Crowd learning for indoor positioning

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Overview

➡ About indoo.rs
➡ Current solution
➡ Crowd learning
➡ Summary & Outlook
The best indoor blue dot you can find!
What indoo.rs does

- **NAVIGATION**
  - Real-time positioning inside
  - Waypoint routing
  - Multi-floor navigation

- **PROXIMITY MARKETING**
  - Geo-fencing
  - Location-based notifications & offers
  - Interaction with customers

- **ANALYTICS**
  - Behavior data – dwell time
  - Foot-flow patterns
  - Heatmaps
Solution

iBeacon, WiFi & Measurements

Mobile SDK
iOS & Android

Cloud Services

Interactor Management Platform
The `indoors.rs` way

- Enables indoor location awareness
- Flexible and developer friendly
Areas of Application

- Manufacturing
- Mobile Games
- Events
- Museums
- Public Safety
- Social e-Commerce
- Enterprise
- Travel
- Retail
- Entertainment

✓ Numerous projects successfully deployed
✓ From simple proximity notifications to full navigation in large multi-story buildings
Example projects

✓ **Transport**
  Navigation for visually impaired (terminal 2)

✓ **Retail**
  Indoor navigation in several shopping malls

✓ **Museums**
  Tour guide through main exhibitions in Vienna museum of modern art

✓ **Events**
  Indoor navigation at largest furniture trade show in the world
Current solution

SLAM Engine
Localization - core technology

RADIO FINGERPRINTING

✓ **Fingerprints**: set \{source: RSSI\}
  ➡ WiFi or Bluetooth (beacons)

✓ **Reference map**
  ➡ Fingerprints at known points

✓ **Estimate location**
  ➡ Measure live fingerprints
  ➡ Find most similar references
  ➡ Interpolate positions

✓ Typical error 5-10m
✓ With *indoo.rs* processing 1-5m
Creating radio maps

✓ CREATION
➡ Collect large number of point measurements
➡ Very labor intensive - (shopping mall - few days work)

✓ USAGE
➡ Local db cloned from cloud before localization

✓ UPDATE
➡ Typically 6 months map lifetime
➡ Environment & infrastructure changes over time
➡ Often require full new measurement
Simultaneous Mapping And Localization (SLAM)

✓ **SLAM Engine™**
  ➡ Path recordings replace point measurements
  ➡ 10x faster measurements
  ➡ Able to do partial updates
  ➡ Improved localization

✓ **Only first step**
  ➡ Still uses dedicated recordings instead of data from navigating users
  ➡ Computationally intensive
Collect scans while walking
SLAM [2/4] (mobile)

Estimate path from steps & position
Use SLAM to improve path
SLAM [4/4] (cloud)

Interpolate scan points to map fingerprints
Crowd learning

Next generation SLAM
SLAM Crowd Engine

Computation Framework
- Combiner
- SLAM, Context, ...
- Input

Data stores
- Refined data
- Crowdsourced

Analytics
- Map-reduce
- Web interface

Crowdsourcing terminal
- WiFi
- iBeacon
- BLE

Client

Analyst
Crowd learning

✓ CROWD DATA
  ➡ Avoids dedicated recordings
  ➡ Quantity compensates for quality

✓ CONTINUOUS DATA
  ➡ Raw data (HBase, HDFS)
  ➡ Refined data (PostgreSQL)
  ➡ Enables streaming - real-time analytics

✓ MULTI PATH SLAM
  ➡ Paths learn from each other
  ➡ Better accuracy!
  ➡ Scalable algorithm
Scalable SLAM

✓ **JOB** - recordings → radio map
  ➤ Parallel per building

✓ **SEGMENTATION**
  ➤ By floors, durations & pauses
  ➤ Parallel per recording

✓ **SLAM** - Improve radio scan positioning

✓ **INTERPOLATE** - Move scans to grid
  ➤ Merge results of other jobs
  ➤ Parallel per transmitter

✓ **Output**
  ➤ RSSI for transmitters at each fingerprint reference point

✓ **Feedback loop**
Analytics

✓ Raw crowd data - mobile input
  ➡ Positions, steps, contexts, sensor, radio

✓ Refined data - cloud calculation output
  ➡ Beacon positions, trajectories, dwell times, radio maps, contexts, clustering

✓ Summary data - streaming output
  ➡ Occupancy, crowding, congestion

✓ Data access layer - hides raw data
  ➡ Refined data export
  ➡ Raw data usable with ad hoc queries
  ➡ Interactive visual analytics tool

Dwell time heat map
Analytics

Transition map through trajectory clustering
Summary

✓ indoor.rs enables indoor location awareness in apps
✓ Many successful deployments around the world
✓ SLAM Engine 10x faster fingerprinting!
  ➡ In active use today
✓ Crowd Learning takes SLAM to the next level
  ➡ Use “free” crowd data instead of dedicated recordings
  ➡ Enables advanced analytics - new products!
  ➡ Requires big data tools to scale
    ➡ Only made possible because of open source tools
Outlook

✓ Just getting started with big data / processing
  ➡ Still determining optimal tool chain

✓ Crowd data mapping
  ➡ Very promising for radio data
  ➡ Other mappings also possible (magnetic, contexts, sensors …)

✓ Analytics
  ➡ Not limited to positions (contexts, sensors, beacons, …)
  ➡ Need custom big data queries to go beyond basic visualization

✓ Data usage
  ➡ Challenging to provide easy and secure access
  ➡ Connections to other geospatial data very exciting!
  ➡ Requires open formats/standards/tools!
Thanks for listening!

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