

# Providing Information in an Augmented Campus

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## Abstract

*Mobile technology provides many benefits to education. In this paper we describe the architecture of a system that allows people to search and retrieve information about its location and activities in a Campus, knowing about the resources available on its surroundings, including buildings, classes, events and people.*

## 1. Introduction

Beginner students have difficulties finding the information they need about their classes, buildings and localization, to name a few. They usually try to find information on signs, tables and so on. As they do not know where to look at, they become lost easily. Thus, in order to get relevant information, they need to talk with people or use a kind of interactive screen, which would be difficult because of the unknown interface of an *ad-hoc* device.

On the other hand, it is not difficult to find a person with at least one mobile device. Such device may be a simple mobile phone or an even more complex and capable device, with wireless access and GPS. So why not allow these people to use its own mobile devices to search and receive relevant information about their localization, buildings, classes and meetings. One important point is that the person is usually familiar to its device interface and possibly will have fewer prob-

lems using it to interact with the information system and retrieve relevant information.

This paper describes the architecture of a system designed to help people search and retrieve information about the environment and activities. This system may be employed in a university campus environment to help students find relevant information and get localized.

The paper is structured as follows: first we give a brief overview of the system; then we describe its architecture, subsystems and related components. After, we provide information about related works and argument in favor of our system, stating its differences and advantages. Finally, we present some final remarks and future work.

## 2. System overview

The system has as objective to retrieve information related to the educational environment the user is inserted and also about the education activities he is engaged. In this sense, one important aspect is the detection of resources and people available in the surrounding area. If we also take in account the user necessities or activities, the system may guide the user showing where to go next, pointing important resources or persons.

Besides the information about the environment, it is also important to know the capabilities of the user

device. This is very important, since the information may be adapted or filtered accordingly. For example, if the user has a limited phone device he can only receive textual instructions and SMS, but if he has a powerful Smartphone with GPS he can receive an entire application displaying a map with detailed real-time instructions.

In our system, to achieve the largest quantity of users as possible, we will focus on WAP enabled devices, which is available on almost all existing cell-phones, even the simplest. Then, the information adaption problem will be minimized.

It is important to know that the user has specific characteristics, such as identification, name, type, sex, language, interests, qualifications and activities, which are also relevant. The user language, for example, is important to know in which language the information must be shown (if it is available in different languages). His type, interests, qualifications and activities allow the definition of information filters and alerts more appropriated to his needs.

All this information, which we call the user profile and the user context, should be easily available to the system in a centralized, controlled and protected way.

To make available such a complex system, it is necessary to plan and architecture different components that are responsible for each of these aspects. The next section provides a description of the system architecture and its components.

### 3. System's architecture

As described before, to allow the construction of the system it is necessary to know about the environment, the user needs and its localization. The general system's architecture is depicted in Figure 1.

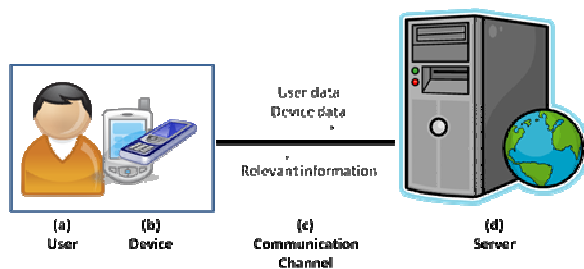


Figure 1. General architecture

The User (a) by activating his Device (b) will connect to the system's Server (d) using an available Communication Channel (c). The initiation depends on the technology used: the ideal system would be pervasive enough to provide autonomic detection and to establish an automatic communication; but less complex technology that involves manual connection can

be used. The present system is able to work only with WAP connections.

The system's Server must contain the following components: Authentication, Perception, Communication, User Management, Device Management and Resource Management. The Server has also three main databases: the User data, Device data and the Resource data. The User Data contains all the information related to the user profile, the Device Data stores devices profiles, and the Resource Data contains information about the existing resources on the environment, such as buildings, people, objects, events, classes, and its descriptions and localization. These components are shown in Figure 2 and described in the following subsections.

Notice that, besides the user, there is another important role in the system – the administrator, which is responsible for the User, Device and Resource Management components, and is able to include, update and exclude elements.

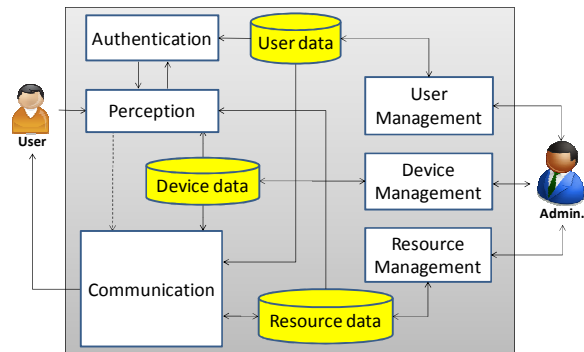


Figure 2. Server's components

#### 3.1. Authentication component

The authentication component is used by the other components to check and identify the user. Non-existing users are treated as guests and have limited access to information, being able to receive information about its surroundings resources. More detail is given in the Communication component. Authenticated (existing) users will be able to receive more detailed information regarding its personal activities, agenda and classes.

#### 3.2. Perception component

The Perception component is a very important part of the system, since it detects the user under the environment and identifies him through the authentication component.

After identified, the user may interact with the system in different forms. The simplest form of interaction with the system is performed when the user starts a WAP connection to the Server and selects the actions

he wishes to perform. The Server then perceives the user, and through the Communication component it interprets these actions and answers accordingly (for detailed information about these actions, see section 3.3).

The second form of using the system is through vocal interaction. In this case, the user should call a specific number and the system will perceive him and the Communication component will vocalize the options available, which are designed using VoiceXML [9]. The user chooses the desired action and the system plays the corresponding stored recording (see sections 3.3 and 3.5 for more details).

Many other forms of interaction are possible, and they are dependable of the technology used to perform the user perception and localization. To name a few, it is possible to accept SMS, infrared and Bluetooth forms of interactions in the future. The use of GPS technology is also an interesting option to autonomously detect the resources geographically referenced in the physical environment. The Perception subsystem is extensible to support these requirements as needed.

### 3.3. Communication component

The communication component is the kernel of the system. Actually, it is responsible for the interpretation of the user necessity and for generating an appropriate response or action. It must also be extensible in order to augment its capacity with the introduction of new actions, commands, and information filters and adapters.

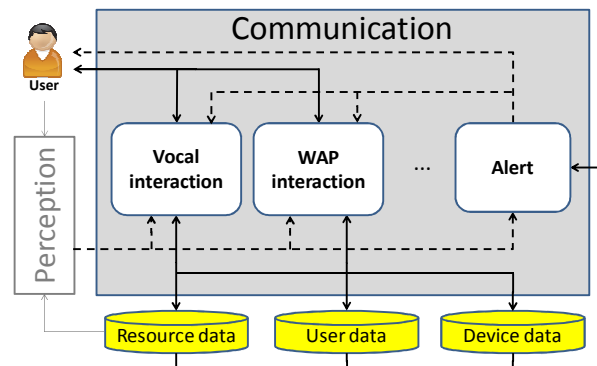


Figure 3. Communication component internals

Once the user is perceived and authenticated, the Perception component activates the Communication component, informing the user identification and its localization (if available). The Communication component then starts the appropriate subsystem to interact with the user. This component will interpret the user commands, identifying their related resource(s), and execute the corresponding actions. By resource we

mean any place (building, room, and object), event (meeting, class) or person registered in the system.

Figure 3 shows the Communication component's internal structure. It demonstrates that the Perception component activates the appropriate interaction component. The user then receives and sends data through them. Depending on the command, and on the user privileges, some actions may recover, insert or update data on the data bases.

At the moment, the following actions or commands are defined:

- **Describe <resource>**: this command returns the description of the given resource, if the user has access/authorization to it. The information is taken from the "Resource data" component, and is specific to the resource type. For example, if the resource is a specific room or building, its location may also be given. If it is a meeting, it is interesting to show its related participants, besides its localization. More details about the information structure of each resource are given in Section 3.5. It is important to clarify that each resource is identified by its name or code, which should be visible on every buildings or object referenced. Classes, professors and events are more easily identified by its names. The *describe* command needs also to know about the user device capabilities to provide the information accordingly. Specific adapters must to be implemented to each type of device. In the proposed system, the information will be available either in textual or vocal format.
- **Locate <resource>**: this command returns the location of the given resource. Depending on the interaction type, the user may receive the textual or the vocal description of the place. If the user is using a more advanced device, he can even receive a map showing the resource location. In the case the system is enabled with a real-time localization/perception system (with the aid of GPS devices, for example), it is also possible to inform the presence or absence of persons (e.g.: if determined professor is in his room and if he is available for meeting).
- **Route <origin> <destination>**: the route command was defined to inform how the user can go from one destination to another. Depending on the interaction form and on the device technology, it will be possible to trace the route and send him its textual or visual representation (such as Google Maps does). More complex devices may even have real-time full interactive maps (such as GPS systems do on cars).

- **Create <resource>**: this command allows the user to create new resources that belongs or that are related to them. For example, teachers can add activities for their students or setup events. Students can add personal activities or reminders.
- **Change <resource>**: it was designed to allow users to change information about the resources they own or create, such as personal activities and reminders.
- **Delete <resource>**: very similar to the change command, but allows users to delete their personal activities and reminders.

It is important to state that each command or action has an associated subcomponent that is responsible for its processing. As we add new commands or actions, new subcomponents must be implemented to treat them.

For example, we plan to design components to recover and adapt information to each device capabilities: imagine that the teacher suggests the reading of a paper for the next class. If this paper is available on the web and the user is using a Palm device, he can ask the system to show it on its interface. However, if the user has a limited cell phone, he can receive the paper abstract and perhaps an automatically generated summary of it. To perform this task we will employ specific summarization tools [2], which is not the focus of this paper.

These more complex actions will need information about the existing devices and its characteristics and limitations, which are found in the Device database.

The last element is the Alert component. It is responsible for reminding the user about pending actions (tasks, meetings, classes...). It is active, since it may work even when the user is not directly interacting with the system. In this case, the Alert will send a SMS to the user containing information about the event or pending action. In the case the user is already interacting with the system, the information will be send by the appropriated component (e.g.: WAP or Vocal components). The architecture also allows that the perception component generates an alarm. It is helpful for environments enabled with more sophisticated devices and sensors (e.g.: GPS, real-time localization), so the system may perform more intelligent warnings and recommendations.

### 3.4. User management component

The User Management Component works as a catalog of users. It is responsible for the storing of information related to each user – the user profile. As we intend a system that is extensible and that contains modules to perform information adaption, filtering and recom-

mendation, according to the user device and to the user type, it is important to maintain as many information as possible in the databases about the user and its activities.

At least three user roles are already specified: guest, students and teachers. The guest user role was planned to allow aliens or non-catalogued users to find and get the description of public resources such as rooms, open talks, buildings and places. In the student role the user will have access to the guest operations and also to information regarding its specific classes, teachers and events. Students may also create personal reminders and personal activities.

The users with the teacher role will have a higher level of access and can recover any kind of information. They will also be able to create activities or events specific to their classes or students. The management of general information is performed by the system administrator. In the future, perhaps, it will be necessary to create information adapters and brokers to import or interoperate with existing (legacy) systems.

Besides the user type, the system will store his personal information (name, address, etc.), its preferences/interests, classes, room and activities.

### 3.5. Resource management component

This component is responsible for the management of information regarding the resources available in the environment. Each resource may have different attributes. Those attributes are defined by a specific ontology of resources attributes. This ontology is not the focus of this paper, but is an important aspect of the system. The main attributes of the resources are: name, identification-code, localization (geo-reference), textual and VoiceXML description.

The management of the resources if performed by the system administrator, but it may also be possible to implement components to import existing information or to interoperate with legacy systems.

### 3.6. Device management component

This component is designed to manage information about the devices known to the system and its corresponding characteristics and restrictions. Existing ontology such as the one described by Mertins [6] can be used and expanded to populate the Device database. This database can be expanded or refined using profiling techniques such as the one presented by [5].

## 4. Related works

In recent years, m-learning [3] is getting the attention of the scientific community, which propose new learning environments adapted to mobile devices. However, the learning experience is not only composed of virtual

environments, but also of real-world objects and live entities that interact actively. Thus, what we propose is a way of augment the environment – the campus – providing a way to access relevant information through mobile devices and also to allow users to interact more easily and actively.

In [1] a system named COALE is presented, and it is designed to provide collaborative and adaptive learning. We do not intend do design a learning environment such as them, but the concepts of collaborative and adaptive that they use are useful in our design. Our system should be able to detect users with similar needs or with common activities and to recommend (aware) them (each-other), so they can collaborate and learn together.

The biggest problem is no to confuse the user with too many recommendations. In this sense, [7] presents a technique that is able to filter the messages in order to provide more efficient collaboration. But if it is useful for awareness and collaboration, it is also important to find a way to provide context-aware adaption.

The system presented by [4] is capable of performing semi-automated adaption, and the actions are defined and controlled by the user, based in a context ontology. In our system, the adaption is also an important aspect, since it is able to provide different types of interaction (WAP and vocal, for the moment) and allows the implementation of information adapters for different types of devices.

A more interesting adaption is presented by [8] where a framework to provide ubiquitous and mobile multimedia services is presented. However, they propose the identification and use of the interface objects available in the user surrounding to make the interaction and adaption. While our system intends to identify the nearby resources, and could also try to use them to interact with the user, it is designed to be simple and to allow the interaction by less complex devices (actually, the simplest as possible).

## 5. Final remarks

The portable devices are changing the life of every citizen. It is not difficult to find a person with at least one cell-phone. In this context, why not use these devices to aid people to find information about the place they are in the moment. The proposed system helps people in a Campus to recover information about their surroundings, including buildings, classes, events, meetings, people and advices. The system architecture, the commands as long as the possibilities described in the example scenarios are interesting contributions to the field of Advanced Learning Technologies.

## 6. Acknowledgment

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