Location Based Services and Pedestrian Navigation

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Research Group Cartography

» Currently 5 researchers involved, led by Prof. Georg Gartner

» Four core research topics

» Web Mapping, Volunteered Geographic Information (VGI), Location Based Services (LBS), Spatial Cognition

» http://cartography.tuwien.ac.at

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Location Based Services

What is LBS?

"Location based services are computer applications that deliver information depending on the location of the device and user."

-- Raper et al. 2007

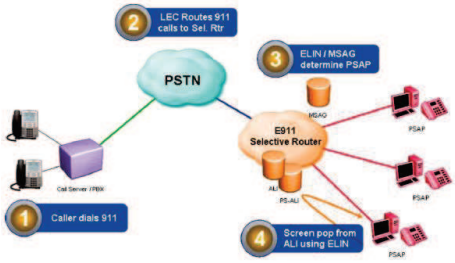
Jonathan Raper, Georg Gartner, Hassan Karimi & Chris Rizos (2007): A criticalevaluation of location based services and their potential, Journal of Location Based Services, 1:1,5-45

Applications of LBS: Emergency services

» E 911 in the US, E 112 in EU

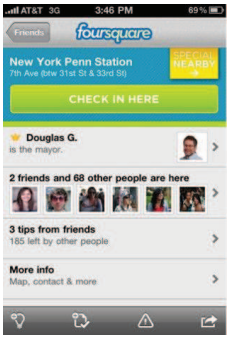
» resolve location from telephone/mobile calls

» dispatch emergency services such as emergency medical services, police or firefighters to the correct location

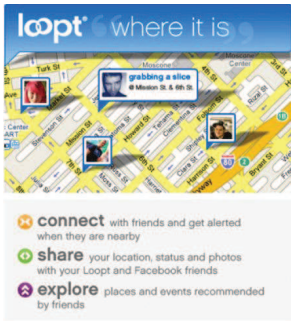


http://knol.google.com/k/e911-location-accuracy-vs-location-resolution

Social networking



Foursquare: check-in



http://8.mshcdn.com/wp-content/uploads/2010/09/foursquare-todo.jpg
http://www.examiner.com/images/blog/wysiwyg/image/loopt(1).gif

Mobile city guides

Nokia: Mobile Augmented Reality applications

AR + Wikipedia = Wikitude

http://research.nokia.com/files/maraposter.png
http://mashable.com/2009/10/02/wikitude/

Location-based game

Geocaching: a worldwide game of hiding and seeking treasure.

A geocacher can place a geocache in the world, pinpoint its location using GPS technology and then share the geocache's existence and location online. Anyone with a GPS device can then try to locate the geocache.

http://www.geocaching.com/

Navigation

» Car navigation, pedestrian navigation

Google Map Navigation: real time traffic view

Navit
Source: Kluge, University of Potsdam

http://www.google.com/mobile/navigation/gallery/full/traffic-view.jpg

Pedestrian Navigation

G. Gartner, H. Huang, A. Millonig, M. Schmidt & F. Ortag (2011): Human-centred mobile pedestrian navigation system. Mitteilungen der Österreichischen Geographischen Gesellschaft (Communications of Austrian Geographical Society), 153.

Mobile navigation systems

» Designed to facilitate users' navigation tasks in unfamiliar environments.

» Often contain three modules
- » positioning ("Where am I"): GPS, WiFi, RFID, …
- » route planning: compute a suitable route from an origin to a destination
- » route communication: conveying route instructions

Mobile navigation systems

» Designed to facilitate users' navigation tasks in unfamiliar environments.

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  » **route planning**: compute a suitable route from an origin to a destination

  » **route communication**: conveying route instructions

Car navigation vs. Pedestrian navigation

» They are different in
  » the degree of freedom
  » the typical resolution of space used for navigation

» The information needs of pedestrians are quite different from those of car drivers.

» Therefore, **the solution of car navigation systems might not be suitable for pedestrian navigation systems**.

Our aims

» We aim to develop mobile navigation systems that are **adapted to pedestrians** and have an optimized utility and usability.

  » route planning: how to calculate a suitable route from origin to destination (projects: UCPNavi, EmoMap)

  » route communication: how to convey route instructions effectively (projects: SemWay, Ways2navigate)

1. Behavior modeling

A. Millonig & G. Gartner (2011): Identifying motion and interest patterns of shoppers for developing personalised wayfinding tools, Journal of Location Based Services, 5:1, 3-21

Behavior modeling

» Part of the UCPNavi (Ubiquitous Cartography for Pedestrian Navigation) project, funded by Austrian FWF.

» It aims to identify **typical classes of pedestrian spatial behavior**, and to determine **characteristic attributes** for each class.

» The results can be used to provide **type-related route recommendations**.

Data collection

» In a big shopping mall (Donauzentrum Wien)

» Bluetooth beacons were placed at different places of the shopping mall.

» Shoppers were provided with a mobile phone, which stores their moving track.

http://www.bluelon.com
http://www.nokia.com/

Hierarchical clustering: results

Cluster		TI-1	TI-2	TI-3
No. of subjects		10	14	30
Gender:	female	40%	35.7%	66.7%
	male	60%	64.3%	33.3%
Age:	< 30	50%	35.7%	20%
	30 – 60	50%	64.3%	63.4%
	> 60	0%	0%	16.6%
Average speed		1.19 m/s	0.61 m/s	0.24 m/s
Av. no. of stops (max.)		0.3 (3)	1.36 (2)	3.57 (13)
Av. duration of stops		6.97 s	2.58 min	4.66 min

2. EmoMap

- considering emotional responses to space for enhancing LBS

http://openemotionmap.org
S. Klettner, H. Huang, M. Schmidt:
"EmoMap - Considering Emotional Responses to Space for Enhancing LBS";
Talk: 8th International Symposium on Location-Based Services LBS 2011, Vienna (invited); 11-21-2011 - 11-23-2011; in: "8th International Symposium on Location-Based Services LBS 2011", (2011), 4 pages.

The EmoMap project

» funded by Austrian BMVIT.
  » partners: Salzburg Research, WildUrb

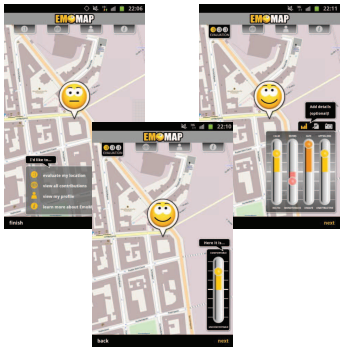
» Current routing algorithms often base on "objective" data.

» "Subjective" information influences people's route choice (comfort, safety, attractiveness).

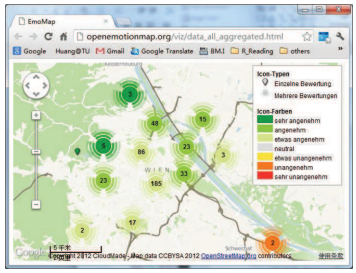
» We aim to **add a "subjective" layer** to the physical environment to represent people's emotions in space.
  » LBS: enhancing route planning, …
  » other applications: urban planning, architecture, policy making, …

Approach

» Crowdsourcing: "citizens as sensors"



EmoApp



Contributions until July

On-going work

» Collecting more data

» Aggregating individuals' ratings to generate collective emotional views
  » pedestrian routing considering emotional information, such as "the most comfortable route"

» Data visualization and analysis
  » "how do people feel differently in daytime and in nighttime?"
  » correlation between emotional ratings and the environment
  » …

» The emotional rating set will be made open to other researchers.

http://openemotionmap.org

3. SemWay

-- Semantics for navigation systems

http://www.salzburgresearch.at/en/projekt/semway_en/

The SemWay project

» funded by Austrian BMVIT.
  » partners: Salzburg Research, …

» Improving voice-based route guidance
  » "walk straight, pass the theatre, and walk to the crossing" instead of "walk straight for 105 meters"
  » "cross the park"

» SemWay aims at developing a methodology and model for building **semantically enriched** navigation systems.

Methodology

» In-situ experiments in Vienna and Salzburg.
  » ask participants to orally describe the possible actions at street intersections

» Deriving fundamental elements from the above data
  » direction and motion concepts
  » landmarks

» A formal model for semantic route descriptions

» Evaluating the model with field experiments

Results from the field experiments

» Comparing metric instructions and semantic instructions
  » similar navigation performances (walking time and decision errors)

» Participants had **more confidence** in their decisions at intersections when using semantic instructions, and clearly **preferred** this kind of instructions.

REHRL K., HÄUSLER E., LEITINGER S. (2010), Comparing the effectiveness of GPS-enhanced voice guidance for pedestrians with metric- and landmark-based instruction sets. In S.I. Fabrikant et al. (Eds.): GIScience 2010, Springer LNCS 6292, pp. 189-203, 2010.

4. Ways2navigate

1. Karl Rehrl, Elisabeth Häusler, Renate Steinmann, Sven Leitinger, Daniel Bell und Michael Weber (2011): Pedestrian Navigation with Augmented Reality, Voice and Digital Map: Results from a Field Study assessing Performance and User Experience. In: Gartner und Ortag (Hrsg.): Advances in Location-Based Services, pp. 3-18, Springer Heidelberg.
2. Huang, H., Schmidt, M. & Gartner, G. (2012): Spatial Knowledge Acquisition with Mobile Maps, Augmented Reality and Voice in the Context of GPS-based Pedestrian Navigation: Results from a Field Test. Cartography and Geographic Information Science, 39(2), pp. 107-116.

The Ways2navigate project

» funded by Austrian BMVIT.
  » partners: Salzburg Research, …

» Aims: investigating the suitability of **mobile map**, **language (voice)**, and **Augmented Reality (AR)** for communicating route information to pedestrians in an urban environment
  » how these technologies can help to reduce cognitive load during navigation
  » how these technologies influence the acquisition of spatial knowledge during navigation

Approach

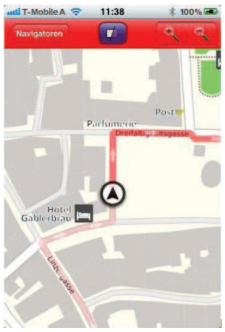
» 3 test routes in Salzburg
  » each with about 600 m long, and about 6 decision points

» 24 subjects
  » 13 female, 11 male, average age 40
  » divided into three groups, within subject design

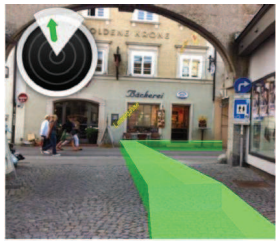
» Wayfinding performances: usability, task load

» Spatial knowledge acquisition: landmark recognition task, route direction task, landmark placement task

Materials



Mobile map

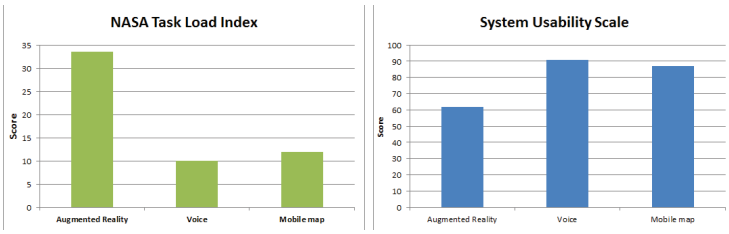


Augmented Reality

Turn right and use the cross-walk towards the hotel.

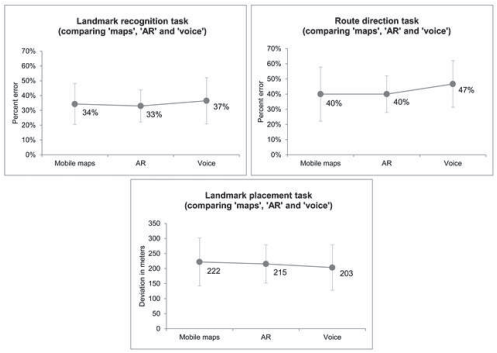
Language (voice)

Results: cognitive load and usability



» **AR** leads to a significant **higher cognitive load**, and a significant **poorer usability**.

Results: spatial knowledge acquisition



» No significant difference among these technologies.

» These three technologies led to **poor results in spatial knowledge acquisition**: no significant difference from chance performance.

Open questions

» Do users (need to) care about spatial learning during navigation?

» If yes, how can we design navigation systems, which **not only** guide users from A to B efficiently, **but also** support them to acquire spatial knowledge during navigation?

ways2navigate

Conclusions and work in progress

» Pedestrian navigation systems should be human-centered.

» adapted to the needs and constraints of pedestrians

» route planning: compute a suitable route from an origin to a destination

» route communication: conveying route instructions effectively

» Work in progress

» context-aware adaptation

» reducing the side effects of navigation systems

» ...

Thank you for your attention!

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