Indoor Navigation and the Conferest Demo App

Dept. of Navigation and Positioning
Finnish Geospatial Research Institute
National Land Survey of Finland
The Finnish Geospatial Research Institute

- Governmental research institute
- About 120 staff (roughly 80 scientists)
- Budget roughly 10 MEUR (mostly outside financed)
- Highly academic institute (nearly 50% staff has PhD and 20% are international)

- Publish around 80 ISI Web of Science peer reviewed articles annually (150 peer reviewed scientific publications)
- Joint professorships with universities
Department of Navigation and Positioning

- Current staff: 23, with 9 PhDs
- Three research groups:
  - Satellite and Radio Navigation (SaRaNa)
  - Sensors and Indoor Navigation (SINa)
  - Intelligent Mobility and Geospatial Computing (IMGC)
- A navigation laboratory with state-of-the-art equipment (signal simulators, roof antennas, repeaters, receivers and sensors)
Expertise areas of the Department

**Satellite navigation**
- GPS, GLONASS, BeiDou, Galileo, IRNSS
- SBAS systems, especially EGNOS
- Interference detection and mitigation
- Software-defined GNSS receivers
- PPP & RTK

**Indoor navigation**
- Sensor integration
- Indoor positioning
- Visual and DTV positioning
- Optical sensors

**LBS and contextual thinking**
- Motion recognition, context awareness
- Positioning in intelligent transportation systems
- Positioning for maritime
Why do we need indoor navigation?

- People spend 90% of their time indoors (https://indoor.lbl.gov/sites/all/files/lbnl-47713.pdf)
- Consumers need navigation in
  - Conferences, malls, hospitals, parking halls…
- Location based services

![Graph showing market growth from 2014 to 2018 with a peak of 2800 M€ in 2018]
Challenges in indoor navigation

- Satellite-based positioning is not always feasible indoors.
  - Signals attenuate while they travel through constructions
  - Signals experience multipath when reflecting/scattering off constructions

The resulting position solution is degraded or not available at all
Conferest application at FIGWW2017

- Positioning everywhere within the conference premises
- Based on HERE’s indoor positioning system using WLAN signals
- Routing for the exhibitor area developed by FGI
- Works only for Android due to Apple’s decision not to open the WLAN measurements via any public API
Conferest layout and routing

- The exhibitor booths are laid over the HERE Venue map

- Routing is based on the Lee algorithm
Lee’s routing algorithm

- Lee’s algorithm is one solution to the Maze routing problem
- Routing surface is represented by a 2D array
- Finds a sequence of adjacent cells from point A (user’s location) to point B (desired destination)
- If a path exists, it is eventually found:
  - The algorithm ensures the selected route is the shortest.
  - In practice, however, there might be some implementation challenges due to the booth overlaying on the venue map
- Time and memory complexities $O(N^2)$ for a $NxN$ grid
  - Performs well in a restricted area, but can suffer in larger areas.
WLAN positioning

Two phases:

- Training phase: The prevailing signal environment mapped and modeled
- Positioning phase: User position is estimated based on the observed signals and using the model

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<th>$x_1, y_1$</th>
<th>RSSI1, RSSI2, ...</th>
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<td>$x_n, y_n$</td>
<td>RSSI1, RSSI2, ...</td>
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Training Data $\rightarrow$ Model $\rightarrow$ Observations $\rightarrow$ Location Estimate

$\text{RSSI1, RSSI2, ...}$

$\text{Observations}$

$\text{Location Estimate}$
HERE’s positioning system

- HERE’s positioning system is robust despite:
  - minor infrastructure changes (e.g. moving radio beacons) and
  - people moving in the environment
- Accuracy 3-5 meters
- Functions also with Bluetooth beacons
  - With beacons, Apple devices can be used also
  - Accuracy 2-3 meters
Give your feedback

- Please let us know what you think of the application and fill the feedback form
- sed for further research
More information on our website

www.fgi.fi

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Thank you!