems.

Interactive EcoPanels RFID [6] is a collaborative and context-sensitive application attached to the concept of social software. Its main purpose is to allow users to share opinions and ideas related to the environment, using simple natural gestures and sensitive panels with RFID technology. Another interesting project is Smartmaps [7] consisting sensorised map using RFID technology, through which the user interacts via gestures with your mobile device. Within the field of video games there are interactive games based on RFID to improve care in children with TDAH and people with intellectual disabilities [8, 9]. In the environment of cultural spaces can be found works as GUIMUININ, which allows anyone through your mobile device to know where is located and through its location receive multimedia information. Similar works are Cyberguide [10], Guide [11], Smart Sight Tourist Assistant [12] e Irreal [13]. The Context Management Systems (CMS) [14] allow you publish, edit and modify multimedia content which is then accessible by users. Our Context

Management Systems shares certain features with the CMSs. Of all the works mentioned none of them faces the challenge of context management in distributed interactive spaces and that is where our proposal takes interest.

3 Management Context in Distributed Interaction Spaces

In this section is presented the context management in distributed interaction space scenarios. Abstraction of the context is one of the challenges that are facing the administrator or Manager of the spaces that you want to provide information, is the create locations that enable you to organize different information containers so that they are consumed by users. Depending on the conceptual model used, the Manager of the space will have different options for modeling different containers.

Here is proposed the use of a conceptual model for the description of containers of information which is completely abstract. Within the framework of our proposal, we introduce the notion of context in order to model any physical entity or not. In this way you can model any distribution manager need, without being limited to combining contexts and nest them. Administrators will benefit since the organizational abstraction will allow them to use any desired distribution, without having to be tied to previous assumptions or predefined objects. It provides flexibility and consistency to the created models. Users are also benefit thanks to the abstraction of contexts. It offers a navigation control according to the context that ensures that information displayed at all times correspond to informative containers that the user is consulted. Systems that provide information to users, for example in museums, are often based on the fingering of a code. This process can lead to errors. The use of the RFID system combined with the management of contexts makes the system information displayed to the user that corresponds according to their physical location at all times.

3.1 Device-Independent and Centralized Information Management Protocol

The establishment of a protocol for the management of flexible information, enabling your update and handling of quick and convenient way to properly is essential to achieve an improvement over existing systems. To achieve that the system fits to the described parameters, has established a protocol for the management, updating and consumption of information.

First of all, taking advantage of the capabilities of writing of RFID tags, has been established in make the association between the multimedia resources (images, text, video and audio) and containers of information, RFID tags. In earlier proposals the information was directly related to the ID of the tag. This identifier must be present in the database of the application. Through our proposal, if realized a substitution of a label, the only action that is performed is the partner resource again through a simple and straightforward action. In the same way, if you decide change resources associated with an RFID tag, simply replace them with a natural gesture, in a simple way.

The second, designed a protocol for information management that allows the independent Association of the RFID tag, discussed earlier, but which also allows that the management, distribution and updating of information is conducted in such a way that it meets the desired objectives, simplicity and flexibility. The Protocol establishes the structure of the information that is stored within the data space, write RFID tag memory. This structure can be seen in Figure 1.

Fig. 1. Information management protocol in RFID tags

The site represents the context that you want to model, representing anything likely to contain other contexts or entities. The entity represents an object within the site, which will have associated text, image, audio or video resources. The last field of the structure, is used to select the type of media (text, image, audio or text) that you want to display within the entity, as well as the navigation (next or previous) among them. Note that the Protocol is independent of the label ID.

3.2 Generalization of the Context Management Protocol

The way in which we can abstract the context to describe the units of information is explained in section 3.1. Later in section 3.2 has been proposed the Management Protocol the context implemented RFID technology with the aim of facilitating your understanding on a specific technology. This section aims to be a generalization of the context management protocol to facilitate its implementation on other similar to the RFID technologies that could do a similar job. Examples of these technologies include the QR [15], ISO/IEC 15426-1 [16] and NFC bar code [17].

The Protocol establishes that regardless of the technology used by each entity or command should have a mark or label to allow storing certain information and that it can be read later. The stored information will be as follows depending on whether a command or entity. If entity, the information store is composed of 13 digits (5-digit code for the site + 5-digit code of the entity + 000 which represents the neutral command). If command, the information store is composed also-13 (5-digit code for the site + 00000 representing the neutral entity + 3-digit command code).

Command codes are the following: 000 = neutral command (indicates that this is an entity and not a command), 001 = show text, 002 = show image, 003 = show video 004 = show audio, 011 = next, 012 = previous.

Explained the generalization of the protocol you can easily see how to detect a change of context (site) is trivial, simply it is necessary to compare the latest site code read with new site code that is read.

4 Prototype CAIM: Manager of Virtual Spaces

For higher compression system will happen to explain a series of important concepts used in the platform, relating to the creation and management of Web management platform of virtual system contexts CAIM virtual contexts, as well as the process of partnership between the different virtual contexts and multimedia resources.

The term "Site" is that use hereafter to refer to different virtual contexts. A site can be any space that you want to manage and contain within other sites. For example in a Museum, would be the main site Museum, this site would have sites children could be Sala1, Sala2 and Sala3, within Sala1 can have another site that is Vitrina1, etc.

A site in turn can contain one or many "entities". An entity will be the logical representation of the physical RFID tag that represents a point of information of the interactive panel, i.e. after its adaptation to physical and real space will be a 'hot zone' interactive panel. Each entity is associated with one or more multimedia resources, resources can be in text, image, audio or video. For example the Museum site has a welcome entity which is a panel that is in the entrance of the Museum.

The term "resource" we mean different multimedia resources that will finally play users. Resources will be associated to the corresponding entities.

CAIM system consists of three applications: two mobile applications and a Web application. The first is the final application which users consume the different multimedia resources of interactive panels. Everything will work through gestural interaction, i.e., if a user wants to view the images of an area of the pane, you must follow the steps that are shown in Figure 2. Step A is to hold the device to the area label which we wish to obtain information, in step B approach the device resource type which in this case will be image and finally in step C approach the device the "following" tag to navigate to the next resource.

Fig. 2. Process to consume information panels. (a) select the location on the map, (b) select the type of resource to display and (c) navigate to the next resource.

The other mobile application of the system is the part of administration of interactive panels. From your mobile device administrators of cultural space will connect to the Web management system platform and can manage all of the panels of their cultural space in a fast and easy way. Once the administrator has downloaded and updated files from the management application, he can see the elements. The next step will be through this mobile application reconfiguring interactive panels of their space. The association is written in the memory of the RFID. In addition, this mobile device management application will allow the administrator change easily interactive panels

commands tags, simply bringing the device to the corresponding label. Figure 3 shows the process. In step A place the device on the label that you want to manage, and in step B indicates the entity or the command.

The third application that is part of the CAIM system is the system management Web platform. This Web-based platform allows you to manage simultaneously different cultural spaces in an independent way.

For the better understanding of the complete project, in following Figure 4 you can see an example of interactive panel to be used in the system. As we can see, the panels are divided into entities and commands. In this example the site would have two entities.

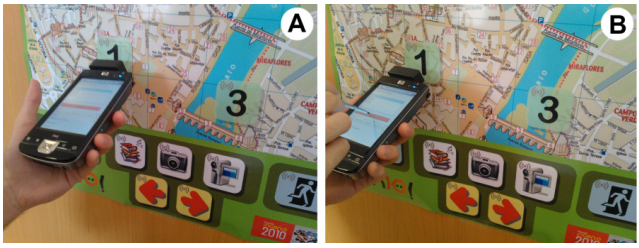

Fig. 3. Process of association of resources with the panels. (a) select the location on the map to manage and (b) indicate the entity or the command that you want to associate.

Fig. 4. Interactive Panel based on RFID

5 Case Study

The objective of this section is to make a practical example using the developed system. For this we will use a real scenario, as is the city of Cordoba. The objective is to give extra information to tourists in three areas of public interest in the city such as the tourist office, the Cordoba Mosque and the Roman Bridge together with the Calahorra Tower.

In this case as the scenario is a city, in which we must computerize three points of tourist interest, we are going to have to locate interactive panels in which users can consume multimedia resources from the environment in which they are found in these

three city areas. For this example we will create a simple virtual structure, we will have a main site, called “Cordoba panels” (“paneles de Córdoba”), which will encompass 3 sites, “Tourist Office” (“Oficina de Turismo”), “Mosque” (“Mezquita”), “Roman Bridge” (“Puente Romano”). Once we have list the structure of Sites, the next point is to associate different Entities (hotspots of the interactive panel) we need to each site.

After you associate the entities to the sites it is necessary to associate various multimedia resources to each entity and finally select the main site that we want and to carry out the process by which leaves a compressed file on the server with all directories and resources you need to manage the real space, according to the protocol.

6 Proposal Evaluation

The resources needed for the collection of information have been the following:

Participants. Among the users selected for the experiment we find two types: among eight users, four of them were experts and the remaining users had no experience on these topics. Ages have ranged between 18 and 35 years. None had seen before the application to evaluate, therefore all departed from the same conditions.

Tasks. Tasks were designed to cover all the main functions of the system. Task 1: Login. The user must authenticate to the Web management platform, with a user name and password given. Task 2: Create virtual structure of cultural space. The user must go to the Site Administration, and create a primary site. Then, the user must add three sites. Task 3: Creation of entities. User must associate the necessary entities to the sites created previously. Each site must contain two entities, which will represent an interactive panel with two "hotspots" at each site. Task 4: Assign Resources. Each entity must have at least one resource from text, image, audio and video. Task 5: Generate content. The user must enter the area of content generation, select the created Site and press the button to generate content. Task 6: Close Session. Once the user has generated contents, ends the session by clicking the "Logout".

Location and users’ profile. The evaluation was carried out in the building I3A at the University of Castilla-La Mancha. Expert evaluators observed participants. We clarified to users that it was not measured their ability, but the ease of use of the system on which they had to perform each of the tasks proposed. We also informed to them about the basic concepts on know to make use of the management platform. In addition, we also explained the association between the different panels of real space with virtual entities of the system. We also explained to them the proposed tasks for the session, and the environment to be used to carry them out. Evaluators gathered relevant data such as: time used, mistakes, if they could do the task or not, etc. Once finished all tasks, we provided them with a questionnaire, called reduced SUMI, 10 questions and is thanked them for their participation. They were also asked to provide us a comment about the usability or any aspect.

Here are the results obtained after the experiment. The metrics necessary for the analysis have been: the time and the completeness of the tasks, the frequency of errors and user satisfaction.

Effectiveness

Task completeness: Completed tasks are those in which the user achieving to perform what he/she asks for each task. Tasks that have not finalized their implementation are considered not completed. We can highlight that all users found the tasks very simple to perform, fast and affordable to all types of users. Only one user was unable to complete the Task 5, by internet connection problems.

Frequency of errors: The frequency of errors is calculated by measuring the errors made by users. Since all users have done all tasks correctly, we will highlight some aspects as possible error that may have delayed the purpose of the task. The user confuses the visual metaphors. Occasionally they cannot understand all virtual space structure to manage. When you add different entities from the entity add form, the feedback is not adequate in some cases, because the confirmation message "Entity successfully added" is maintained, which means that a user is not sure if the entity has been added.

Efficiency

Average task time: It is measured in minutes and gives us the average temporary efficiency obtained when performing tasks. These data are the time medium that has taken 8 participants for each task and will determine the productivity and efficiency offered by the system. The task times (from Task 1 to Task 6) where the following: 0,11 minutes; 1,06 minutes; 1,88 minutes; 4,60 minutes; 0,08 minutes and 0,03 minutes.

Results show that the four task has been that more time has consumed. This is because each entity has associated different multimedia resources, and this entails more time than the other tasks. Remaining tasks are performed in less time.

Satisfaction

In the test done to measure the user satisfaction have been provided ten statements and three possible answers; agree, undecided and disagree. They were numbered in the following way: 1 -> Agree, 2 -> Undecided, 3 -> Disagree. After analyzing in detail the results we have calculated the proportional value of each statement, below all twenty-five statements will be explained.

1. This software responds too slowly to inputs. Of those surveyed, 87.5% are in disagreement with the statement and 12.5% replied that is undecided. This means that the system responded quickly to the demands of users.
2. I would recommend this software to my colleagues. 75% of users would recommend the software to colleagues against 25% who was undecided.
3. The instructions and prompts are helpful. 50% of users think that the instructions and dialogues are useful, compared with 37.5% which are undecided and 12.5% were disagreement with this statement. This means it would be advisable to improve them.
4. This software has at some time stopped unexpectedly. 87.5% of the people who used the software found that it worked quite fluently. But 12.5% met with little fluidity at some point.

5. Learning to operate this software initially is full of problems. 75% of respondents felt that it is very easy to learn to use the program. However, 25% were undecided. The statement showed that we get a program intuitive and easy to use.
6. I sometimes don't know what to do next with this software. The results were that 25% of users felt indecisive something using the application, compared to 75% at all times able to react to tasks required.
7. I enjoy the time I spend using this software. 75% of users enjoyed the session, however there were 25% undecided. This means that none of the tested users had tense or frustrated with the software.
8. I find that the help information given by this software is not very useful. Most users think that the information was useful to 75%, compared with 25% that they were undecided if the information given was useful or not.
9. If this software stops it is not easy to restart it. 87.5% of respondents did not have to restart the session, because they had no problem. 12.5% had to restart the session and they seemed that it could restart easily.
10. It takes too long to learn the software functions. 100% of users did not take hardly anything to learn the software commands.

7 Conclusions and Future Work

The scenario of interaction in which a user interacts with more than one device to perform same task is known as distributed interaction space. The profusion of mobile devices like tablets and smartphones, operating together with traditional desktop or portable systems thank you Internet services, make up this new distributed environment of interaction. One of the most pressing problems that appear in the distributed interaction spaces is how to manage the context of information that the system provides to the user based on, for example, of its geographical location. The issue occurs when the system is not able to manage the change of context as the user moves, causing that this can be lost to receive information that does not match your current location. This article proposes the system Cayman as a solution for the management of contexts in spaces of interaction distributed to maintaining coherence and consistency, both the interaction and information. CAIM system solves the problem both from the point of view of the user who consumes the information, as the responsible administrator associate digital resources to the different locations. CAIM system can manage distributed both physical and virtual spaces. Tests with users, as well as provide information for improving the system, confirm that the adopted solution solves effectively providing contextualized according to the physical location information.

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