Manage the Data from Indoor Spaces: Models, Indexes & Query Processing

Huan Li

Database Laboratory, Zhejiang University

lihuancs@zju.edu.cn

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Overview

Aims

- To give a brief review introduction to *indoor data management techniques*.
- To review a series of works in this field, including their proposed *models*, *indexes* and *algorithms*.
- To discuss how to bring those advanced theoretical contents into practice.

The Great Indoors

- Research on data management with an outdoor setting provides part of an enabling foundation for growing LBS industry.
  - objects may move in *Euclidean space* (possibly constrained).
  - or some form of spatial network.
  - GPS or GPS-like positioning is assumed explicitly or implicitly.
- People lead large parts of their lives in indoor spaces.
  - London Heathrow Airport, 180,000 passengers daily.
  - Tokyo Subway, 8.7 million passenger rides daily in 2008.
  - ...
- Indoor differs from outdoor in important ways, thus calls for new research.

Indoor Vs. Outdoor

- To provide a wide range of indoor location-based services akin to those enabled by GPS-based positioning in outdoor settings.
- Symbolic models rather than geometric models are often used for modeling indoor spaces [3].
  - indoor entities like rooms and hallways enable as well as constrain movement
  - uses may be positioned in terms of the discrete indoor entities rather than use coordinates (lat, lon)
  - conventional Euclidean distance is not generally applicable in indoor spaces
  - indoor space can be modeled using a graph model to indicate accessibility between locations
- Proximity-based indoor positioning differs fundamentally from GPS-like positioning
  - proximity analysis [1] are unable to report velocities or accurate locations
  - an object is detected when it enters the activation range of a positioning device
  - deployment graph is created that captures the deployment of positioning devices

Example Ongoing Research

The goal of **indoor tracking** is to capture the position of an object at any time in time. By exploiting the floor plan, the deployment graph, and maximum speeds limit, it is possible to minimize the possible region(s) an object can be at a particular time.

Due to the discrete nature of indoor space, hashing may be applied for **indoor indexing**.

- Map devices to the active objects in their ranges
- Map cells to the deterministic objects they contain
- Map cells to the non-deterministic objects they contain
- Map objects to the cell or cells they are or can be located in

It is interesting to extend the R-tree to index large volumes of historical indoor tracking data.

Research Directions

1. to integrate different types of positioning technologies in order to improve positioning accuracy
2. to integrate with outdoor positioning to enable services that cross the indoor/outdoor boundary
3. to accommodate distances in indoor models that enables distance-aware queries for security and social-network applications
4. to mine patterns or association rules on large volumes of real tracking data
5. to consider more advanced models of object movement, e.g., probabilistic analysis
6. to develop benchmarks for indoor moving object data management

Brought up by Christian S. Jensen and Hua Lu in year 2010 [2].

References

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The End. Thanks :)