Cricket: A Location-Support System for Pervasive Mobile Computing
9807-04
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A. Funding

We would like to continue our project and funding for the period July, 1 2001 to June 30, 2002 for our work on the Cricket system. Our work is part of Project Oxygen.

B. Proposed work

Over the next year, we plan to prototype and experiment with a "software compass" for Oxygen. Over the past 18 months, under NTT funding, we have developed a system called "Cricket" for position and spatial estimation. Cricket uses active beacons transmitting RF and ultrasonic signals, together with passive listeners attached to devices, to enable applications to learn where they are located and adapt their behavior to their location.

We propose to extend this work in an important direction, to build an Oxygen compass infrastructure. By analogy to an ordinary magnetic compass, knowledge of orientation through the "Oxygen compass" attached to a mobile device will enhance various important context-aware pervasive computing applications, including efficient way-finding and navigation, directional service discovery, and "augmented-reality'' displays. The Oxygen compass will leverage Cricket's active beaconing support to determine the orientation of a mobile device, in addition to its position.

We plan to design algorithms and prototype a system of passive position sensors and active beacons that can estimate the orientation of a device to within 5 degrees. This capability is several times better than what is possible today on a handheld device. There are two essential pieces to this capability. First, we plan to place multiple ultrasonic receivers precisely, a few centimeters apart on the compass, so that the differential arrival time of an ultrasonic carrier can be precisely estimated for any pair of receivers to within the required sub-centimeter accuracy. Second, we will deploy a set of fixed, active beacons whose locations are known, and use this infrastructure to develop and implement algorithms that combines several carrier arrival times to produce a robust estimate of the rigid orientation of the mobile compass. We will also develop a rich software API for applications to use the information provided by Cricket in a convenient manner.

Our goal is to build a working system with two important Oxygen applications. Our first application is called the "Viewfinder". The user can point it in any direction, and specify a "sweep angle'' and maximum distance. Using an active map integrated with the INS system for resource discovery (developed under previous NTT funding), the Viewfinder will retrieve and display a representation of the set of devices and services lying inside the sector of interest specified by the user and allows the user to interact with these services via the representation on the map. For example, if the user points the device toward a printer, the user interface for the printer will be automatically retrieved and displayed, allowing her to interact with the printer. If she then

turns the device in a different direction towards, say, a music system, the Viewfinder retrieves and displays the corresponding interface. All of this happens with little (or no) manual intervention.

Our second application is called the "Wayfinder". We envision this application to run on a handheld computer and help sighted or blind people navigate toward a goal in an unfamiliar setting. It will have a speech interface. For example, the Wayfinder might lead a visitor from the entry lobby of a building to the office of the person hosting the visitor, or to a seminar room. The Wayfinder gives incremental directions to the user on dynamically retrieved ("active") maps, using the user's position and orientation with respect to a fixed set of wireless beacons placed throughout the building.

The Wayfinder application is synergistic with Prof. Teller's NTT-funded project (9904-20); we will use that work to obtain a detailed map of the environment.

C. Collaboration

1. We have made 3 visits to NTT from our group. We have had about 5 visits from NTT researchers, including one for a video shoot.

2. We have not published any joint papers. A paper on WIND appeared in the NTT R&D journal.

3. January 2000 issue of Wired Magazine describes the work funded by this collaboration.

The highest-impact results of the collaboration thus far have been:

1. INS, the intentional naming system. It is being used by several other groups within the Oxygen project for resource discovery.

2. Cricket. Several groups, both within MIT and outside (e.g., Nokia, HP, Delta, CMU, Georgia Tech, Dartmouth) have expressed interest in using this for their work.

INS was demonstrated during a live talk at NTT last year. It was also used by a group in NTT (Dr. Katayama).