Enhancing mobile crowd-sensing for indoor space characterization (WiFi monitoring)

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Motivation

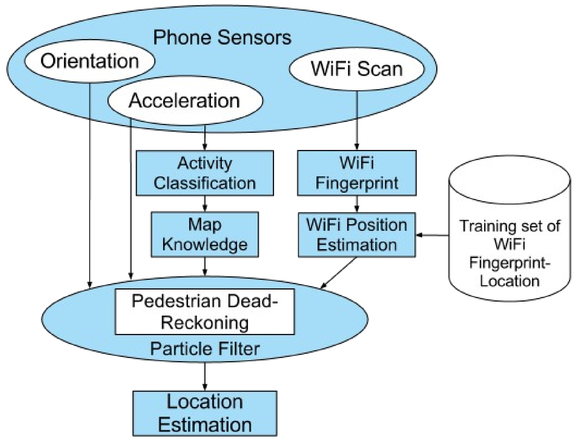
Smartphones come equipped with a variety of sensors that can be utilized to monitor different aspects of the environment. With the widespread of smartphones, the task of sensing the environment can be laid on multiple users for continuous crowd-sourced data collection. As a case study, this work focuses on monitoring the WiFi environment.

WiFi in indoor environments exhibits spatio-temporal variations in terms of coverage and interference in typical deployments with multiple APs. Network administrators can use this information to adapt the WLAN deployment in order to match the user expectations.

Challenges

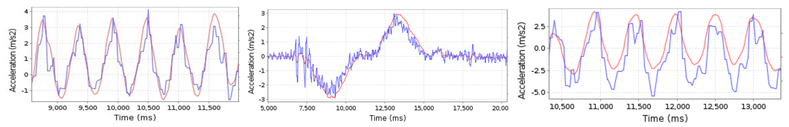
- Location indexing
- Security perception

Localization



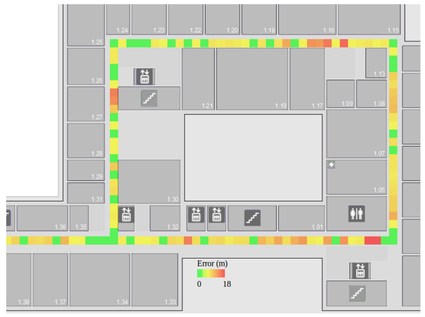
Dead Reckoning assisted by WiFi

- **Dead Reckoning**
  - exploit built-in smartphone sensors like accelerometer and compass for continuous tracking [1].
  - error accumulation needs occasional fix from anchor points: activity recognition and map-matching.



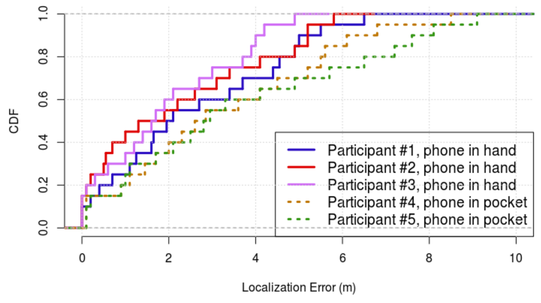
walking *elevator* *stairs*

- **WiFi Fingerprinting**
  - more energy required for WiFi scans.
  - spatial differences of the location estimation accuracy due to environmental conditions (building structure and radio propagation effects)



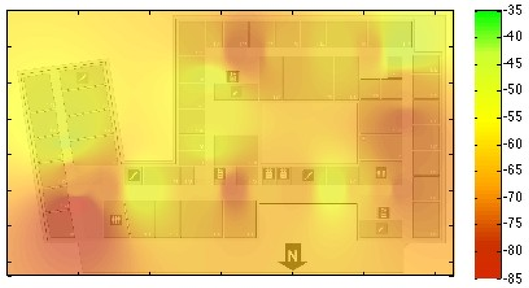
- **Particle filter**
  - weights are adjusted in the particle filter according to the confidence of the activity classification, compass deviation, distance estimation and WiFi fingerprinting estimation accuracy.

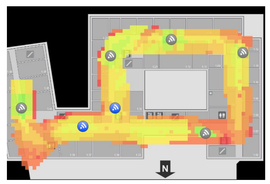
Results



Crowd-sourcing

Users moving freely with their daily activities inside the building collect data that is annotated with the time and location to be merged on the server.





WiFi site survey, comparison with Ekahau

Future work and Conclusions

Smartphone sensors like barometer, light sensor and thermometer can be exploited to create other maps that would help to improve the energy efficiency of indoor spaces. Through Bluetooth and RFID data from other low power sensors can be collected and uploaded to a server. All these make smartphones an ideal tool for ubiquitous sensing.

Security

People are naturally concerned about their location being tracked. Understanding how their concern can be overcome would bring great benefits to such crowd-sourced data collection systems. Some of the key aspects:

- system security (both on the phone and on the server).
- data protection. Only users should have access to their own data with permanent removal option.
- user privacy. Solutions: random identifiers associated to users or data strip of personal information on the server.
- secure incentives. Users should see the final map with no implications on the privacy of other users.

References

[1] D. Gusenbauer, C. Isert, and J. Krsche. "*Self-Contained Indoor Positioning on Off-the-Shelf Mobile Devices*". In IEEE IPIN 2010.