

Map-based Positioning using Mobile Phones

XXIII International FIG Congress

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Munich, October 12th, 2006

Motivation

- Data Optimisation for Integrated Telematics (Do+T) project granted by Federal Ministry of Economics and Technology
- Acquisition and forecasting of traffic state
- Use of 'floating phone data' (FPD) available within the GSM network instead of cost-intensive
 - Local loop data
 - 'Floating car data'
- Focus of talk on positioning methods

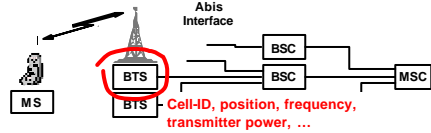
➔ Objective:
Generation of map-referenced trajectories

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GSM Network

Base Transceiver Stations



- Communication of mobile stations (MS) via basetransceiver stations (BTS) within GSM network
- Management of several BTS's by base station controller (BSC)
- Bundle of these BSC's in one mobile switching center (MSC)

➔ First test runs were carried out using MS for data acquisition
GPS positions are used for evaluation of results

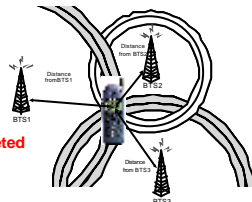
Available Measurements

Timing Advance (TA) value

- Performed within the GSM network for time synchronisation
- Available from the serving cell
- Resolution ~ 550 m
- Accuracy ~ 1100 m

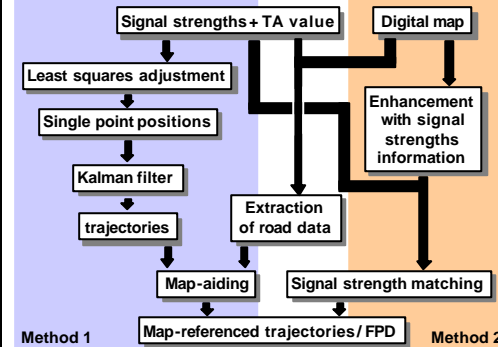
Signal strength value

- Used for handover decisions, network optimisation and administration
- Available from the serving cell and up to six neighbouring cells
- Resolution 1 dB
- Accuracy 2 – 3 dB
- Okumura-Hata model (Description of signal attenuation, derivation of distance)



➔ Both measures can be interpreted as distance information

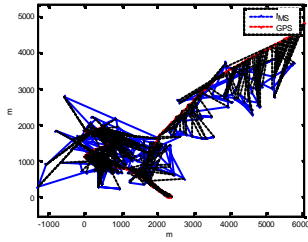
Positioning methods - overview



Positioning methods – method 1

Least squares adjustment

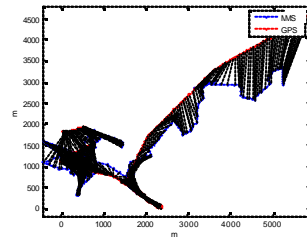
mean deviation 840 m
standard deviation 961 m



Positioning methods – method 1

Smoothed least squares adjustment

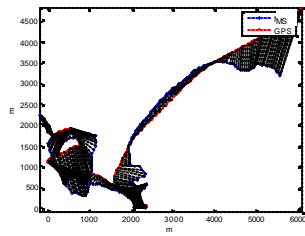
mean deviation 663 m
standard deviation 736 m



Positioning methods – method 1

Kalman filter

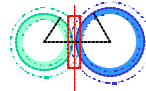
mean deviation 452 m
standard deviation 545 m



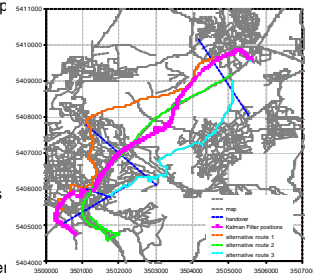
Positioning methods – method 1

Reference to digital map

- 2 TA values in case of handover
- Search area within digital map



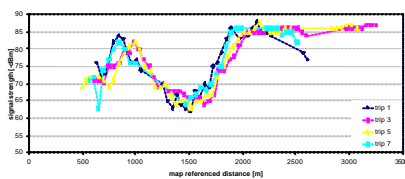
- Extraction of nodes within the search area
- Calculation of shortest paths between extracted nodes
- Decision for one trajectory is made by comparison with filter



Positioning methods – method 2

Signal strength matching

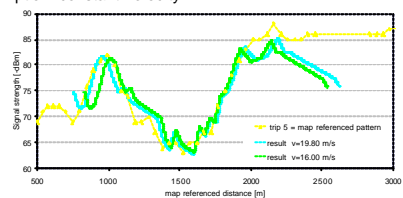
- Detection of significant structures in signal strength pattern in repeated driving scenarios
- Generation of a signal strength map based on digital road map with measured signal strengths and GPS positions



Positioning methods – method 2

Signal strength matching

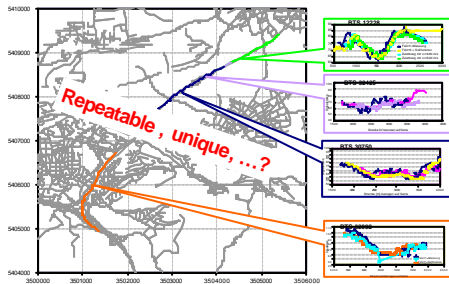
- Matching of signal strengths measured to received neighbouring cells to the map of signal strengths
- Procedure
 - Measurement: Signal strengths over time
 - Assumption: constant velocity



Positioning methods – method 2



Signal strength matching



Summary and future outlook



- Achieved accuracies several 100 m
- Evaluation and further enhancement of availability, correctness and repeatability for method 2 necessary
- There is still potential to improve the shown methods
 - Search area
 - Velocity
 - Coupling of methods
- Further improvement is also expected by direct use of data from the Abis interface
- First results suffice for acquisition and forecasting of traffic state, but determination of single trajectories have to be improved
- Development of further methods is in progress

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