

User-Centered Location Awareness

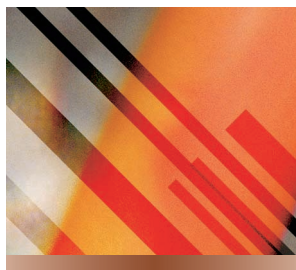
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Mobile computing and communication devices now provide access to information from nearly anywhere, and many of these devices know where they are. In the US, the Federal Communications Commission requires that 95 percent of mobile phones must be able to determine their location within 50 to 300 meters by the end of 2005, and that wireless carriers must make this information available to emergency call responders.

Much current research focuses on using location awareness to provide information about a user's surroundings. This can certainly be quite helpful if you're lost, need to find the nearest ATM machine, or are involved in an accident in some out-of-the-way place.

However, because geographic databases are quite large, a mobile phone must be connected to a network to access such services. This limits opportunities for small-footprint and peer-to-peer services on phones, or services that operate even when the phone isn't connected to the network. In addition, network-based location-aware services can reveal a user's identity as well as serve as a vehicle for mobile spam.

We believe that geographic information can be personalized based on its relevance to the user, with appropriate descriptions or granularity to deliver valuable location-aware services. To demonstrate the practicality of this approach, we have implemented several prototype applications in mobile phones that combine location awareness with communication technology.



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MEMORY AID

A location-aware memory aid, comMotion tracks a user's path via the Global Positioning System (GPS) and maintains "to do" lists for select locations consisting of text and voice recordings. After the user has visited a place several times, the system displays the location on a map and prompts the user to name it—for example, "home," "bank," or "grocery store." The user can also instruct the system to ignore other detected locations, such as a bus stop or train station used only in transit.

As Figure 1 shows, when the user approaches a named location stored in the system, comMotion indicates whether there are any reminders for that location and presents them on request. Friends, family members, office colleagues, and other authorized persons can also send messages to a virtual location that are delivered upon the user's arrival at the actual place—for example, a list of additional items to pick up at the market.

CHILD MONITOR

Safe & Sound is a monitoring application implemented on a pair of mobile phones, one for a parent and one for a

child, that communicate via peer-to-peer IP. The parent sets a "secure zone" in one phone, to which the child's phone periodically sends its coordinates—latitude, longitude, direction heading, and speed. If the child wanders outside the defined boundary, both phones beep. The parent can then call the child as well as display the child's coordinates.

Although Safe & Sound currently

uses a Euclidean distance metric, a straightforward extension of the system would let the parent physically demarcate a secure zone—for example, by walking around the block and designating certain spaces, such as the local park and selected neighbors' yards, as safe play areas.

Looking further into the future, we envision the possibility of shopping malls, amusement parks, and other venues providing their bounding-box coordinates on the Web for downloading to such devices. Parents could use these coordinates to give older children more freedom to roam while keeping tabs on their whereabouts.

A similar system could be used to monitor other persons, such as patients at elderly care facilities, who must be restricted to a certain area for their personal safety but for practical reasons cannot be continually observed either directly or using stationary video cameras.

WRISTWATCH PHONE

WatchMe is a wristwatch phone that lets users share their position information with family members or intimate friends. The watch face, which ordinarily shows the time, features periph-

eral icons that the user can assign to other individuals. Clicking on one of these icons yields a detailed view, like that shown in Figure 2, of that person's current position (via GPS) and activity status (via accelerometers)—for example, driving, walking, or riding a bicycle.

Monitoring isn't surreptitious: The goal is to let users choose opportune times to touch base or relay a message, not to spy on one another. If Mary clicks on an icon assigned to John, John will see Mary's face—optionally accompanied by light, vibration, or sound—on his own watch phone, so John knows that Mary is thinking of him.

The system's location detection and naming system is similar to that of comMotion. However, WatchMe uses Assisted GPS, which achieves a much better signal-to-noise ratio with the help of nearby cell towers, enabling some indoor positioning capability.

The device continually tracks a wearer's coordinates and compares this data to established routes that originate and terminate at user-named locations. For example, if WatchMe determines that John is following a familiar route, Mary's device will display his predicted destination (such as home or office) and estimated arrival time. If John's path doesn't match a known route, the display can instead indicate, say, that John left home 15 minutes ago. Because WatchMe doesn't rely on map displays, it can track any route, whether it follows a named road or an unmarked path.

The inclusion of GPS reception in mobile phones is rapidly enabling a wide variety of location-aware personal communication applications. Some of these are purely personal, but others empower users to share an increasing array of data with friends and family, or even trade information anonymously—for example, by alerting oncoming drivers of a major accident or congestion on the highway.

Despite the possible benefits of loca-

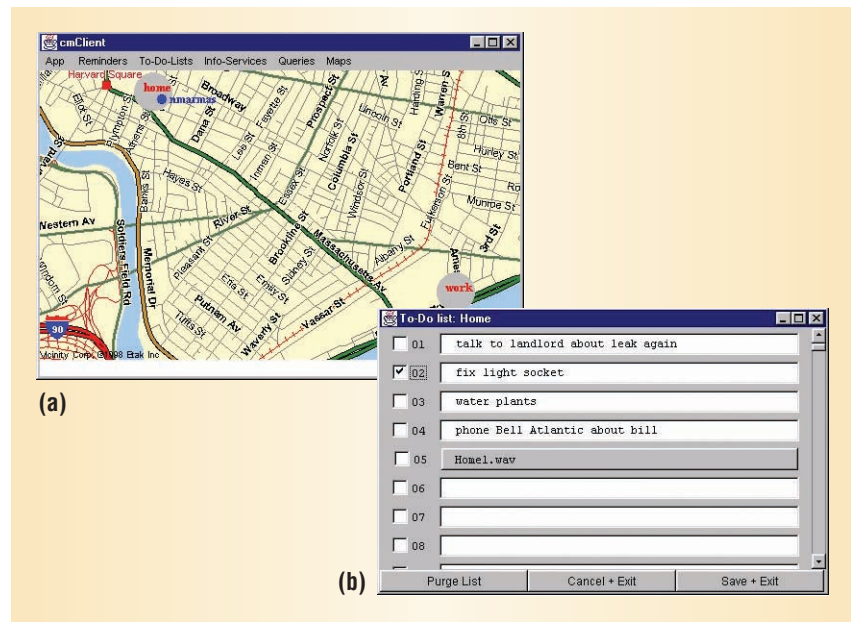


Figure 1. Location-aware memory aid. (a) When the user returns "home," (b) comMotion presents a "to do" list.

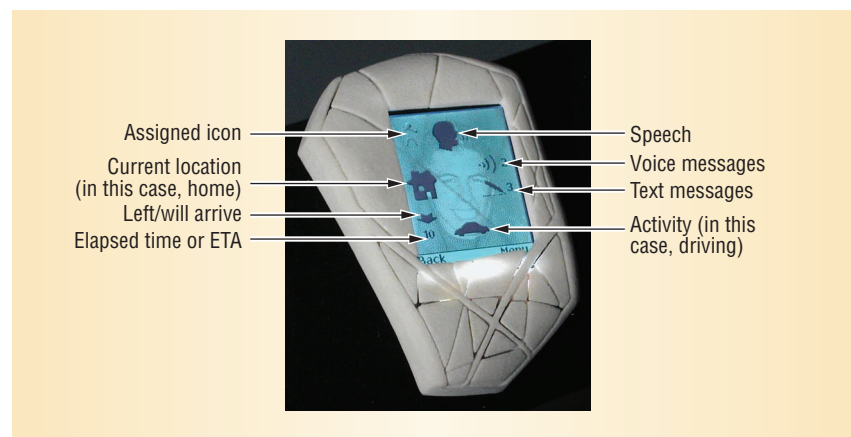


Figure 2. Location-aware wristwatch phone. Clicking on one of WatchMe's assigned icons reveals that person's current whereabouts.

tion-tracking technology, many potential users find it threatening. We believe that a user-centered model such as we have developed, in which location information is "encoded" into forms that have little meaning to outsiders, is one way to address this security challenge. ■

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