SensorMap: A Web Site for Sensors World-Wide

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1. Introduction

SensorMap (http://atom.research.microsoft.com/sensormap) is a portal web site for real-time real-world sensor data. Geo-centric web services such as Windows Live Local (http://local.live.com) and Google Maps (http://maps.google.com) provide APIs to visualize spatially and geographically related data over a map interface. The desire to add useful geographic related information to a map interface has resulted in a number of maps-based interfaces with specific sorts of data placed on the map. Examples of such applications overlay housing information (http://www.housingmaps.com), crime-rate statistics (http://www.chicagocrime.org/map/), weather (http://www.wunderground.com), and so on.

We envision publishing and querying real-time sensor data over such maps-based web interfaces. Existing solutions like those referenced above, although useful, have several drawbacks in achieving this vision. First, publishing even a single stream of data as a useful service is a nontrivial task. Programmers need to understand complicated web map API and to manage the acquisition, archiving, indexing, and displaying of data. Second, existing applications are mutually incompatible. One cannot bring up a single map that shows both the housing information and crime rates in an area. Third, existing solutions do not provide basic useful functionality such as querying live sensors based on location or aggregating results from a number of sensors in a useful manner.

The SenseWeb project at Microsoft Research aims to address these challenges by providing a research web portal (SensorMap) and a set of tools for data owners to *easily* publish their data and users to make useful queries over the live data sources. SensorMap allows data owners to make their data available on the map. The platform also transparently provides mechanisms to archive and index data, to process queries, to aggregate and present results on geo-centric web interfaces such as Windows Live Local, etc. We believe that such a platform will encourage the community to publish more live data on web and users to build useful services on top of it.

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2. SenseWeb Architecture

The SenseWeb platform consists of the following four components (Figure 1): a *GeoDB* indexes the data so that it can be queried efficiently, the *DataHub* web service provides an interface for sensor registration and archiving of real-time sensor data, an *aggregator* aggregates clusters of sensors and summarizes sensor group data in useful ways, and the *SensorMap* GUI that lets users query data sources and view results on the map.

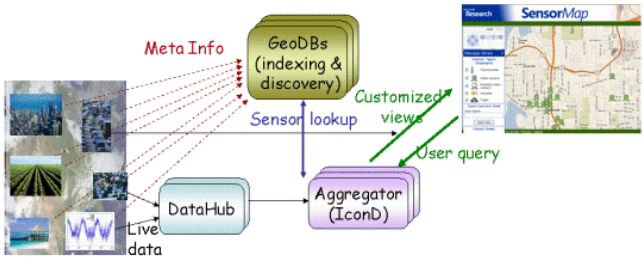

Figure 1.SensorMap Architecture.

GeoDB. GeoDB is a database housing sensor metadata. The metadata includes information such as publisher name, sensor location, sensor name, sensor type, data type, unit, sensor data access methods, and free text descriptions. We envision that typical user queries will be based on sensor types, descriptive keywords, and geographic locations, such as list of all cameras along a route or average temperature reported by all the thermometers inside a geographic region, etc. To efficiently support these types of queries, GeoDB indexes data by using hierarchical triangular mesh (HTM) indexing scheme [2] which is particularly suitable for geographic queries. The indexing is implemented as user defined functions in SQL server.

DataHub. There are basically two ways to make real-time data available on SensorMap. For sensors that provide public web interfaces, they can register their URL directly to GeoDB. These URLs are used by the SensorMap client to fetch real-time data. For sensors with Internet connection but no URL, the DataHub web service provides a simple interface to cache sensor data. The sensors are clients for the DataHub web service, and can send in real-time data using standard web service calls. The Aggregator or the SensorMap client can retrieve these data.

Aggregator. The aggregator creates icons representing sensor data that can be mashed up with maps. Depending on the sensor type, an aggregator can reside either on the client side or on the server side. It accepts queries from the client and redirects the geographic components of the queries to the GeoDB. After obtaining the metadata of a set of sensors that satisfy a client query, it contacts the sensors for their real-time data. It then aggregates the data accordingly (e.g., depending on the zoom level of the underlying map shown to the client). By doing so, SenseWeb provides useful summarization of data to the client. The particular aggregation performed by the aggregator depends on sensor types. For example, an average of the temperatures in a neighborhood can be displayed for data collected from thermometers.

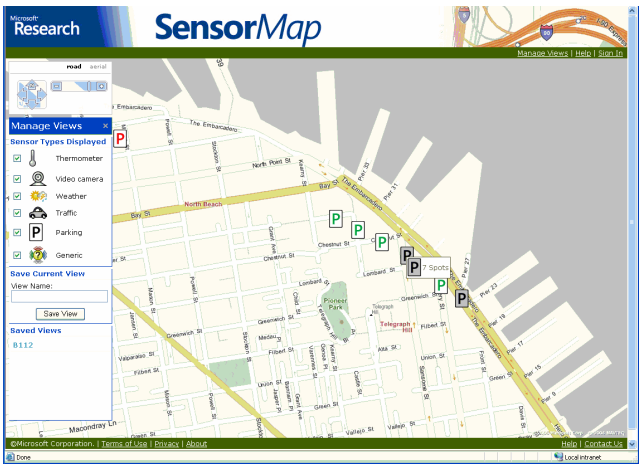

Figure 2. SensorMap interface for parking sensors

SensorMap GUI. This web interface lets end-users to pose queries by drawing geometric shapes (e.g., a region, a route) and by specifying keywords and sensor types. It overlays the results returned from the aggregator on Windows Live Local. Note that the GeoDB and the Aggregator are transparent to both the data publishers and users. The interface also allows users to save views (geographical region, sensor type filters, etc.) on the client machine as cookies, which can be quickly retrieved later. Figure 2 shows an interfacing showing street parking data in part of San Francisco[1].

3. Demonstration Scenarios

We will demonstrate both the SensorMap interface and the mechanism for data owners to publisher their data.

On the data publisher side, we will show two publishing mechanisms:

- We use a small sensor network consists of T-Mote Sky and a PC microserver running MSR Sense[2] to show how to use the DataHub web service interface.
- If IP configuration permits, we will demonstrate how SenseWeb can directly access URL-enabled sensors. We also show how a third party collaborator can sign into sensor map and add their web-ready sensors directly through the sensormap web interface.

On the user side, we will show how an end user queries the data sources based on keywords, sensor types, and geographic regions or routes and how the data get displayed over Windows Live Local. We will show how the live data from different sources get clustered and aggregated as the end user changes the zoom level of the map in Windows Live Local.

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[1] Street parking data is published by Streetline Networks, Inc.
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