Different Views on Location Awareness

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Abstract

Location awareness is a key ingredient to many applications of mobile devices. Devices with the ability to determine their own position can retrieve, filter or present information depending on this position in space. There are, however two different ways to view this situation resulting in different distributions of computational resources. We argue that in many cases it will be better and easier to put some computational effort and design wits into the environment and infrastructure than into the actual mobile device. In this sense we claim that there should be more artificial intelligence *around* mobile devices than *in* them.

1 Introduction

This article is the result of a week of discussions with visitors and other exhibitors of the German computer fair CeBIT 2000 in Hannover, where some of the authors were presenting their building navigation system for the Palm Pilot PDA. This building navigation system (IRREAL, [3]) requires only minimal resources and no additional hardware on the handheld organizer. All it takes is a 26K piece of software that we beamed to all visitors who came with their own device. Yet the software seemingly makes their device location aware. There is no tracking system involved whatsoever, yet the device apparently knows not only where it is to a resolution of 2-3 meters, but also in which direction it is pointed (to a resolution of 30-45 degrees). This fact managed to astonish most of the visitors until they saw the strong infrared transmitters that were mounted to the walls above all the exhibits at the booth.

These transmitters constantly broadcast text and vector graphics data in a scheme similar to the one used in the Video Text[1] system. A browser program on the handheld collects this data, displays it on the screen and allows for interaction with it. The graphics can contain clickable elements and the user can interact with it in a way similar to web pages (or Video Text pages for that matter). We used this setup as a booth information system with which visitors could retrieve project descriptions and contact information for all the projects on display. They could also save the information they wanted to keep on their devices and take it home while all the rest of the data disappeared as soon as they left the booth.

Now were those Palm Pilots location aware? Certainly not, because at no point they were able to determine their own position in the usual sense. Nevertheless they exposed a behavior that can be characterized as location awareness. In such a situation it might be more appropriate to attribute the term awareness to the other side of the communication channel, namely the infrastructure or the environment. By placing infrared senders throughout the environment and broadcasting localized information from those senders we had created an environment that could be characterized as being device aware or locally adapted for the mobile device.

2 Location aware devices

Location awareness in the classical sense implies some means of tracking, be that GPS, radio bearing or conventional ultrasonic, magnetic or infrared tracking systems. Another approach is to place active or passive markers in the environment, such as ultrasonic or infrared senders or bar codes that are scanned by the mobile device. The main principle here is, that the device has information of some sort about its position in space and can then retrieve, filter or present information appropriate to this position. This paradigm puts the mobile device in charge of a) determining its position and b) selecting, retrieving and displaying the appropriate information. For a classic example see [4].

There are better and worse examples of wide spread location aware devices, the most widespread of which probably are GPS based car navigation systems. They obviously vary their output depending on their measured position, direction and velocity in space. Currently under development are location aware tourist guides based on GPS tracking and/or augmented reality output facilities (see [8, 10, 2]). Within buildings, infrared markers are used to mark exhibits in museums, so a portable device can select fitting descriptions from its database (see [5, 6]). Most of these systems struggle with the required amount of computing power or memory that is needed to do position determination, content selection and presentation and possibly even retrieval all on the mobile device.

3 Locally adapted environments

The opposite approach is to keep the mobile device as simple as possible and make use of the fact that it can only receive information within a certain range. In this sense even a simple transistor radio is location aware to a certain degree, since it will only play radio stations nearby, resulting in localized news, weather forecasts and traffic reports, all even in the appropriate language (if we forget about international travel for a moment ;-). On the more technological side many FM stations in Europe use their RDS[9] channel to scroll this same localized information across car radio displays. Although no GPS is involved, the traffic warnings are roughly localized for the area the car is driving through.

There is even more potential in existing network infrastructures with a finer granularity than public radio. One well known application are electronic museum guides that play different texts in their headphones depending on the room people are in. They receive their signal from infrared or weak radio transmitters that can only be received within the room in question, and thus provide localized information by their pure working principle. A German cellular service provider[7] is using the position of their mobile phones measured by the radio cell in use to charge their customers different rates depending on their being at home or away. Just like the museum description this is achieved without ever explicitely dealing with positions in space, yet seemingly makes the mobile phone location aware.

4 Consequences for mobile AI

If this decentralized paradigm is applied to location aware mobile computing devices, the benefits are twofold: A simple mobile device whose location awareness is provided by its locally adapted environment can be much more lightweight and requires no tracking hardware or position calculation. On the other hand by shifting the task of localization to the environment side we can afford (in comparison) almost unlimited computing power and memory. By simply providing adapted information in all the different places and letting the mobile device display whatever it is able to receive, we effectively make it appear location aware while it can be kept very weak in terms of computational power, and thus generally very lightweight and cheap. The AI part which in many cases is required to generate localized information is shifted from the mobile device to the infrastructure where it is

much easier to provide the computational resources for it. This schema, of course, will only pay off if there are more than a few users, since the investment on the infrastructure side can easily surpass what we save on the mobile side. In addition there is another tradeoff to consider: While adapted environments generally make for very simple mobile devices, they also limit the amount of accessible data. While the reqirements for computing power and memory are kept low, the required communication bandwidth might actually increase, since instead of a few bytes for position information, all the localized data has to be transmitted. Also the number and complexity of services is limited by the environment instead of the individiual device.

Nevertheless we believe that in the future a major challenge will be to provide localized services with the devices and infrastructures already in place. A mobile phone with the ability to 'know' whether it is used in its owner's house or not can just as well provide a list of nearby restaurants or a textual or acoustic description of the sights in its direct vicinity. It can just as well warn about traffic jams in the immediate neighborhood. This functionality requires no additional investment from the user, but provides a huge potential for localized services to infrastructure carriers. These in turn won't be able to handle localization and adaptation on any larger scale without applying AI techniques to some extent.

This paper is meant primarily as a basis for discussion at the workshop. Its main purpose is to make explicit the two different views on location awareness and to invite people to reconsider the overall design of their location aware devices and applications.

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