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

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Overview

Aims

- To give a brief review of *indoor data management techniques*.
- To introduce 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.

About This Work...

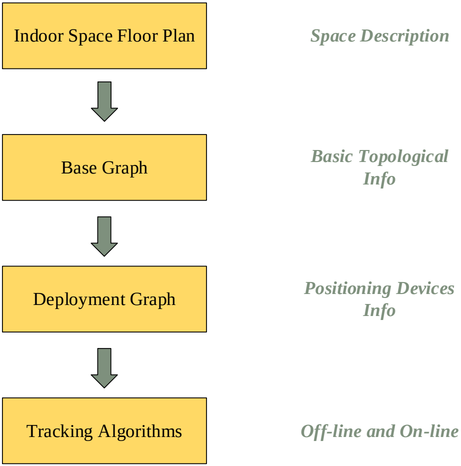
Graph Model Based Indoor Tracking. [2]
C. S. Jensen, H. Lu, and B. Yang.

- Published in year 2009, *MDM* conference.
- A pioneering work that introduces base graph model to indoor data management.
- Detailed tracking algorithms are designed for RFID-based positioning.
- Easy to understand, with comprehensive concepts.

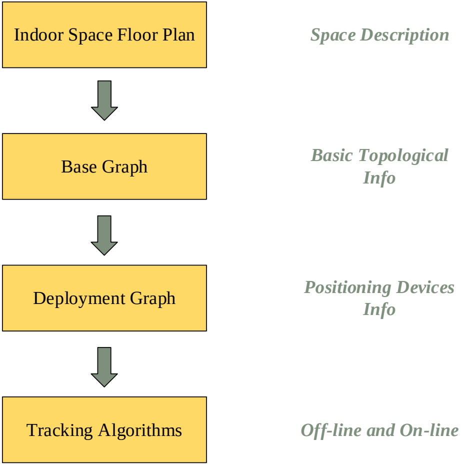
Motivation

- We are spending most of our time in indoor spaces
  - Office building, University, Shopping Centers, etc.
- We cannot use GPS-based tracking indoor movements
  - Indoor navigation and route guidance (museum)
  - Flow analysis
    - how do people use the indoor space $\rightarrow$ important in pricing of advertisement space in store rental
- We can use other technology...
  - Wi-Fi, Infrared, Bluetooth or RFID
  - This paper is focusing on RFID, since it is now mature and effortless
  - RFID tags are cheap and RFID reader are expensive

Idea


Indoor Space Floor Plan
Space Description
Base Graph
Basic Topological Info
Deployment Graph
Positioning Devices Info
Tracking Algorithms
Off-line and On-line

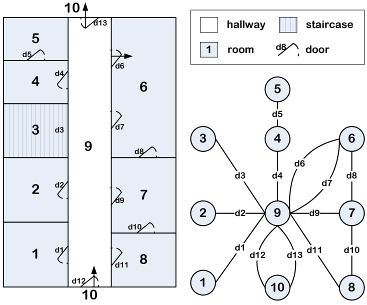
Idea



Goal: Improve indoor tracking accuracy from a data management perspective, to capture where a particular object can be at a particular time.

Base Graph Model

By capturing the essential connectivity and accessibility, **Base Graph** describes the topology of a floor plan of a possibly complex indoor space.



(a) Floor Plan (b) Connectivity Base Graph

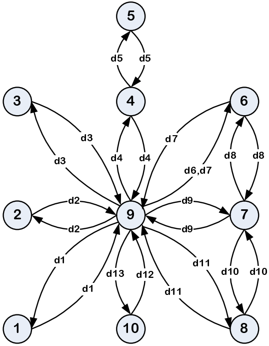
Connectivity Base Graph

a labeled, undirected graph.

- $G_{conn} = \{V, E_d, \Sigma_{door}\}$
- V: each separate partition is represented as a vertex
- E_d: each door is captured as an edge
- Σ_{door}: a set of edge labels that represent connections

Base Graph Model

Accessibility Graph is constructed to represent the movement permitted by doors or connections.



Accessibility Graph

a labeled, directed graph.

- $G_{accs} = \{V, E, \Sigma_{door}, l_e\}$
- V: the set of vertices
- E: the set of directed edges, i.e., $E = \{\langle v_i, v_j \rangle | v_i, v_j \in V \wedge v_i \neq v_j\}$
- l_e: a function that maps edges to subsets of the set of doors, i.e., $l_e : E \rightarrow 2^{\Sigma_{door}}$

Base Graph Model

In addition to the topological information of a floor plan, its geometrical information should also be captured.

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The *Doors Mapping* is defined as:

Base Graph Model

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The *Building Partitions Mapping* is defined as:

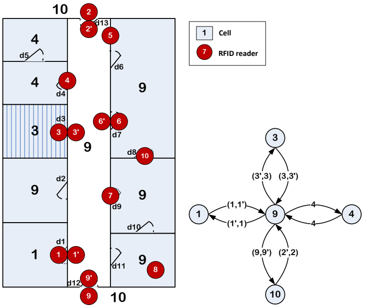
$$BuildingPartitions : V \rightarrow Ploygons \quad (1)$$

The *Doors Mapping* is defined as:

$$Doors : \Sigma_{door} \rightarrow Line\ Segments \quad (2)$$

RFID Deployment Graph Model

In RFID technology, the readers are embedded in the indoor space in known positions and the tags are associated with the moving objects.



(a) Readers Deployment (b) Readers Deployment Graph

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Motivation

Scalable Continuous Range Monitoring of Moving Objects in Symbolic Indoor Space. [3]

Probabilistic Threshold k Nearest Neighbor Queries over Moving Objects in Symbolic Indoor Space

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Spatio-temporal Joins on Symbolic Indoor Tracking Data

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A Foundation for Efficient Indoor Distance-aware Query Processing

A Foundation for Efficient Indoor Distance-aware Query Processing. [1]

Efficient Distance-aware Query Evaluation on Indoor Moving Objects

Efficient Distance-aware Query Evaluation on Indoor Moving Objects. [2]

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The End. Thanks :)