Human-Centered Location and Navigation
9807-04

Progress Report: September 1, 2002—December 31, 2002

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Project Overview

This project is exploring absolute address schemes for locations in the world (such as buildings, street corners, and park benches) that are easy for humans to understand, remember, locate, compare, and communicate to others.

Commonly, people identify locations in a city by giving a street or block address, such as "77 Massachusetts Avenue, Cambridge, MA 02139 USA," or "7-8-4 Roppongi, Minato-ku, Tokyo, Japan."

Today, however, the increasing availability of Global Positioning System (GPS) receivers raises the possibility of using absolute coordinates for everyday location and navigation. Absolute coordinates have some powerful advantages. A location can be found, and distances and directions can be computed, without reference to a map. Fine-grained locations can be described by coordinates even if they lack a distinct street address --- for example, buildings in a complex (such as a shopping mall, campus, or office park), locations in a public space or park, and particular features of a building (such as entrances, loading docks, or parking lots). Finally, unlike street addresses, absolute coordinates are unambiguous. There are many streets in the Boston area named "Main Street" or "Broadway", which can easily lead a visitor astray. No such confusion is possible with absolute coordinates.

Current GPS receivers use latitude and longitude to express absolute positions. Describing a position to an accuracy of a few meters requires 5 decimal places, such as "N42.35933 W71.09400". Unfortunately, this code is not ideal for a human user to remember and communicate to others. Part of the problem is its length (14-16 digits) and self-similarity (digits can be easily confused or transposed). Worse, latitude/longitude coordinates bear no relationship to the human world --- unlike street addresses, in which the hierarchy of country, province/state, city, neighborhood, and street correspond to social and geographical features that are easier to remember and understand. Latitude and longitude must be expressed absolutely, even if the destination is only a few blocks away --- unlike street addresses, which allow users to take advantage of spatial locality. For these reasons, it seems unlikely that people will rush to use latitude and longitude for everyday addressing.

We are working to devise new address schemes for GPS that overcome these flaws, and to compare them against both latitude/longitude coordinates and traditional street addresses.

Progress Through December 2002

This project joined the NTT/MIT collaboration in earnest on September 1, 2002. The project has taken some time to roll up to speed, hiring its first student researcher only in December. Nevertheless, progress to date includes:

- design of an absolute address scheme in which each address has three parts:
    - a human-readable name identifying a coordinate system, such as *Cambridge*;
    - a two-dimensional offset relative to that coordinate system, such as *.239.870*;
    - an optional check letter that verifies the consistency of the address

- design of a distributed, hierarchical name lookup service which resolves a name such as *Cambridge* into a coordinate system (latitude, longitude, and scale factor) and optional child names (such as *MIT*, *Harvard*, or *East Cambridge*).

Research Plan for the Next Six Months

Our plan for the next six months is as follows:

Conduct a user study of addressing. In a controlled lab study, users will be asked to perform realistic tasks using three different coordinate schemes (the new address scheme, latitude/longitude, and traditional street addresses). Tasks will include locating an address on maps (both paper and computerized), entering an address into a handheld device (such as a PDA or cellphone), hearing and recalling an address while under cognitive load, and estimating the distance between two addresses. Addresses will be drawn from both a familiar area (e.g., Cambridge/Boston) and an unfamiliar one. The performance of the coordinate schemes will be compared for error rate, time on task, and subjective satisfaction.

Implement and deploy the name lookup service. The initial deployment will serve several hierarchies of spatial regions, including US postal codes and US state/county/municipality regions, both available from the US Census bureau.

Implement and deploy a coordinate translation service. This web-based service will convert between three address schemes: the new scheme we have designed, latitude/longitude, and traditional street addresses.

Integrate with handheld navigation. The new address scheme will be incorporated into a handheld application running on an HP/Compaq iPaq with a GPS receiver installed. The new address scheme will be used to display the user's location, and to enter and display waypoints for navigation. The application will also have a map display, if suitable mapping software can be obtained.

The implementation work will be conducted by an excellent MIT undergraduate as part of his MEng thesis. Another MEng student will assist with the user study. Details of the addressing schemes, name lookup service, and coordinate translation services will be described in a technical report.