A Framework for Navigating with Map Signboards on Smartphones Using Basic and Advanced Image Geocoding Methods

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Introduction

- Nowadays, as cities are growing bigger and bigger, the spatial environments in the cities has become more and more complex. People rely more and more on map services to travel in the cities.

http://img.niuzhu.com//upload/2011/05/13/10/625625535_1291607834QZO7.jpg/

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Widely used maps

- Mobile Maps

Google Map

Apple Map

- Map Signboards

- Others…

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Comparison of mobile maps and map signboards

		Mobile Maps	Map Signboards
Coverage Areas	★	Large	Small
Topic		General	★ Thematic
LBS	★	Positioning, directing, searching, and so on	YOU ARE HERE
Style		Placeless	★ Diverse

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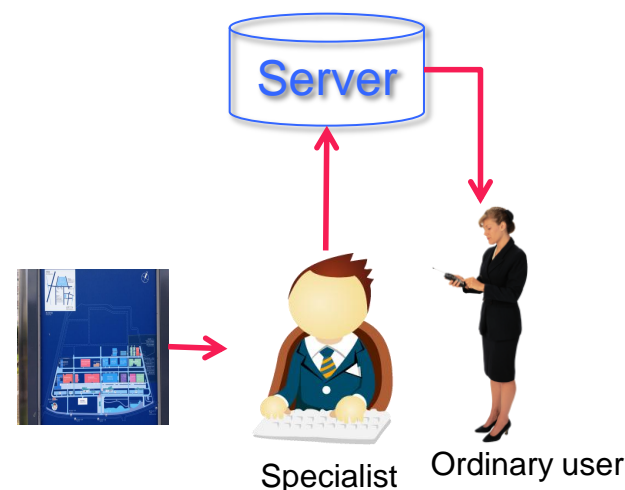# Combine the map signboards with web maps on smartphones
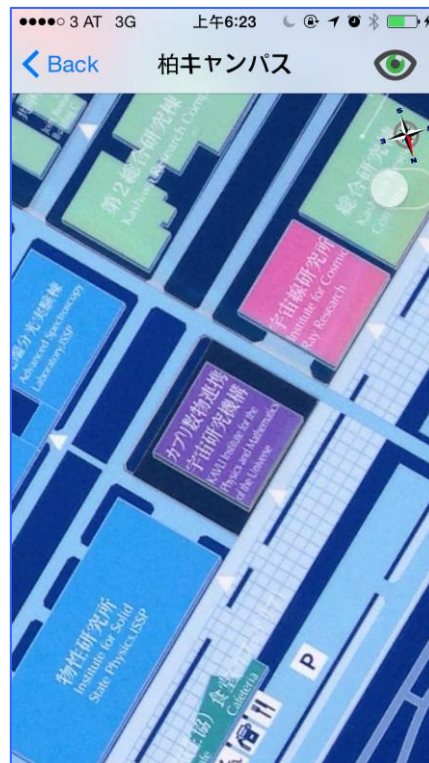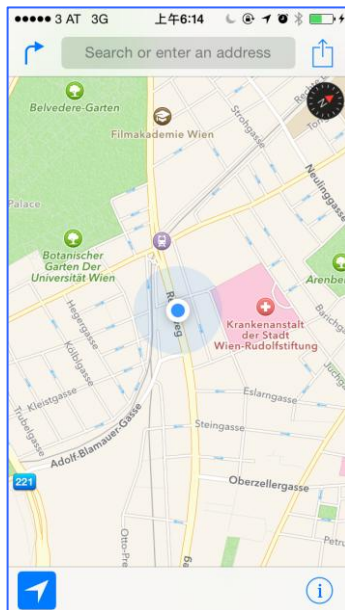
Related Works

- Schöning et al. (2009), Wang et al. (2012) ,
  Lu and Arikawa (2013, 2013 and 2014), and so on.
- Common point: mainly use points as spatial references to calculate the positions on distorted map images.
- Some problems are:
  - *Difficulty* in making point-based geocode by ordinary users;
  - Map images are *not aligned*;
 - Positioning *accuracy* is not high and stable.

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Framework of *two levels* in image geocoding

- Basic and advanced image geocoding are used for different situations.

- Basic geocoding uses points as references to calculate positions. It is easy for users to operate, but the accuracy of the positioning results are limited.

- Advanced geocoding use polylines as references. It provides accurate positioning results. It's difficult for ordinary users to make the advanced geocoding. Users are supposed to download the geocoded map made by specialists.

Server

Specialist   Ordinary user

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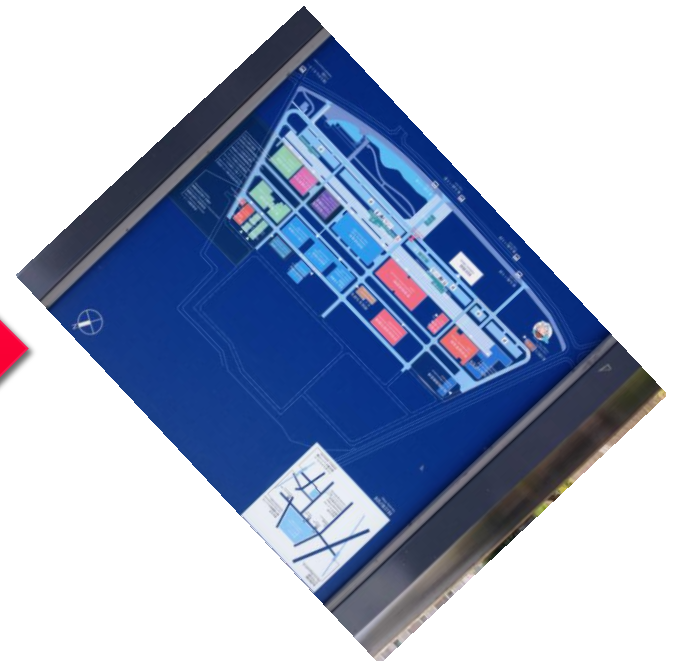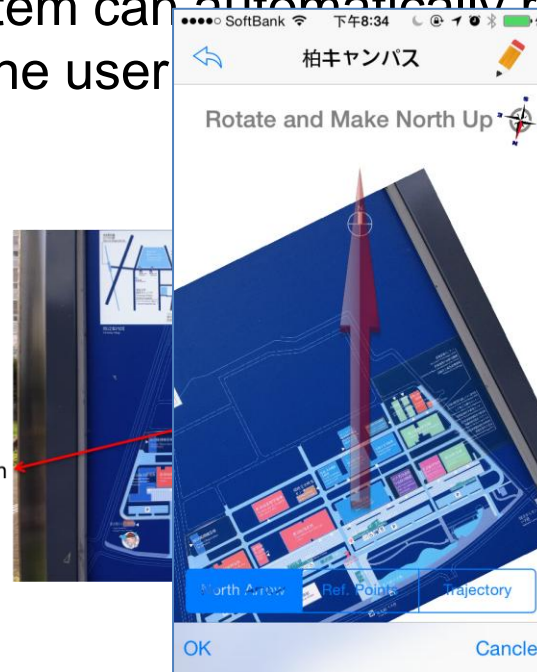Center for Spatial Information Science The University of Tokyo

Basic Image geocoding

- Align the direction of the map
  - Rotate the north arrow on the map to the up direction.
  - Then the system can automatically rotate the map to align it according to the user's direction.
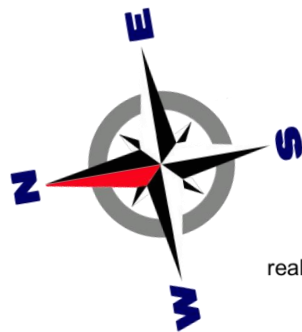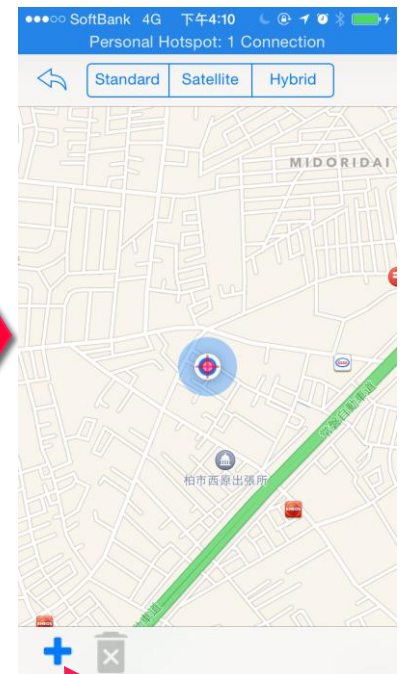
Basic Image Geocoding

- Add reference points
  - Add by GPS
  - Add on web maps
  - Add by matching trajectory
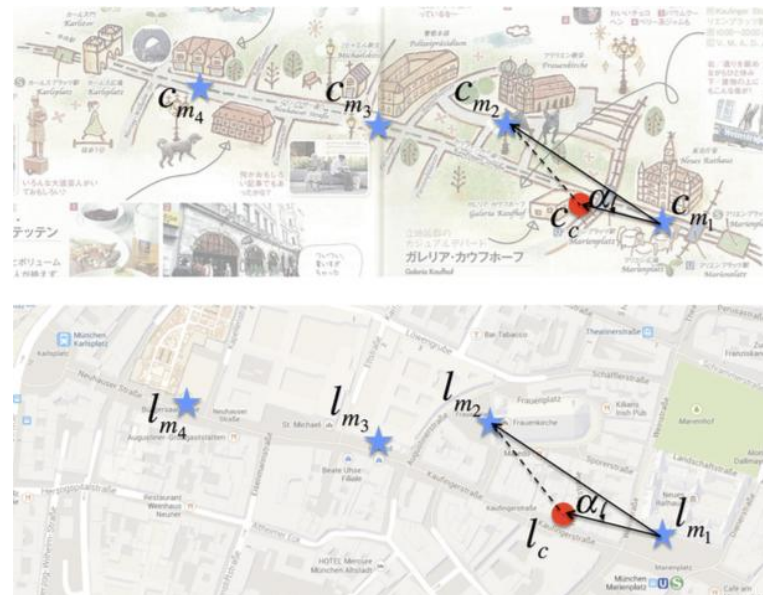

1. Add ref. point on image

2. Add GPS location on the base map

Basic Image Geocoding

- Calculate positions on the map signboard image.
 - We refer to the two point mapping algorithm from Lu and Arikawa (2014)

$$\frac{Dist\left(c_{m_1}, c_c\right)}{Dist\left(c_{m_1}, c_{m_2}\right)} = \frac{Dist\left(l_{m_1}, l_c\right)}{Dist\left(l_{m_1}, l_{m_2}\right)}$$

M Lu and M Arikawa (2014) Walking on a Guidebook with GPS: a Framework Geo-enabling Pages with Illustrated Maps in LBS. Principle and Application Progress in Location-Based Services Lecture Notes in Geoinformation and Cartography 2014: 243-264
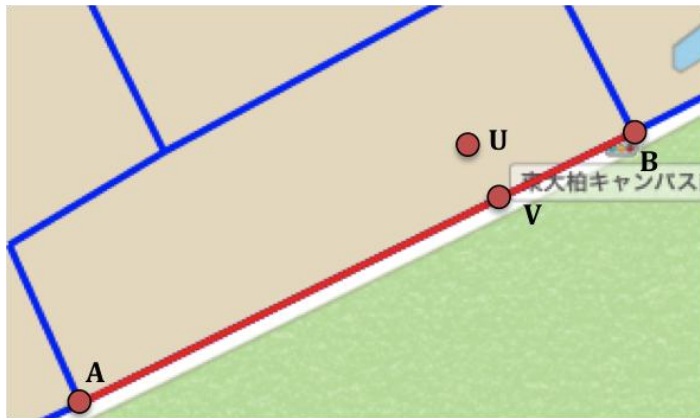
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Advanced Image Geocoding
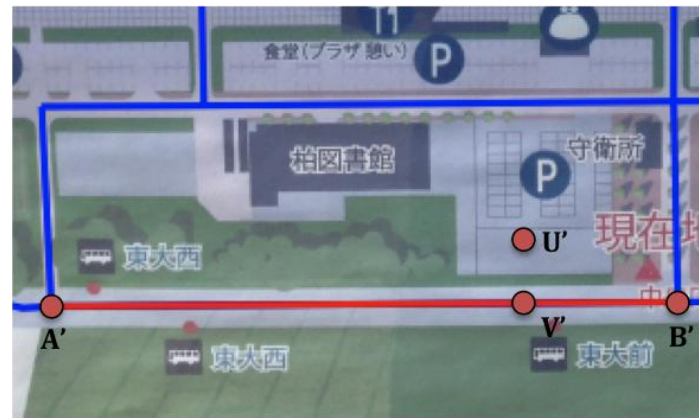
- Add reference polylines
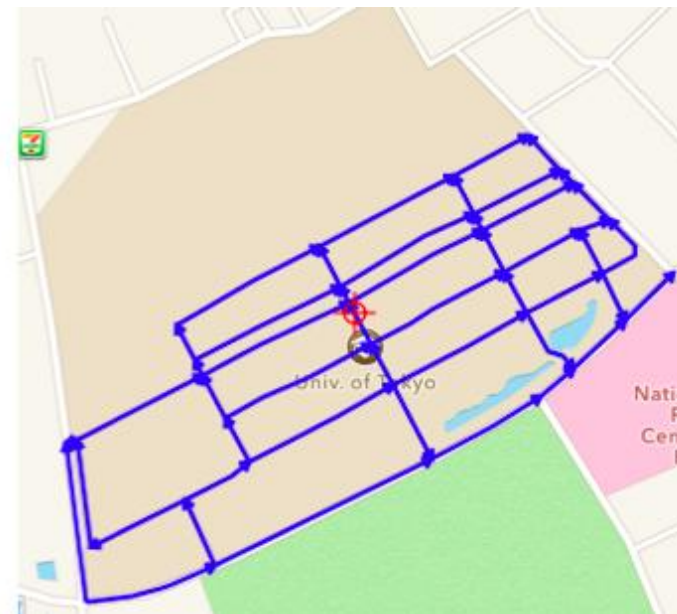
Advanced Image Geocoding

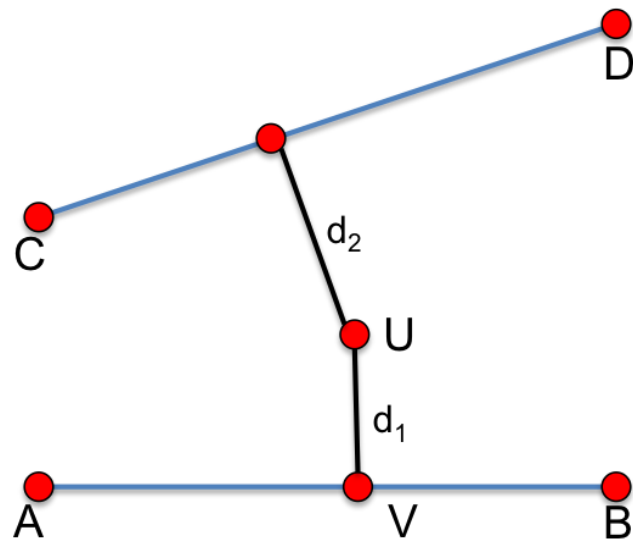• Calculate positions on the map signboard image.

Web map

Map signboard

$$\frac{AV}{VB} = \frac{A'V'}{V'B'} \qquad \frac{UV}{AB} = \frac{U'V'}{A'B'}$$

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Advanced Image Geocoding

• Adjust positions
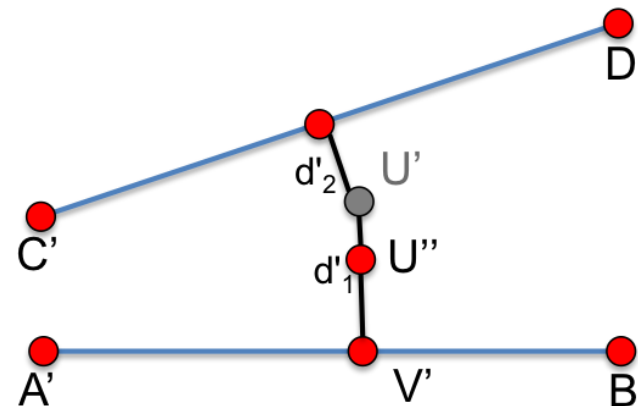
on web map   on map signboard

$$\frac{d_1}{d_2} = \frac{d'_1}{d'_2}$$

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Experiments and Results

- Experiment on feasibility of basic geocoding

	Very easy	Easy	Hard	Very hard
Geocode map signboards (generally)	7	4	1	0
Make the direction alignment	6	4	2	0
Add reference points (use GPS to add users' locations on base maps automatically)	7	4	1	0
Add reference points (add corresponding reference points on base maps manually)	2	5	5	0
Match the trajectory with the map image	3	7	1	1
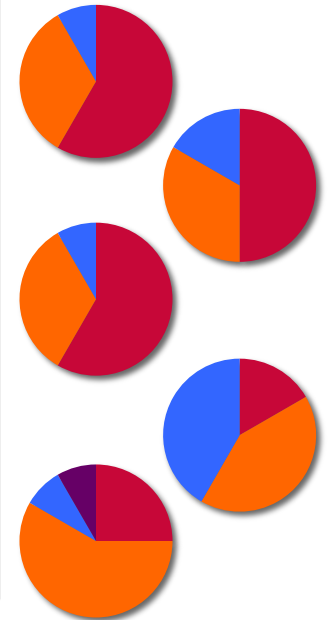
■ Very easy　■ Easy　■ Hard　■ Very hard

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Experiments and Results

- Comparison of positioning accuracy

web map

Point-based geocoding results

Polyline-based geocoding results

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Experiments and Results

- Comparison of positioning accuracy
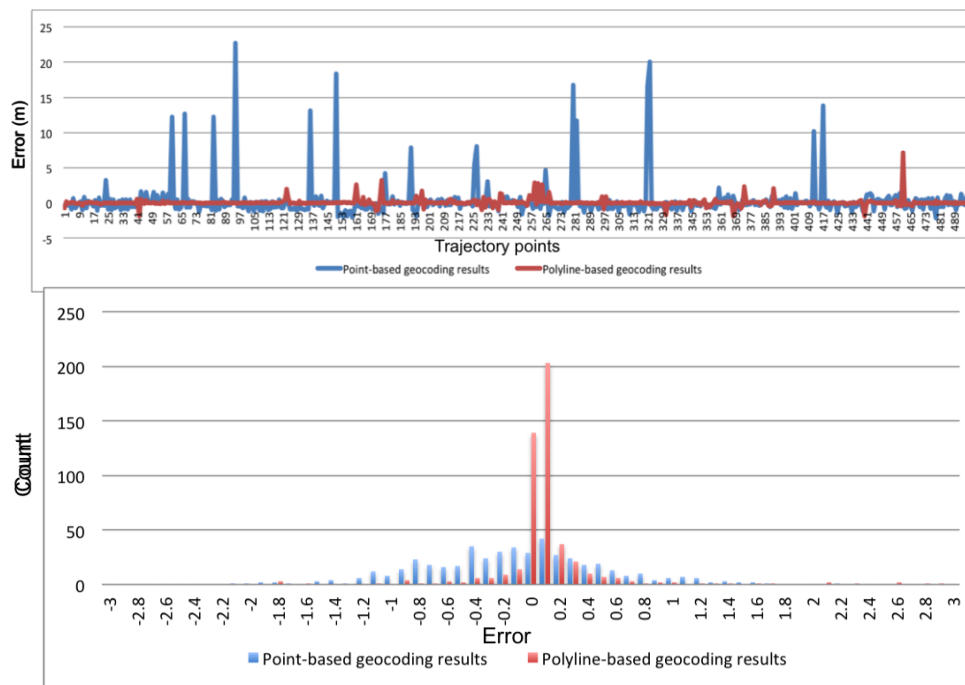
	Point-based geocoding	Polyline-based geocoding	
Average of errors (m)	0.295	0.073	
Standard Deviation of errors (m)	2.566	0.544	

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Conclus...

- A framew...
  signboard...
  geocodin...
  users
  images
- Main i...
  - Map
  - Pro... tha...
  - Po... p...
- Nee...
  - The difficult... the base map is...
  - Natural dynamic switc... signboards.