Pedestrian Smartphone-Based Indoor Navigation
Using Ultra Portable Sensory Equipment

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Teaser

Car Navigation

Unknown city, last few blocks to go, suddenly the GPS signal is lost. How do I still get there on time?

Large Plant

How do I find Mr. Smith’s office E 3.401 in building 42?

Unfamiliar Underground Car Park

Dropped car off in a hurry. How do I find it again?

How to accomplish all this using just a single device?
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## Agenda

- **Motivation**
- **System Concept**
- **Hardware**
- **Approach**
- **Conclusion & Outlook**
Motivation

- Aim: low-cost, highly portable indoor navigation system
- Independent of dedicated infrastructure
- Pre-existing analyses based on MTi-G by Xsens
  - INS/GPS navigation
  - 'low-cost'

Results

- By itself good, but
  - 'Expensive', bulky, inaccurate / Unsuitable for algorithm dev.
System Concept

- **Inertial Navigation System**
  - baro
  - imu
  - Strapdown Algorithm

- **Geo Server**
  - Geo Data GIS

- **Smartphone**
  - GPS Receiver
  - WLAN Receiver
  - BT Receiver
  - IRDA Receiver
  - Sensor Fusion Algorithms
  - Camera
  - USB Port
  - Navigation Mapping Routing
  - Visualization
Smartphone

- Ultra portable
- Fitted with many sensors and communication interfaces
- Highly integrated hardware
- Powerful CPU
- No 'additional' device required

Nokia N900

- Linux
- Low-level access to sensors and data
- High-level programming languages
Custom INS Hardware

Smartphone (yet) lacks gyros → custom hardware

- Inertial navigation system
- Highly integrated circuits (MEMS) → small footprint
- High-performance digital signal processor
- Interfacing with smartphone (platform independent)
Approach

Part I (Custom Hardware)

- Basic principle: INS continuously provides position and orientation estimates
- Supported by baro sensor (vertical channel) and GPS fix (if available)
- Core: Strapdown Algorithm, KF for GPS/INS fusion

Part II (On Smartphone)

- Basic principle: There is always some available information
- Evaluation / Weighting
- Ranking / Selection
- Sensor Fusion Algorithms (KF, PF, GA, ANN)
- Support for INS
Conclusion

- Ultra portable pedestrian (indoor) navigation system
- Independent of (dedicated) infrastructure
- Independent of additional external hardware (step counter, antennae, etc.)
- Independent of utilized platform (key component (INS) designed removable)
Outlook

Potential uses

- Indoor location-based services
- Guide inside (public) building
- ...

Idea: Synchronization of device with 'smart' point of information at points of entrance

- Shopping Malls
- Trade / science fairs
- Museums
- (Public) buildings (town halls, large plants)
- ...
The End

www.geomatik-hamburg.de/digitalcity

Thank you for your kind attention!