A Locally Limited Indoor Location-Based Service for Privacy-Aware Location Sharing

Bachelor's Thesis
Lukas Murmann
Thursday, October 20, 2011
Abstract

At the VMI group since March - What are my results

MMensa  Ubiversity  Field Study  Thesis
Outline

• Problem Domain  LBS Outdoors and Indoors

• Ubiversity  Indoor Location Sharing

• Field Study  Goal, Execution, Results

• Conclusion

• Q&A
Related Location-Sharing Services

Foursquare
- Gamification
- Checkin only

Facebook Places
- Checkin
- Social

Google Latitude
- Continuous tracking
- Location History
- Now also: Checkin
Common Building Blocks of Outdoor LBSs

Mapping

- Google Maps
- OpenStreetMap

Localization

- Cell Towers
- GPS
- WiFi

Places of Interest

- Google Places
- Many POI databases (Cafés, Restaurants, ...)

Images: office.com
No Building Blocks Available For Indoor Services

Mapping
- Google Maps
- OpenStreetMap

Localization
- Cell Towers
- GPS
- WiFi

Places of Interest
- Google Places
- Many more Geocoders

→ There is a need for reusable indoor service building blocks
General Architecture

Android Clients

User Interaction
Maps
Lists
Manual Checkin

Sensors
WiFi
NFC
QR-Code

Django Backend

POI Data
Rooms
Buildings
Fingerprint DB

Social Data
Accounts
Friend Lists
Permissions

Sources: office.com, djangoproject.com, android.com, python.org
Checkin-Based Self-Training Localization

**Online Training**
1. Manual Checkin at POI
2. Send WiFi Fingerprint to Server
3. Server stores (POI, FP) tuple

**Localization**
1. Send WiFi Fingerprint to Server
2. Server calculates similarity to reference fingerprints
3. List of most probable POIs is returned

→ No need for initial training phase
→ Outdated training data gets continuously updated
→ Deployable wherever enough WiFi APs exist
Mapping Tool

- User Locates three Pins
- Tool solves linear equation
- Calculates Map Tile's
  - Translation
  - Rotation

- On Device: Combine several tiles to a single map
Ubiversity's most important POIs are TUM rooms

- Read Room Data from TUMOnline (25,000+ Rooms)
- Store most important data locally on device
- Synchronize full data set on server

- Django → SQLite export tool exists.
- Make RoomDB available as Android Content Provider
The Ubiversity App Showcases those Building Blocks

See Friend's Checkins

Check In at TUM

Combined Map View

A Locally Limited Indoor Location-Based Service for Privacy-Aware Location Sharing – Lukas Murmann
The Field Study

Does a local web service like Ubiversity have a less severe privacy impact than global, commercial services?

Pre Survey
Questions on experience with related services

Test Phase
Participants used Ubiversity for 2-3 weeks

Post Survey
What was the perceived value? Were there privacy implications?

Interviews
Personal interviews with selected participants
Study Evaluation

Location-Sharing may be even more useful in single-campus deployments
• Short distances

Location sharing has high dependency on network effects
• Challenge for both, field study and real product

Very positive feedback regarding privacy impact
• No commercial use
• Local scope
• Less connectedness

→ Interviews and post survey suggest that users feel less reluctant to share location information on a platform with smaller scale.
Conclusion

Contributions by this work

Reusable components for indoor LBS
Privacy-aware location sharing on campus
Field study on possible barriers for LBS adoption

→ Thank you for your attention
A Locally Limited Indoor Location-Based Service for Privacy-Aware Location Sharing – Lukas Murmann
User study concluded

Saturday, September 10 2011 - Lukas Murmann

After approximately one month of online time, the Ubiversity user study has now come to an end.
I would like to thank all participants of the study. Your feedback has been a valuable contribution to my thesis which I should now be able to finish during the next weeks.

This site will soon receive some updates and layout changes and become archive and documentation of the Ubiversity-App and my thesis work in general.

v1.0 - User Study

Wednesday, August 3 2011 - Lukas Murmann
MMensa App Contributed to VMI Mensa

A Locally Limited Indoor Location-Based Service for Privacy-Aware Location Sharing – Lukas Murmann
Localization Algorithm in Pseudo Code

```c
struct RssiTuple{
    string mac_addr
    int rssi
}

float calculateSimilarity(List<RssiTuple> fp_a, List<RssiTuple> fp_b) {
    float similarity = 0.0

    foreach mac_addr that appears in both fingerprints {
        rssi_a = rssi of mac_addr in fp_a
        rssi_b = rssi of mac_addr in fp_b

        distance = abs(rssi_a - rssi_b)

        if(distance == 0)
            similarity += 2.0
        else
            similarity += 1 / distance
    }
    return similarity
}
```