ALGORITHM FOR SELECTION OF CONTENTS IN A LOCATION-BASED SYSTEM

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Abstract: This article presents a geo-referenced and personalized radio system for mobile terminals that works over wireless broadband networks. The architecture of the system allows the combination of thematic contents that are chosen by the user and contents with local information that depends in the first instance on GPS coordinates, velocity and direction of travel of the user and in the second instance on the preferences of the user, who can configure its terminal according to its interests. The requesting, downloading and playing of local information is managed by a predictive algorithm that takes into account not only the position of the terminal or the preferences of the user but also other features as the area where the information must be played and the loading time.

1 INTRODUCTION

Positioning is used to find out the spatial location of a person in terms of longitude, latitude and altitude. There are some technologies for positioning, but the most well-known is GPS (Global Positioning System) that consists of 24 satellites that are in medium Earth orbit transmitting signals. GPS receivers take this information and use triangulation to calculate the user's exact location. The European system, GALILEO, will be operative in 2011-12 and will provide a higher precision.

Positioning is the key concept to develop location-based services, which provide information taking into consideration the position of the users. There are many possible applications for location-based services such as health care, navigation, advertising…

The first generation of located-based services was not successful, but the apparition of low-cost GPS receivers and new geographic content changed dramatically the situation. Nowadays there are highly successful devices such as GPS navigators.

In the other hand, the radio is the most widespread communication mean. Another important feature of radio is that users do not need a high degree of attention, so they can develop other activities while they are listening to radio. This feature allowed the evolution of use cases from static (a person listening to radio at home) to dynamic (a driver listening to radio).

The combination of the location-based services and the radio establishes the basis for a new service of information and entertainment of general purpose. A new generation of digital, geo-referenced and personalized radio that overcomes the limitations of the current standards of digital broadcasting (DAB), taking advantage of the features of the bidirectional transmission of data by packets (UMTS, HSDPA, WiMAX).

At present there are many works about location-based services, but few of them deal with the application of these services to a radio system.

I. Takei et al. proposed a position-adaptive broadcasting system for mobile terminals. The approach is similar to the one proposed in this article, but their solution consists of broadcasting summaries of local information to all the terminals. Then every terminal selects which summaries are going to be extended and downloads the complete contents from the corresponding server. This solution is not feasible in this problem because the contents of the thematic channel are played asynchronously in every terminal and broadcasting all the summaries of advertising may overload the network.

This article presents a new radio system for mobile terminals. It allows the combination of thematic contents that are chosen by the user (in a

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similar way to a radio channel) and contents with local information that depends on the location, velocity and direction of travel of the user. The second section is an introduction to the system architecture. The third section concentrates in the algorithm used by the terminals to select the contents that are played. The proposed algorithm is an adaptation of Takei's algorithm that fulfils the requirements of the problem exposed in this paper. The fourth section illustrates the functioning of the algorithm by means of a simulation.

2 ARCHITECTURE OF THE SYSTEM

In this section there is a brief resume of the business model that involves the providers, the customers and the technological means that allow their interactuation. To illustrate this, there will be expounded some habitual use cases that the system supports.

The profile of the customer consists of a person or group of persons that carry a terminal that is playing auditive information. There may be portable terminals that can be carried by a person, for example a small radio receiver, but the most usual profile consists of a person that is travelling by car (or some vehicle of that kind) and is listening to the terminal that is installed in its car. The choice of this profile as predominant is based on the high percentage of drivers that listen to radio, due to their capability for developing activities (in this case driving a car) while are consuming auditive information. Other means that integrate sound and images are not so suitable for drivers because can cause distractions that jeopardize the safety.

The system allows to the customers consuming two kinds of contents: one of them is a thematic channel. The information is sent from the server to all the terminals that select the channel (in a similar way to a radio channel), but the innovative aspect is that the content is asynchronous. Every terminal can play different parts of the content at the same time. This feature is necessary because the second kind of content, the advertising, is asynchronous too because is dependent on the position of the terminal. If the thematic channel was synchronous, there may be lost of information produced when the thematic channel was replaced by the ads. So the terminals request the data from the server when they need to play some information of the thematic channel. If some ad is inserted, the terminal continues playing the thematic channel at the point it was interrupted.

Related to the kinds of contents there are two kinds of providers. One of them is the *contents provider*, that provides data for the thematic channel. The other is the *ad provider*, that provides the geo-referenced advertising.

There must be some technological resources that support all the system. First of all there must be a server that stores the thematic content and the geo-referenced advertising, must receive the requests from the terminals and must send the corresponding data to every terminal. Another component of the system is the terminal. The main use case consists of a personal radio that has capability of playing the data sent from the server and requesting the necessary data to the server, This terminal can be configured with the preferences of the customer. For example, the user may not be interested in listening information relative to hotels. The secondary case of use consists of the web interaction. The terminal may access to internet and apply information extraction techniques to look for specific information. The data found is converted to auditive information with a voice synthesizer. Finally, the terminal must have the capability to extend the information about one specific ad. This is necessary because one geo-reference ad must be a resume of the information to avoid overloading the network with information that may not be interesting for the customer. If the customer was interested in some ad, by pressing a button he can obtain a more detailed information.

The communication between the terminal and the server must be through a wireless wide band network. Nowadays this technology is supported by UMTS but there are incoming standards as HDSPA and WiMAX that improve the speed of transmission and support more users.

To illustrate the functioning of the system some possible use cases will be explained.

The first case of use consists of a family that is travelling by car through Guadarrama Mountains. They choose the thematic channel "Discover Madrid" and activate the traffic warnings. While the presenter talks about the mountains, the local festivals and monuments, there are inserted some warnings about the traffic in the area and some ads about services that can be found through the route.

The second case consists of the owner of a new restaurant located near an office building. He wants to attract more clients, so hires the service to insert an ad during the hour previous to habitual lunch time. The ad is played in a ratio of 500 metres around the restaurant. If a customer is interested, presses the button “action” of the terminal, and the information is extended. The owner of the restaurant pays a fee for the emission of the ad and another fee for every person that pressed the button “action”.

The third case consists of a local radio station that broadcasts programmes about the history and curiosities of Madrid. This programmes are geo-referenced and integrated in the system explained above, inserting placements for advertising. The benefits of the emission of advertising in those programmes is shared with the local radio station. This way, the local radio station increases its benefits reusing contents that already owns.

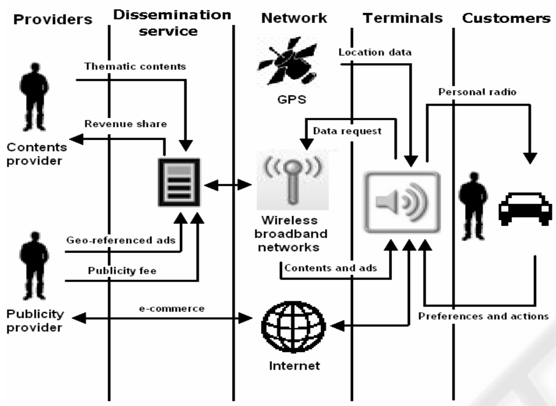

Figure 1: Architecture of the system.

3 ALGORITHM OVERVIEW

Bellow is a description of the algorithm that manages the contents that are played by the terminal. This algorithm is the responsible for switching the thematic and the local information channels and for requesting, downloading and playing the data that is related to the coordinates of the portable terminal.

The map is divided into rectangular pieces called *quadrants*. At the beginning, the algorithm loads into memory the *quadrant* related to the GPS coordinates where the terminal is. But from then on, it is necessary to predict which quadrants will be the next ones to be crossed by the trajectory of the terminal to avoid the delay caused by loading into memory one *quadrant* when the terminal is already into it.

Every quadrant is crossed by four lines that are parallel to its sides. The distance between the sides of the quadrant and these lines depend on the speed of the vehicle. The higher the speed of the terminal, the longer will be the distance. If the trajectory of the terminal crosses one of this imaginary lines, the terminal loads into memory all the quadrants that are adjacent to the *sub-quadrant* where the terminal enters. For example, in figure 2, the terminal will probably enter into the *sub-quadrant* Q_{41}. If it happens, the *quadrant* Q_1 is loaded into memory. If the vehicle enters into the *sub-quadrant* Q_{42}, then the *quadrants* Q_1, Q_2 and Q_5 will be loaded into memory.

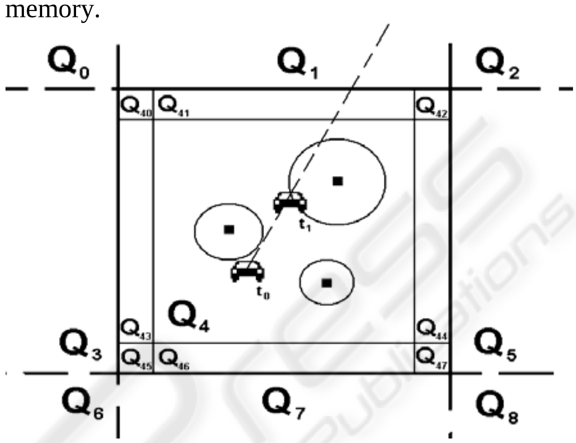

Figure 2: Division of the map into *quadrants*.

Every *quadrant* contains the data relative to the position of the points of interest and their *influence ratios*. If the vehicle enters into the area delimited by one *influence ratio*, the information related to that point of interest must be played by the terminal.

Depending on the direction of the vehicle the algorithm calculates the intersection of the trajectory of the terminal and the *influence areas*. If one *influence area* is intersected, the *loading ratio* is added to the *influence ratio*. The *loading ratio* represents the time necessary for requesting and loading into memory the information relative to one point of interest. It is directly proportional to the speed of the vehicle and depends on the volume of the information and the loading of the network too.

When the vehicle reaches one *loading area*, the terminal begins to download from the server the data relative to the point of interest. When the vehicle reaches the *influence area*, the terminal plays the information that was downloaded.

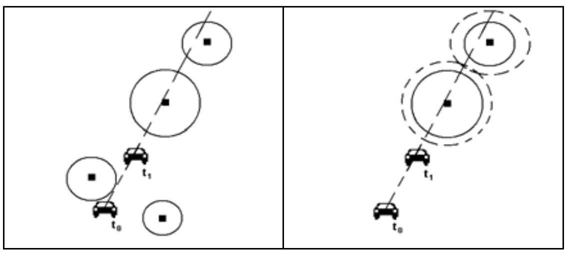

Figure 3: Influence and loading areas.

If the vehicle changes its trajectory when is outside of any loading area, the new intersections must be recalculated and the new *loading ratios* reconsidered. If the vehicle is inside a *loading area* but outside the *influence area* and its new trajectory does not intersect the *influence area*, the information is downloaded from the server and stores it in a buffer, but it does not play it.

There are some problems related to the overlapping of *influence* and *loading areas*. The simplest solution consists of storing the information in a playing buffer. This way all the information relative to the points of interest is played, but if there are some overlapped areas the information relative to one point may be played when the terminal is outside its influence area. Another solution consists of assigning priorities to the points of interest. The information pills are stored in the buffer sorted by priority but when they have to be played, if the terminal is outside the *influence area*, the information is not played and deleted from the buffer.

4 SIMULATIONS

The algorithm for selection of contents has been programmed in Java. A graphic interface has been developed to show the results of the simulations. The interface draws one *quadrant* with the position of the vehicle, its trajectory, the position of the points of interest and their *influence* and *loading ratios*.

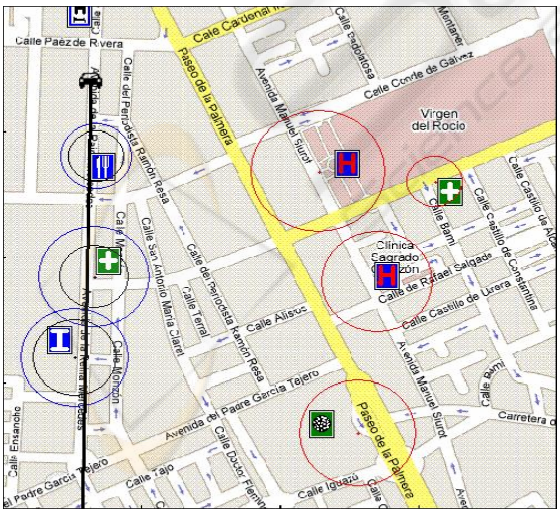

Figure 4: Screensave from simulation.

To illustrate the functioning of the algorithm some screensaves from one simulation are shown bellow. The *quadrant* of the simulation contains seven points of interest with their corresponding influence ratios.

The vehicle begins at *Avda. Reina Mercedes* street. Its trajectory intersects three influences areas, so the *loading ratio* is added to the *influence ratio* of the areas intersected, as shown in figure 4.

The vehicle follows the predicted trajectory, so enters inside the *loading area* of the first point of interest. At that moment the data relative to the point is downloaded from the server and stored in the playing buffer. In the figure 5, the vehicle is just entering inside the *influence area* of that point. The information stored in the buffer is played then.

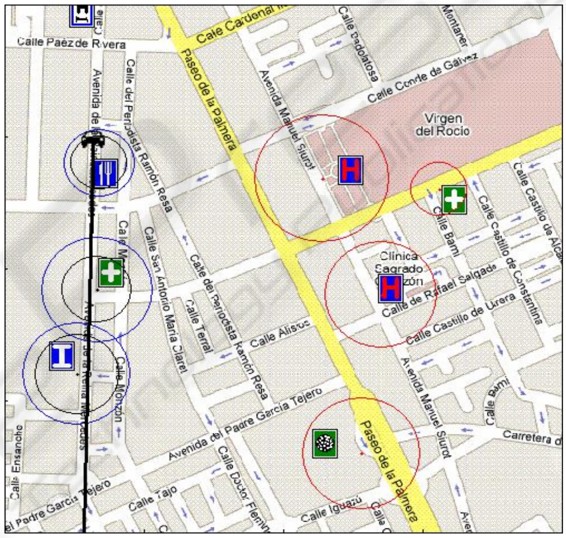

Figure 5: Screensave from simulation.

The simulation continues and the vehicle enters inside the influence area of a second point and the data relative to that point is played too. But before entering the influence area of the third point, the vehicle turns to the left, as shown in figure 6. The new intersections of the trajectory with the influence area are calculated, and the corresponding loading ratios added. Along this trajectory the vehicle brakes, so the loading ratios decrease.

Figure 6: Screensave from simulation.

Finally the vehicle continues the predicted trajectory through the street and crosses the influence area of two points of interest more, so their contents are played too.

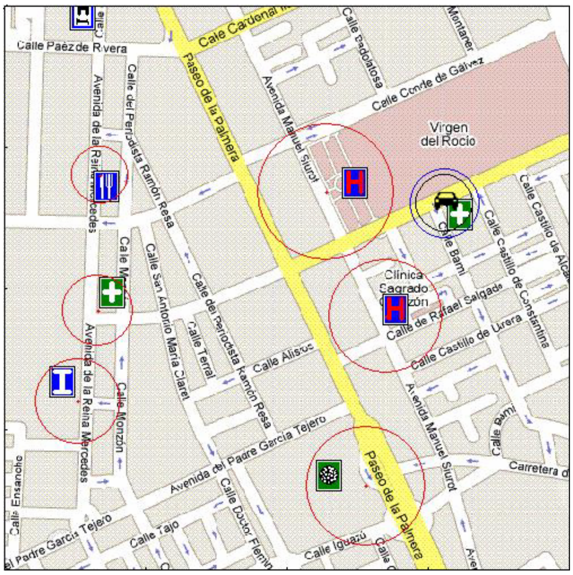

Figure 7: Screensave from simulation.

5 CONCLUSIONS

The problem of contents selection in location-based services is well-known and studied in the case of mobile phones, but there are few works about the same problem in radio systems. The dissemination services for advertising or news services in mobile phones scenes do not have to manage a big amount of data. In the case of radio systems the quantity of information that has to be sent is much higher, so the architecture of the system has to be considerably modified.

Even the existing works about radio systems can not be applied to solve the problem exposed in this article due to the asynchronous nature of the data that should be played by the terminals. The solution proposed in this paper for contents selection is a modification of Takei's algorithm that takes into account the requirements exposed before.

This project is currently in progress and there are many aspects that require further research, specially the ones related with the architecture of the system.

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