Ubiquitous and Mobile Computing
CS 403x: Automatically Characterizing Places with Opportunistic CrowdSensing using Smartphones

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Problem Statement

- Traditional location sensing systems only make use of WiFi and GPS
- The error in GPS-, GSM-, or WiFi-based location estimates often ranges between 10 and 400 meters
- 426 of the 1,241 place visits incorrectly reported based on the location estimate
Introducing CSP

- CSP - CrowdSense@Place
- Interpretation of a location from Location Sensor to user - as a place
- Framework that exploits sensors that most phone’s have
- Smartly capture images and audio clips from smartphones
- Goal is to link place visits to various place categories
Current Approach

- Place-discovery techniques these days:
  - Exploit large-scale data collections, like point-of-interest databases (Google) to allocate place descriptors
Related Work

- Bing, Yelp
- Facebook, Twitter, FourSquare
- CenceMe - Similar application but doesn’t infer from images
- SenseCam - Goal to understand user’s environment
- VibN - Identifies points of interest in the city
How is CSP different?

- CrowdSense@Place - Place classification based on existing methods to perform place segmentation
Overview

- Smartphone Application
  - Sensing and Data Collection
  - Privacy Settings

- Offline server-side processing
  - Processing and Location Detection
Data Collection

- Audio detection
  - “Do you have a Large size of these pants?”

- Pictures of objects

- Written Texts
Methodology
Smartphone Client

- Place Segmentation - WiFi fingerprinting and GPS to discover places
- Sensor Sampling - Simple heuristic to improve quality of data collected
- Privacy - Data resides on device for 24 hours
Sensor Data Classifiers

- Optical Character Recognition (OCR)
- Indoor Scene Classification
- Objects Recognition
- Speech Recognition
- Sound Classification
Place Modeling

- Data preprocessing
  - Classifier Terms
  - Mobility Terms
- Place Categorization
Results - Classifiers

- Indoor scene classification (GIST features) has the largest impact
- OCR does not have a strong overall effect
- Object detection, speech recognition, and sound classification had major effects

Figure 6. Accuracy of different classifiers used by isolation.
Results - Location Accuracy

- 69% Accuracy
- CSP outperforms GPS and Mobility by around 22% to 40%
- Mobility has 44% accuracy for workplace and 52% for college while CSP has 80% and 71% respectively
Applications of CSP

- Enhanced Local Search & Recommendations
- Rich Crowdsourced Point-of-Interest Category Maps
- Understanding City-scale Behavior Patterns
Limitations and Future Work

- Finer Place Categorization
- Privacy
- Activity vs. Place Category
- Energy Issues
Conclusions

- 36 person study
- Seven-weeks total
- 1241 places on 5 locations
- Average accuracy of 69%
What we liked/disliked about the paper?

Likes:
- Graphs and tabulated data findings
- The intensive study conducted
- Limitations and issues considered

Dislikes:
- Doesn’t address privacy concerns appropriately
Questions
References