



Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

Indoor Location-based Services

betreut von Prof. Dr. Birgit Wendholt

Fakultät Technik und Informatik
Studiendepartment Informatik

Inhalt

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- ≡ Indoor Location-based Services
- ≡ Indoor Localization
- ≡ Ausblick

Motivation

Motivation

Location-based Services

“Location-based services are any service that takes into account the geographic location of an entity.” [1]

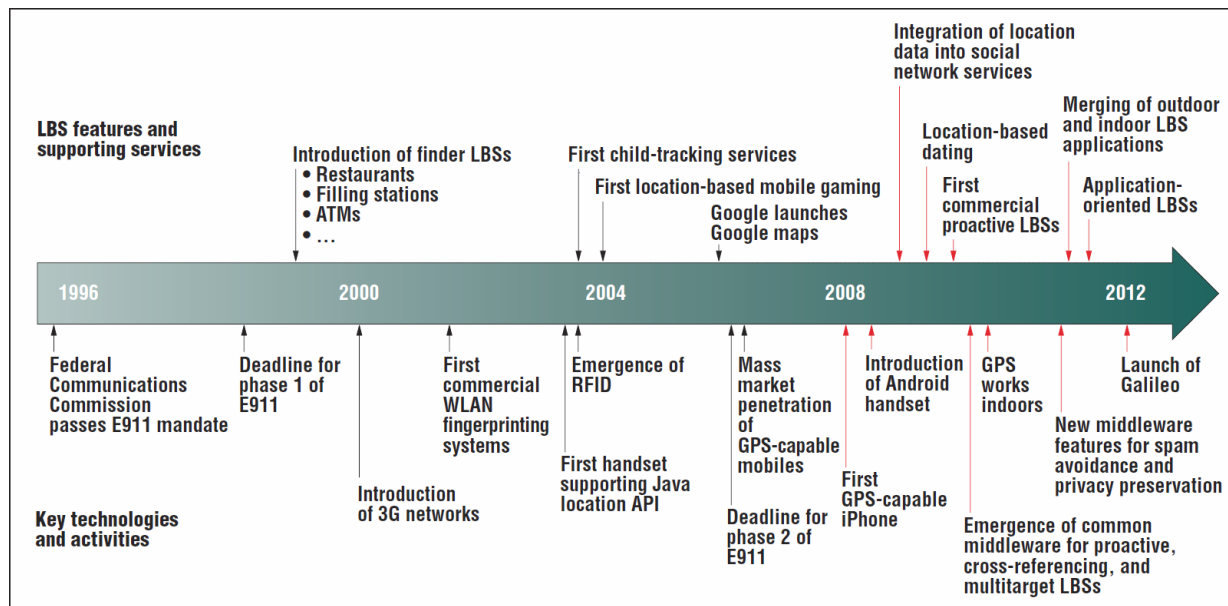
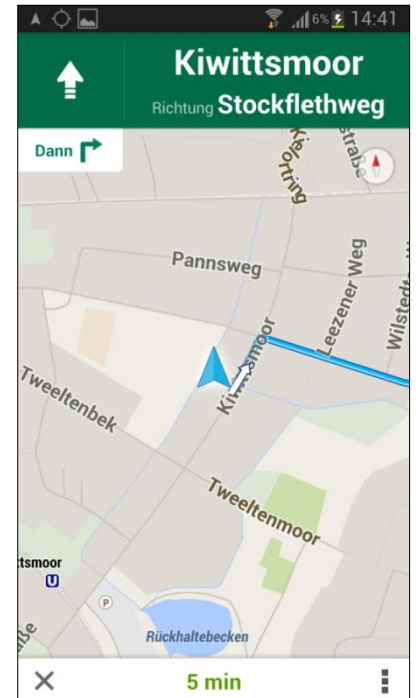
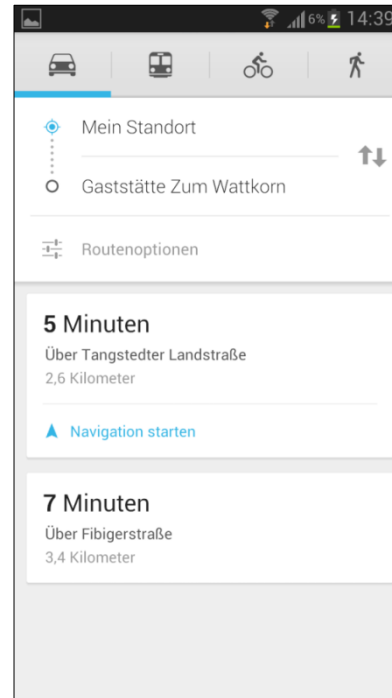
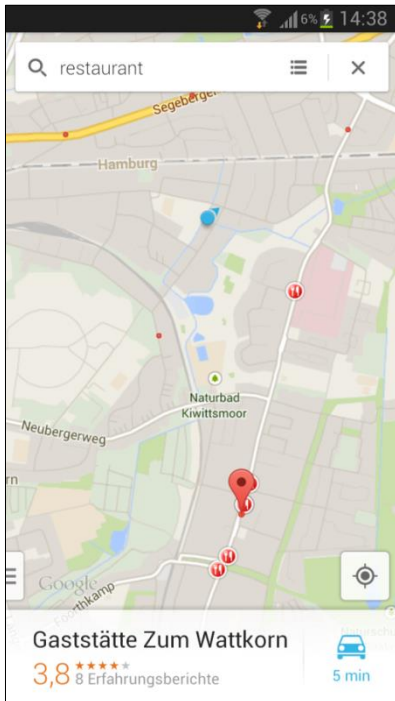


Bild: Bellavista et al. / Location-Based Services: Back to the Future [2]

Motivation

Location-based Services



Bilder: Google Maps (Android)

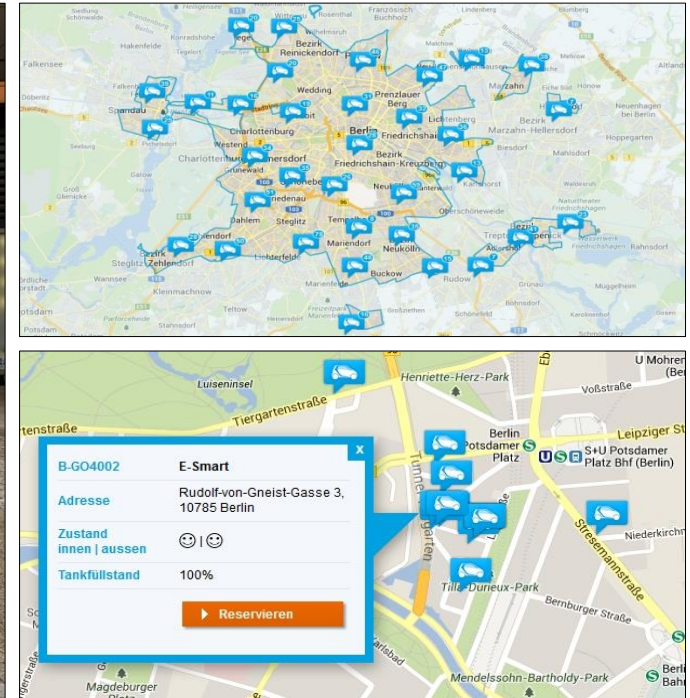
Navigation

Motivation

Location-based Services



Foto: Avda / [Wikipedia](#)



Bilder: [car2go](#)

Carsharing

Motivation

Location-based Services

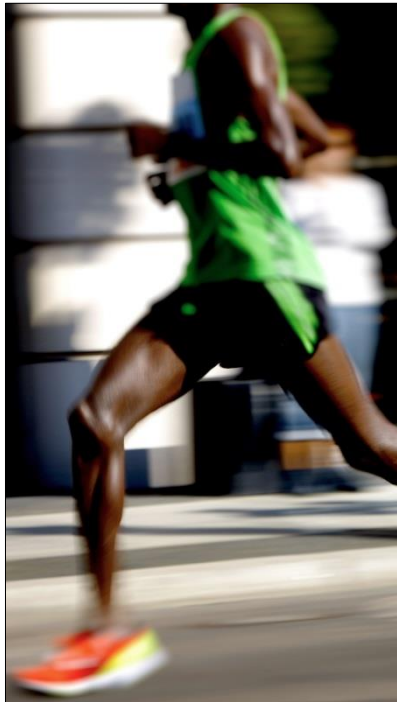


Bild: [Q.pictures](#) / pixelio.de

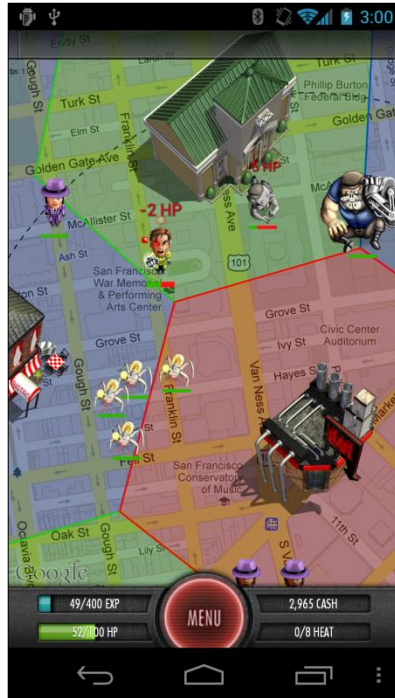


Bild: [Parallel Mafia](#)



Bild: [pixelproducer](#) / pixelio.de

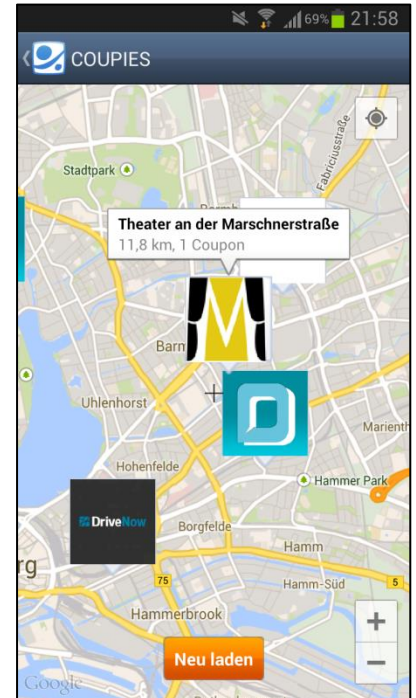


Bild: Coupies (Android)

U.S.W.

Indoor Location-based Services

Indoor Location-based Services

Anwendungsfelder



Krankenhäuser

Bild: [Rainer Sturm](#) / pixelio.de



Flughäfen

Bild: [Raphael Reischuk](#) / pixelio.de

Bibliotheken

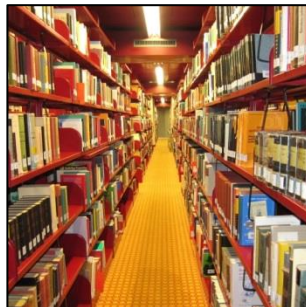


Bild: [olga meier-sander](#) / pixelio.de

Bahnhöfe



Bild: [La-Liana](#) / pixelio.de

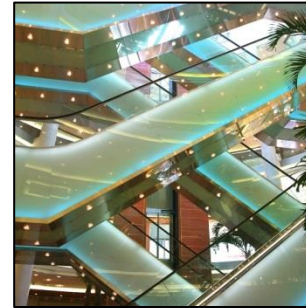
Indoor Location-based Services

Anwendungsfelder



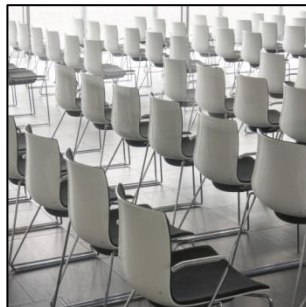
Hochschulen

Bild: [Rainer Peter von Bechen](#) / pixelio.de



Kaufhäuser

Bild: [Albrecht E. Arnold](#) / pixelio.de



Konferenzen

Bild: [Rainer Sturm](#) / pixelio.de



Museen

Bild: [Rolf Krekeler](#) / pixelio.de

Indoor Location-based Services

Indikatoren

- Google will es
 - Indoor Maps Beta
- Apple will es
 - iBeacon
- Viele Unternehmen mit Insellösungen
 - „Large Ecosystem Players Will Spur Growth But No One Vendor Will Dominate Globally“ [3]
- Großes Forschungsinteresse

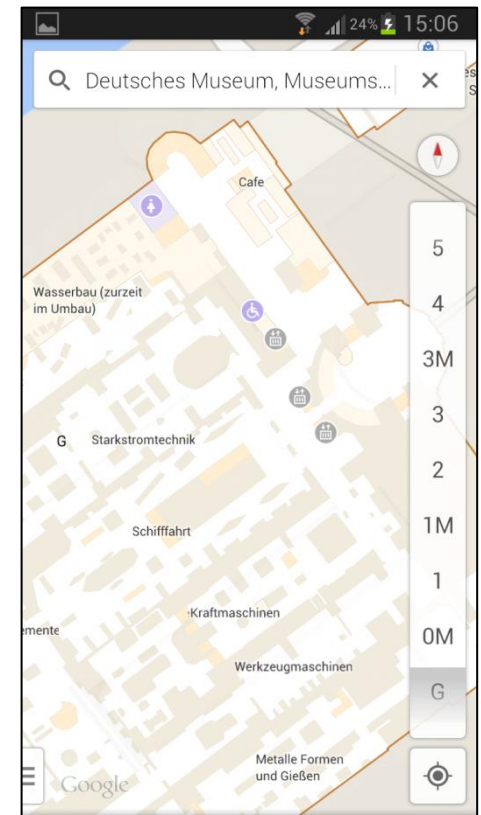


Bild: Google Maps (Android)

Indoor Location-based Services

Indikatoren

„The In-Location Alliance promotes the deployment of location-based indoor services in the mobile environment.” [4]



Bild: nach In-Location Alliance / Introduction [4]

- ≡ Use Case Working Group
 - ≡ Einsatzgebiete, Anforderungen
- ≡ System Architecture Working Group
 - ≡ Komponenten, Entwurf von Architekturen
- ≡ Pilot Working Group
 - ≡ Entwicklung und Testen von Prototypen

Indoor Location-based Services

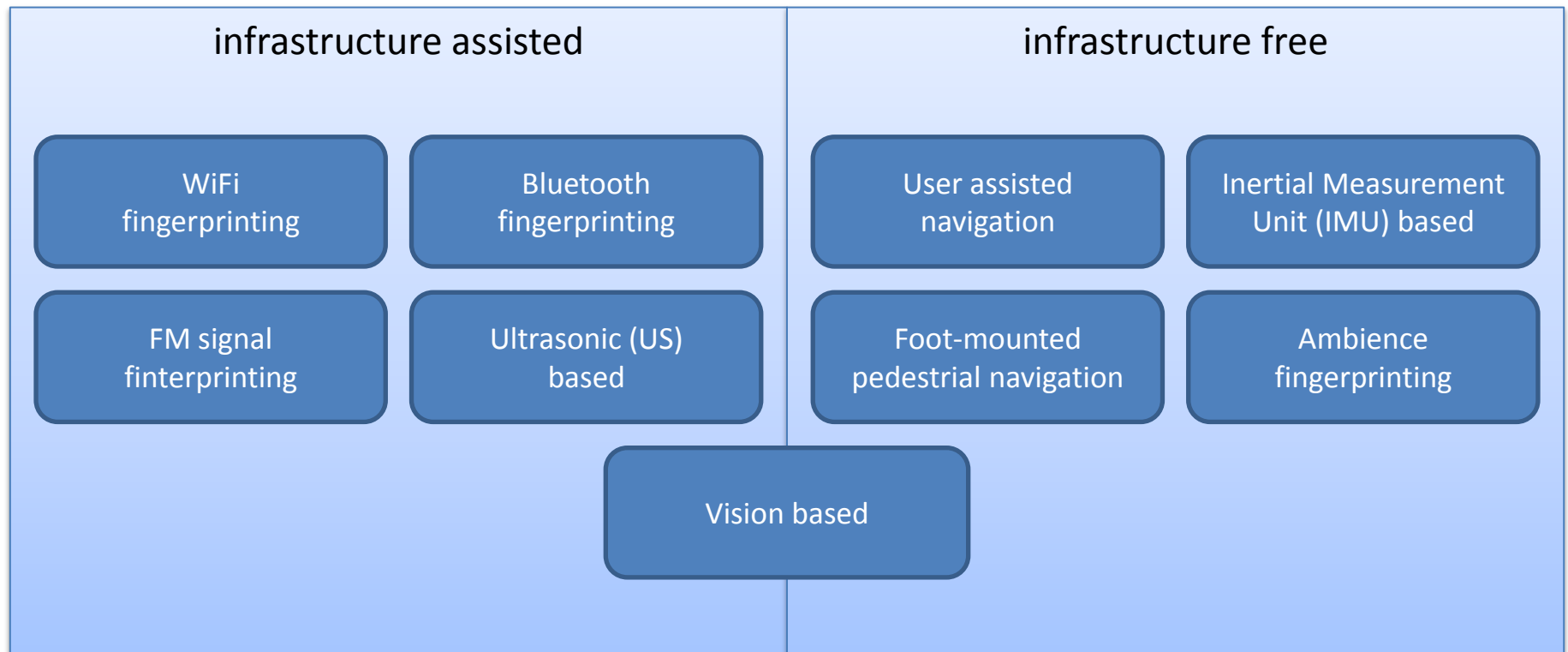
Probleme

- ≡ Kein ausgereifter Standard für Indoor Localization
- ≡ Kartendaten
- ≡ Eingeschränkte Internetverbindung
- ≡ Keine einheitliche Architektur / Infrastruktur
- ≡ Privatsphäre

Indoor Localization

Indoor Localization

Überblick



Indoor Localization

RADAR

- ≡ Bahl, Padmanabhan [5]
- ≡ Sampling von RF-Fingerprints
(x,y,d,ss,bsnr)
 - ≡ x,y ... Position
 - ≡ d ... Richtung
 - ≡ ss ... Signalstärke
 - ≡ bsnr ... Basisstation
- ≡ Positionsbestimmung durch
vergleich Empfangener
Signalstärke mit Samples

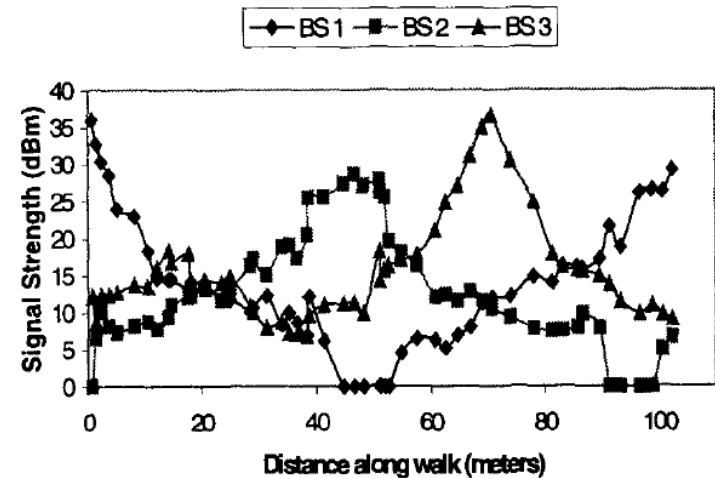


Bild: RADAR: An In-Building RF-based User Location and Tracking System / Bahl et al. [5]

Indoor Localization

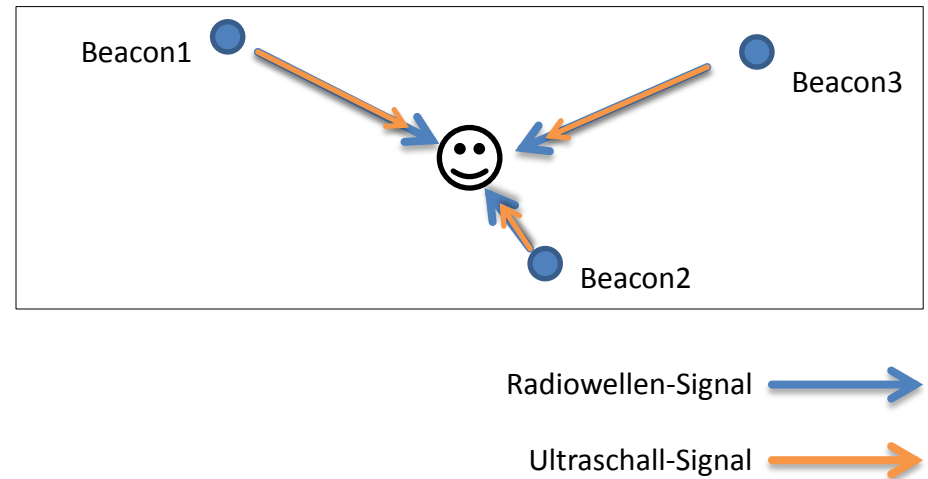
RADAR

- ≡ Durchschnittliche Genauigkeit von 2-3m
- ≡ Probleme
 - ≡ Signalschwankungen
 - ≡ Multipath phenomenon
 - ≡ Orientierung
 - ≡ Verschiedene Empfänger
 - ≡ Hoher Aufwand für Sampling
 - ≡ Änderungen der RSS Fingerprints über Zeit

Indoor Localization

Cricket

- ≡ Priyantha, Chakraborty, Balakrishnan [6]
- ≡ Kombination aus Radio- und Schallwellen
- ≡ Lichtgeschwindigkeit > Schallgeschwindigkeit
- ≡ Time difference of arrival



Indoor Localization

Cricket

- ≡ Probleme
 - ≡ Multipath phenomenon
 - ≡ Interferenzen
 - ≡ Einflussfaktoren auf die Schallgeschwindigkeit
 - ≡ Temperatur
 - ≡ Luftfeuchtigkeit

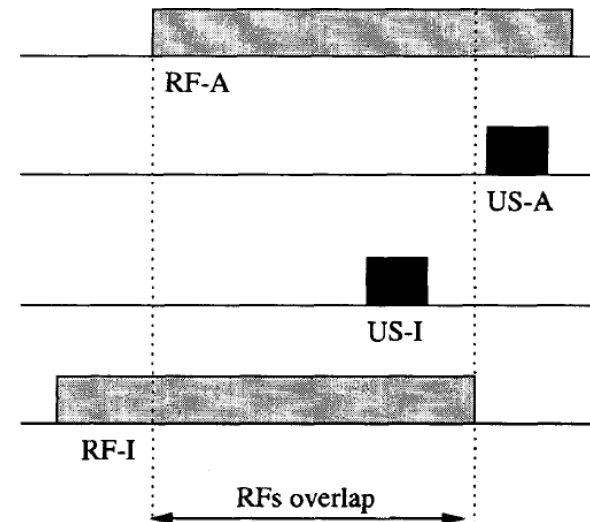


Figure 1: RF-A:US-I interaction, with US-A arriving after US-I. The two RF transmissions overlap in time at the listener.

Bild: The Cricket location-support system / Priyantha et al. [6]

Indoor Localization

IMU based localization

Li, Zhao, Ding, Gong, Liu, Zhao [7]

Inertial Measurement Unit

- Beschleunigungssensor
- Magnetometer
- Gyroskop

Lernen des Schritt-Modells zur Personalisierung

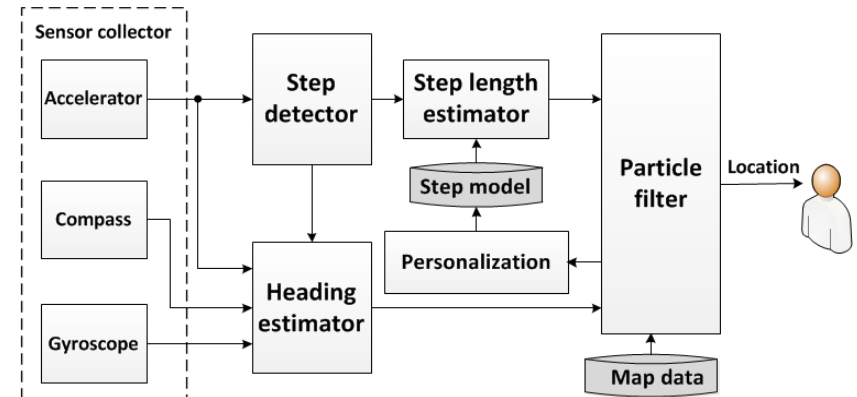
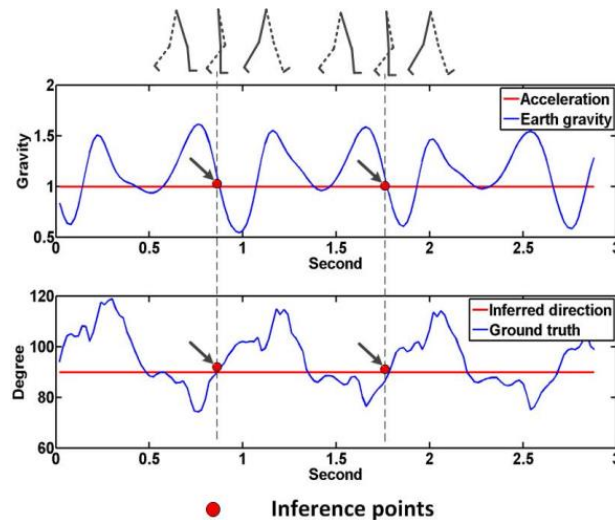


Bild: A Reliable and Accurate Indoor Localization Method Using Phone Inertial Sensors / Li et al. [7]

Indoor Localization

IMU based navigation



— Estimated trajectory - - - Ground truth

Bilder: A Reliable and Accurate Indoor Localization Method
Using Phone Inertial Sensors / Li et al. [7]

≡ Probleme: Sensor-Drift, extreme Schrittmodelle, false-positives

Indoor Localization

Konferenzen

≡ IPIN'13 (Indoor Positioning and Indoor Navigation)

- ≡ „Scalable Indoor positioning“
- ≡ „A Microscopic Look at WiFi Fingerprinting for Indoor Mobile Phone Localization in Diverse Environments“
- ≡ „RSSI Distance Estimation Based on Genetic Programming“
- ≡ „HiMLoc: Indoor Smartphone Localization via Activity Aware Pedestrian Dead Reckoning with Selective Crowdsourced WiFi Fingerprinting“
- ≡ „Optimal RFID Beacons Configuration for Accurate Location Techniques within a Corridor Environment“
- ≡ „A Cooperative NLoS Identification and Positioning Approach in Wireless Networks“

Indoor Localization

Konferenzen

≡ MobiSys'13 (Mobile Systems, Applications, and Services)

- ≡ „FM-based Indoor Localization via Automatic Fingerprint DB Construction and Matching”
- ≡ „Guoguo: Enabling Fine-grained Indoor Localization via Smartphone”
- ≡ „Avoiding Multipath to Revive Inbuilding WiFi Localization”

≡ MobiCom'13 (Mobile Computing and Networking)

- ≡ „SmartLoc: Push the Limits of Smartphone”

“The well known acoustic range based localization scheme, **Cricket** also utilizes the same **concept** of using the difference in arrival times of **concurrent transmissions of radio and ultrasound signals** at the target device to infer the distance.”

- ≡ „SpyLoc: A Light Weight Localization System for Smartphones”

Ausblick

The Active Badge Location System

- Want, Hopper, Falcão, Gibbons [8]
- Intention: Tracking von Mitarbeitern in großen Gebäudekomplexen
- Personen tragen Infrarot-Badges
- Infrarot-Sensoren an den Workstations übermitteln Position des Mitarbeiters an zentralen Server

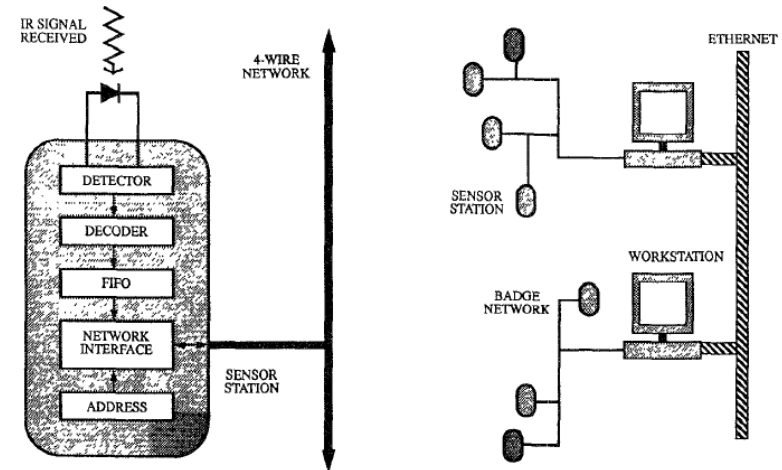


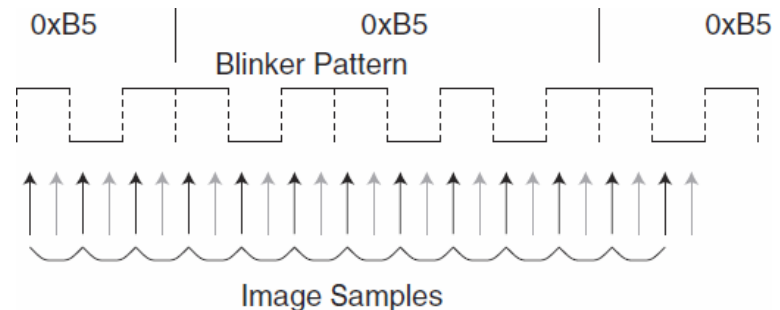
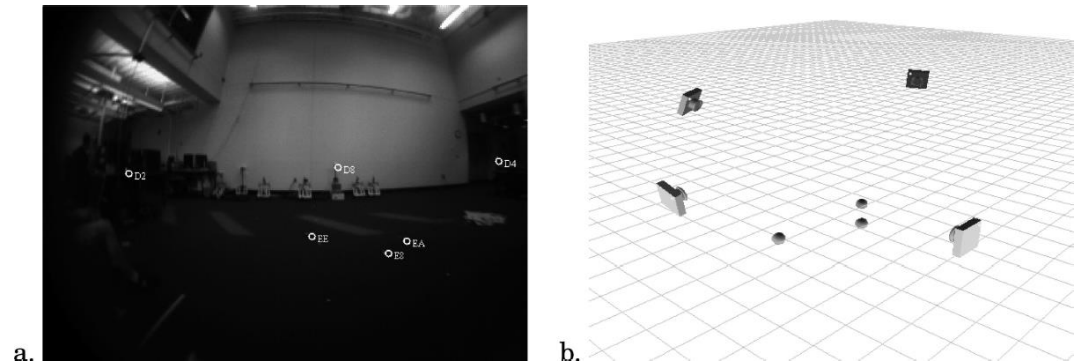
Fig. 2. Badge sensor and telemetry network.

Bild: The Active Badge Location System / Want et al. [8]

Ausblick

Self-localizing smart camera networks

- Shirmohammadi, Taylor [9]
- Kamera ausgestattet mit steuerbarer Lichtquelle und Accelerometer
- Identifikation anderer Kameras anhand von Morsecodes
- Berechnung der relativen Positionen zueinander

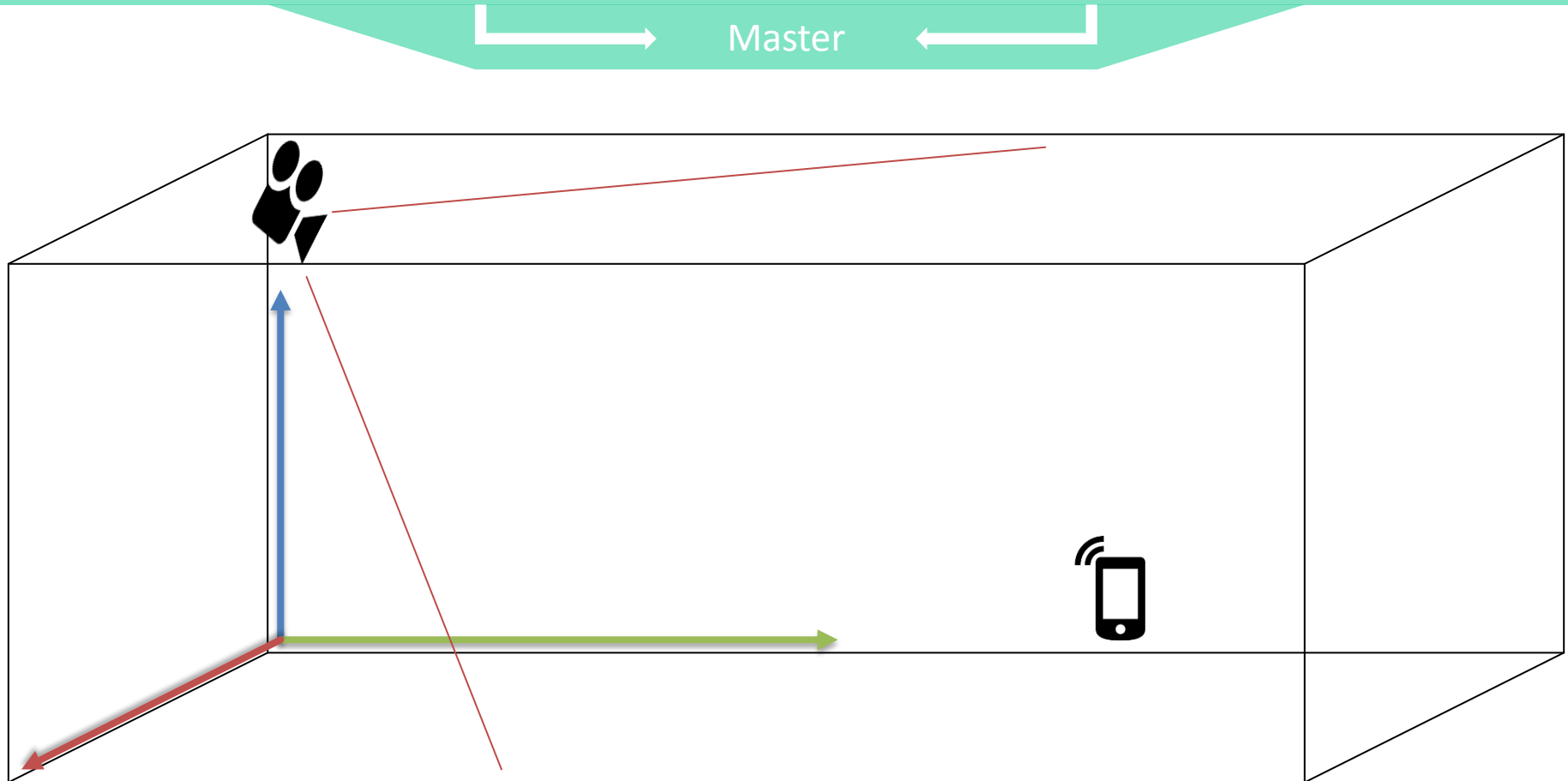


Bilder: Self-localizing smart camera networks / Shirmohammadi et al. [9]

Ausblick

The Active Badge Location System

Self-localizing smart camera networks



“Android 4.4 introduces platform support for built-in **IR blasters**, along with a new API and system service that let you create apps to take advantage them.” [55]

Ausblick

ALTAIR:Automatic Location Tracking system using Active IR-tag

- Sakata, Yasumuro, Imura, Manabe, Chihara [10]
- Tracking von Benutzern im Raum anhand von Infrarot Signalen
- System-initiiert. Wo ist Gerät X ?
- Durchschnittliche Abweichung von 9cm (max. 40cm)

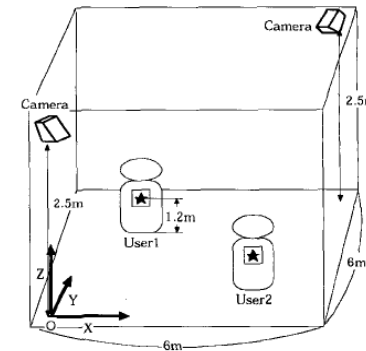


Figure 7. Experimental Space setup.

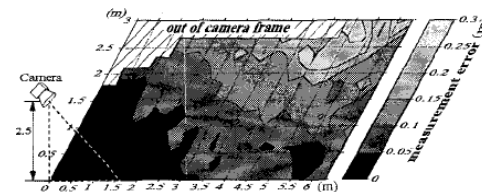


Figure 8. Positioning error distribution for one camera measurement.

Bilder: ALTAIR:Automatic Location Tracking system using Active IR-tag / Sakata et al. [10]

Ausblick

Roadmap

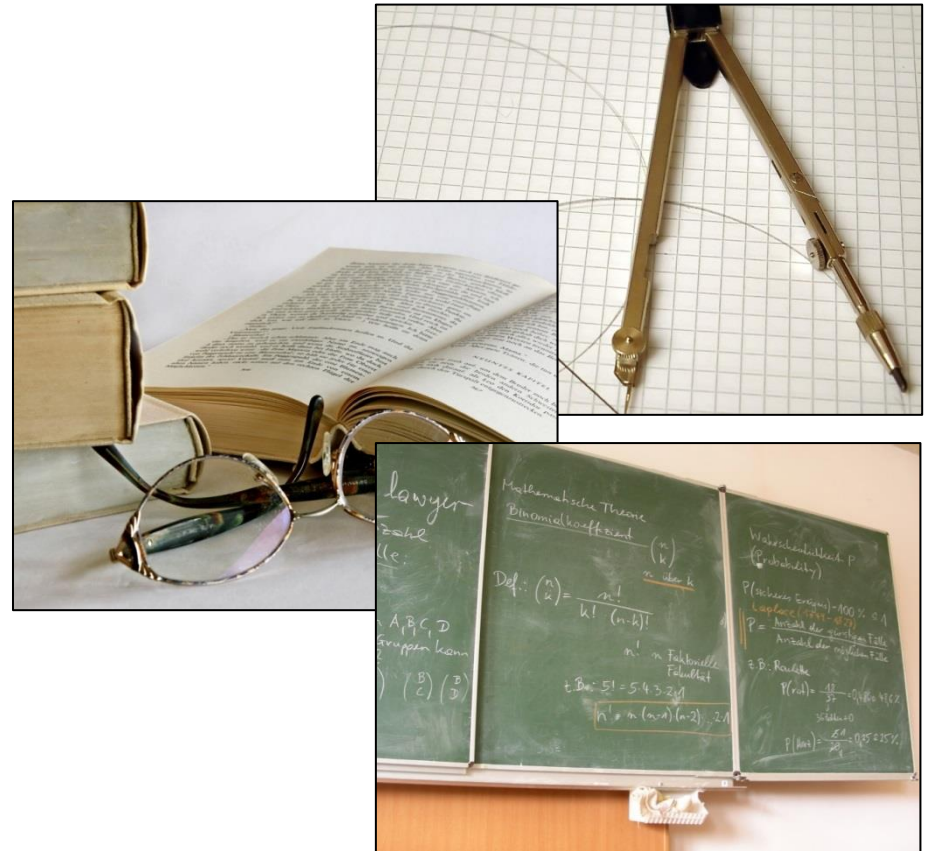
≡ AW2

≡ Single-View Geometry

≡ Bildverarbeitung

≡ Vertiefende Literatur

≡ Ähnliche Projekte



Fotos v.o.n.u: [Claudia Hautumm](#), [birgith](#), [bernhard pixler](#) / pixelio.de

Ausblick

Roadmap

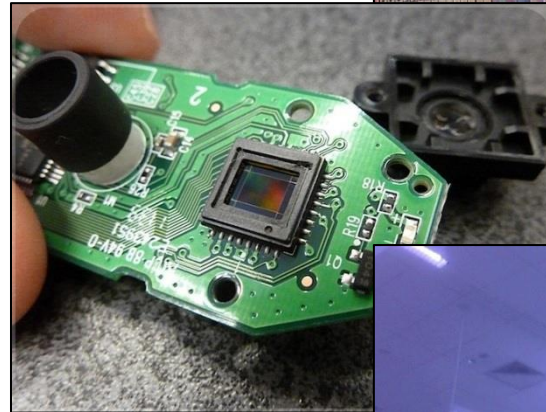
≡ PJ1

≡ Basteln

≡ Prototyping

≡ Optik

≡ Architektur



Fotos: [JoshMc](#) / [Webcam Conversion to \(Near-\) Infrared](#)



Fragen?

Quellen

- | # | Quelle |
|-----|--|
| [1] | Iris A. Junglas and Richard T. Watson. 2008. Location-based services. <i>Commun. ACM</i> 51, 3 (March 2008), 65-69. DOI=10.1145/1325555.1325568
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| [2] | Bellavista, P.; Kupper, A.; Helal, S., "Location-Based Services: Back to the Future," <i>Pervasive Computing, IEEE</i> , vol.7, no.2, pp.85,89, April-June 2008
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| [3] | Competitive Landscape: Indoor Positioning Technologies
Gartner, Inc.
https://www.gartner.com/doc/2230915 |
| [4] | In-Location-Alliance, Introduction, August 2013
http://www.in-location-alliance.com |

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|-----|---|
| [5] | <p>Bahl, P.; Padmanabhan, V.N., "RADAR: an in-building RF-based user location and tracking system," INFOCOM 2000. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE , vol.2, no., pp.775,784 vol.2, 2000
doi: 10.1109/INFCOM.2000.832252
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| [6] | <p>Nissanka B. Priyantha, Anit Chakraborty, and Hari Balakrishnan. 2000. The Cricket location-support system. In Proceedings of the 6th annual international conference on Mobile computing and networking (MobiCom '00). ACM, New York, NY, USA, 32-43. DOI=10.1145/345910.345917
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| [7] | <p>Fan Li, Chunshui Zhao, Guanzhong Ding, Jian Gong, Chenxing Liu, and Feng Zhao. 2012. A reliable and accurate indoor localization method using phone inertial sensors. In <i>Proceedings of the 2012 ACM Conference on Ubiquitous Computing (UbiComp '12)</i>. ACM, New York, NY, USA, 421-430.
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| [8] | Roy Want, Andy Hopper, Veronica Falcão, and Jonathan Gibbons. 1992. The active badge location system. <i>ACM Trans. Inf. Syst.</i> 10, 1 (January 1992), 91-102. DOI=10.1145/128756.128759
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| [9] | Babak Shirmohammadi and Camillo J. Taylor. 2012. Self-localizing smart camera networks. <i>ACM Trans. Sen. Netw.</i> 8, 2, Article 11 (March 2012), 24 pages. DOI=10.1145/2140522.2140524
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| [10] | Sakata, M.; Yasumuro, Y.; Imura, M.; Manabe, Y.; Chihara, K., "ALTAIR: automatic location tracking system using active IR-tag," <i>Multisensor Fusion and Integration for Intelligent Systems, MFI2003. Proceedings of IEEE International Conference on</i> , vol., no., pp.299,304, 30 July-1 Aug. 2003
doi: 10.1109/MFI-2003.2003.1232674
URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1232674&isnumber=27619 |

Quellen

Quelle

[55] <http://developer.android.com/about/versions/kitkat.html#44-ir-blasters>

Icons <http://iconmonstr.com>