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Position estimation based on MEMS inertial sensors for the use as pedestrian navigation

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Geomatics | HafenCity University Hamburg

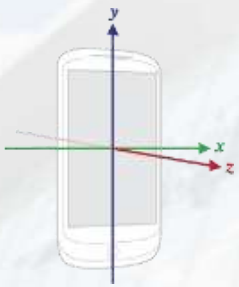
Content

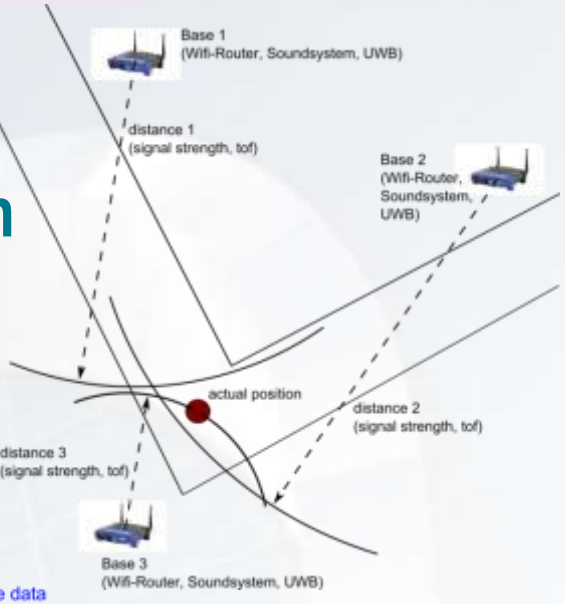
- position estimation without GNSS
- conditions / available information
- position estimation with PF
- edge based approach
- outlook

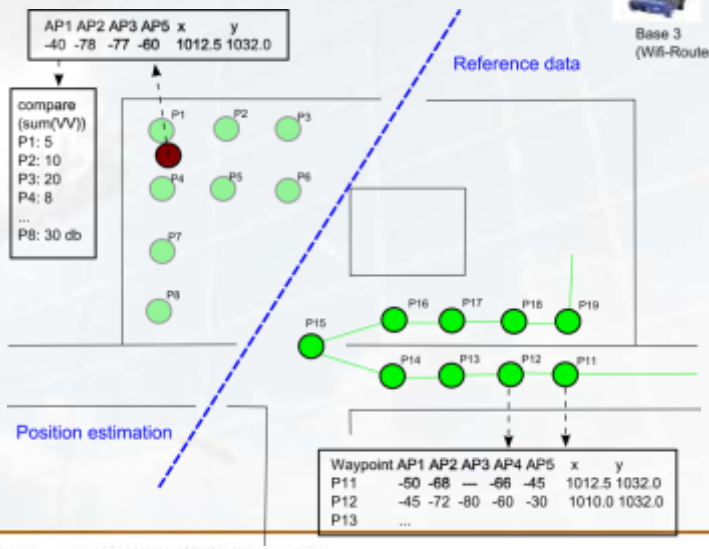
Position estimation without GNSS information

different possibilities for position estimate

- Trilateration (signal strength, TOF, ultra sound)
- Fingerprinting (WIFI, BT)
- Cell of Origin (WIFI, RFID, BT)
- Inertial Measurement Unit (IMU)





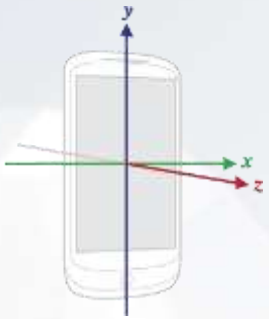


Requirements of own approaches

- indoor navigation with less work for implementation and for navigation
- no server based system
- using the existing infrastructure
- minimization of changes or work on the infrastructure
- accuracy of position estimate: 1-5 m, but clear room identification

MEMS inertial sensors

- IMU sensors in smartphone/tablets
  - 3-axis-accelerometer
  - 3-axis-gyroscope
  - 3-axis-magnetic field sensor
  - barometer
- MicroElectroMechanical System (MEMS) show high measuring uncertainties
  - Support of the position is required



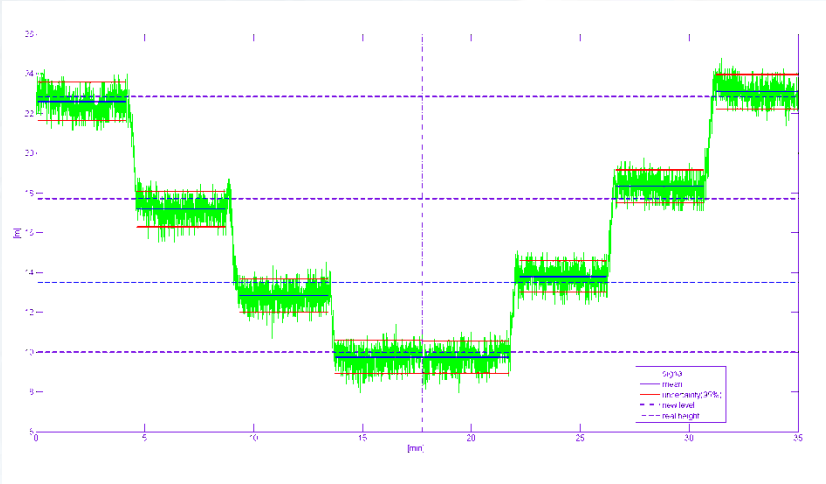
Available / provided resources

- smartphone sensors:
  - accelerometer
  - gyroscope

  → 2D Dead Reckoning
  - barometer

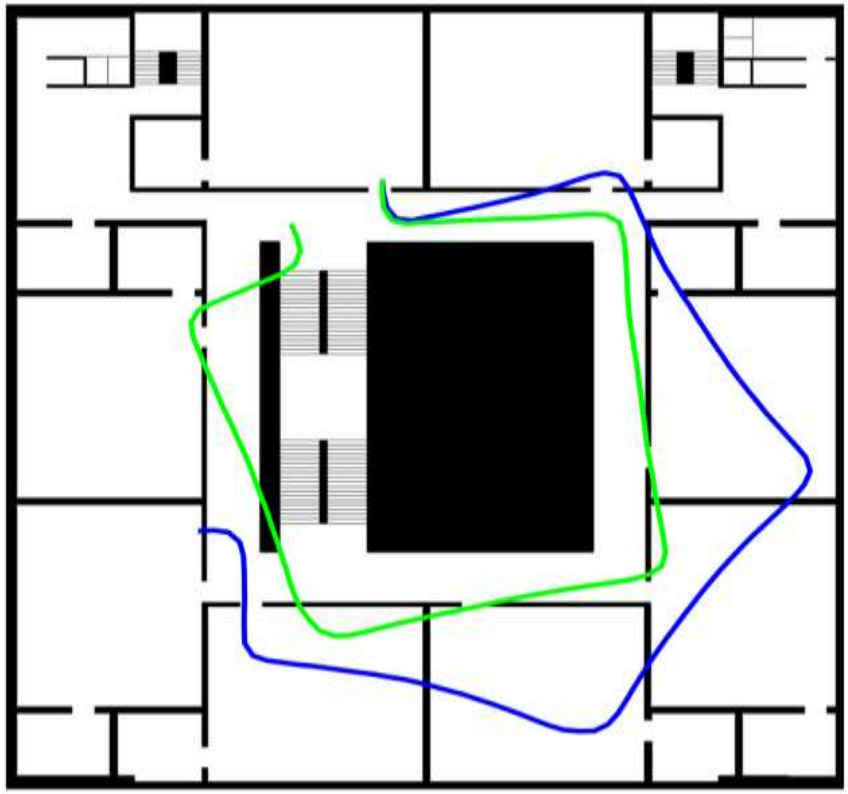
  → 1D with relative pressure
  - magnetic field sensor

  → support for 2D-orientation



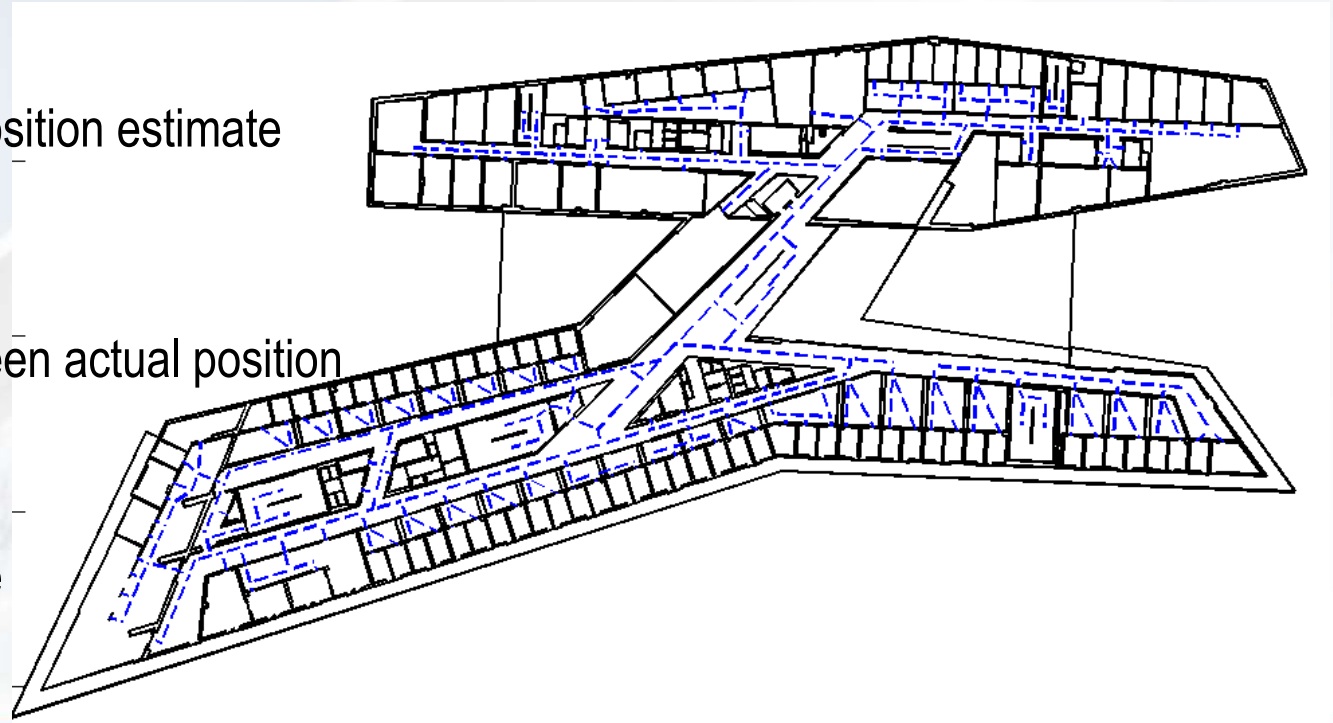
Pedestrian dead reckoning trajectory

- blue: without correction;
- green: correction of the orientation with Zero Velocity Update



Available / provided resources II

- map data:
  - visualization
  - support of the position estimate
- routing graph
  - navigation between actual position and destination
  - support of the position estimate

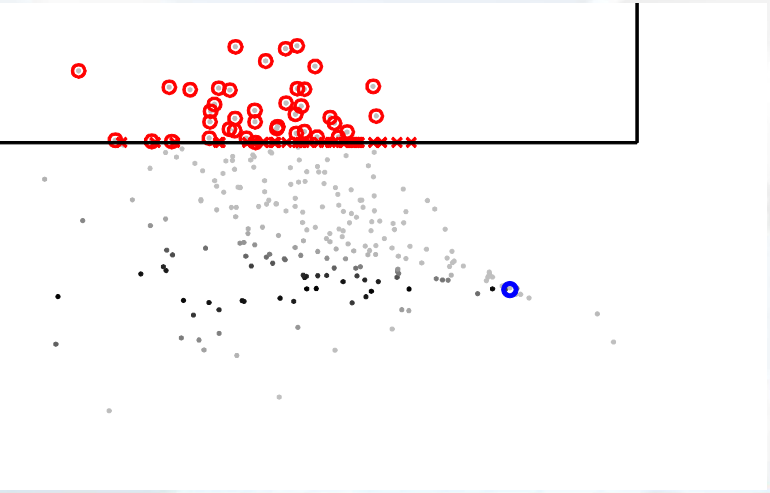


Particle filter

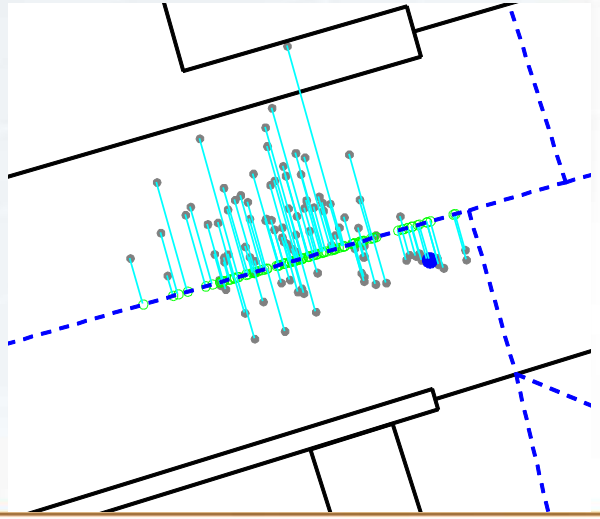
- Filter based on pedestrian dead reckoning (fix step length)
- relative pressure for height detection

- correction by map data (walls)
- routing graph is used for the correction of orientation and position

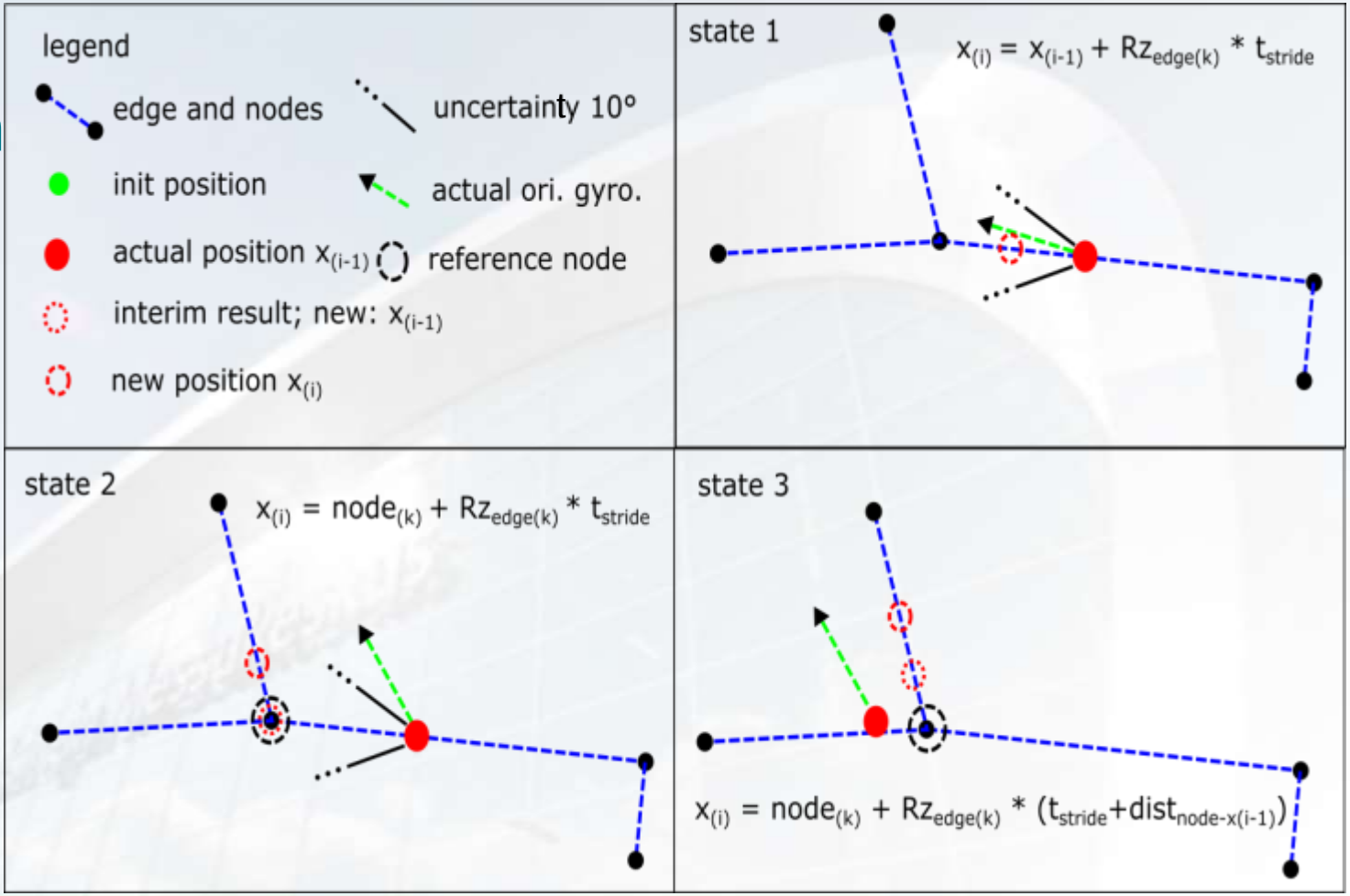
Correction with walls and



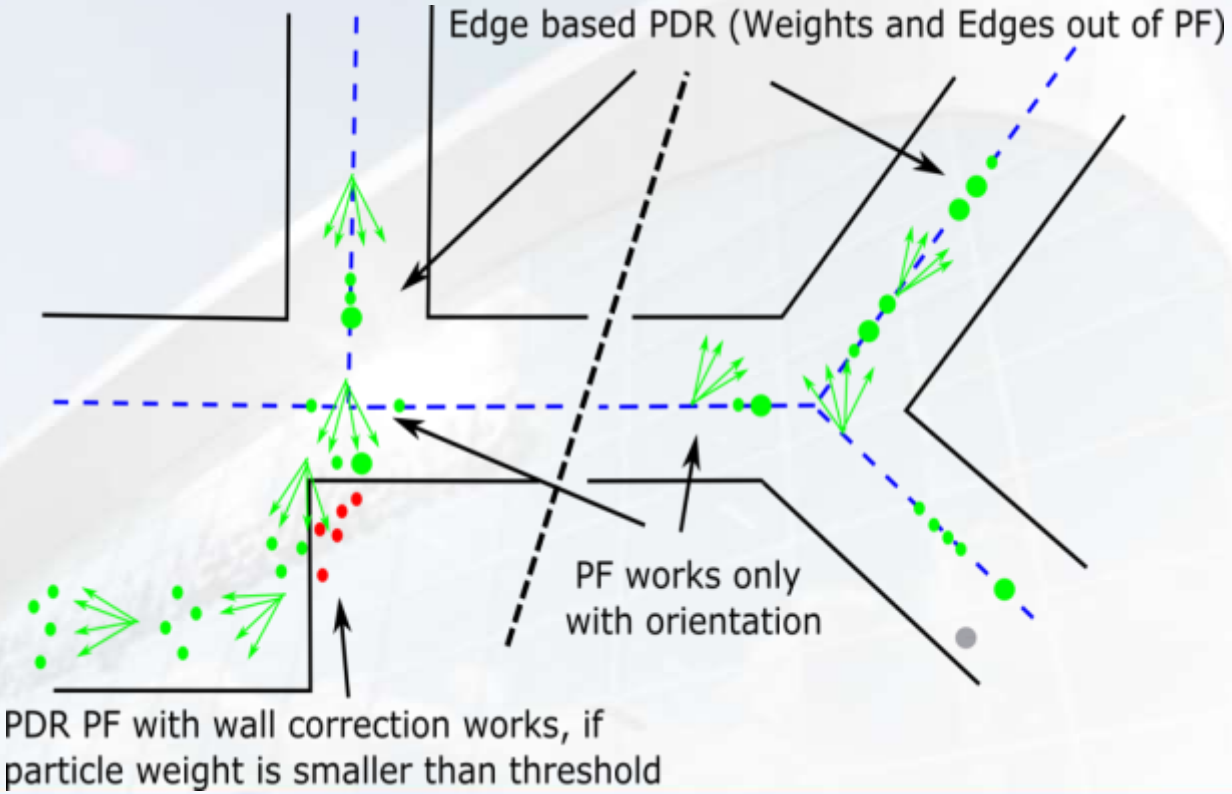
Routing edges in the particle filter



Implementation



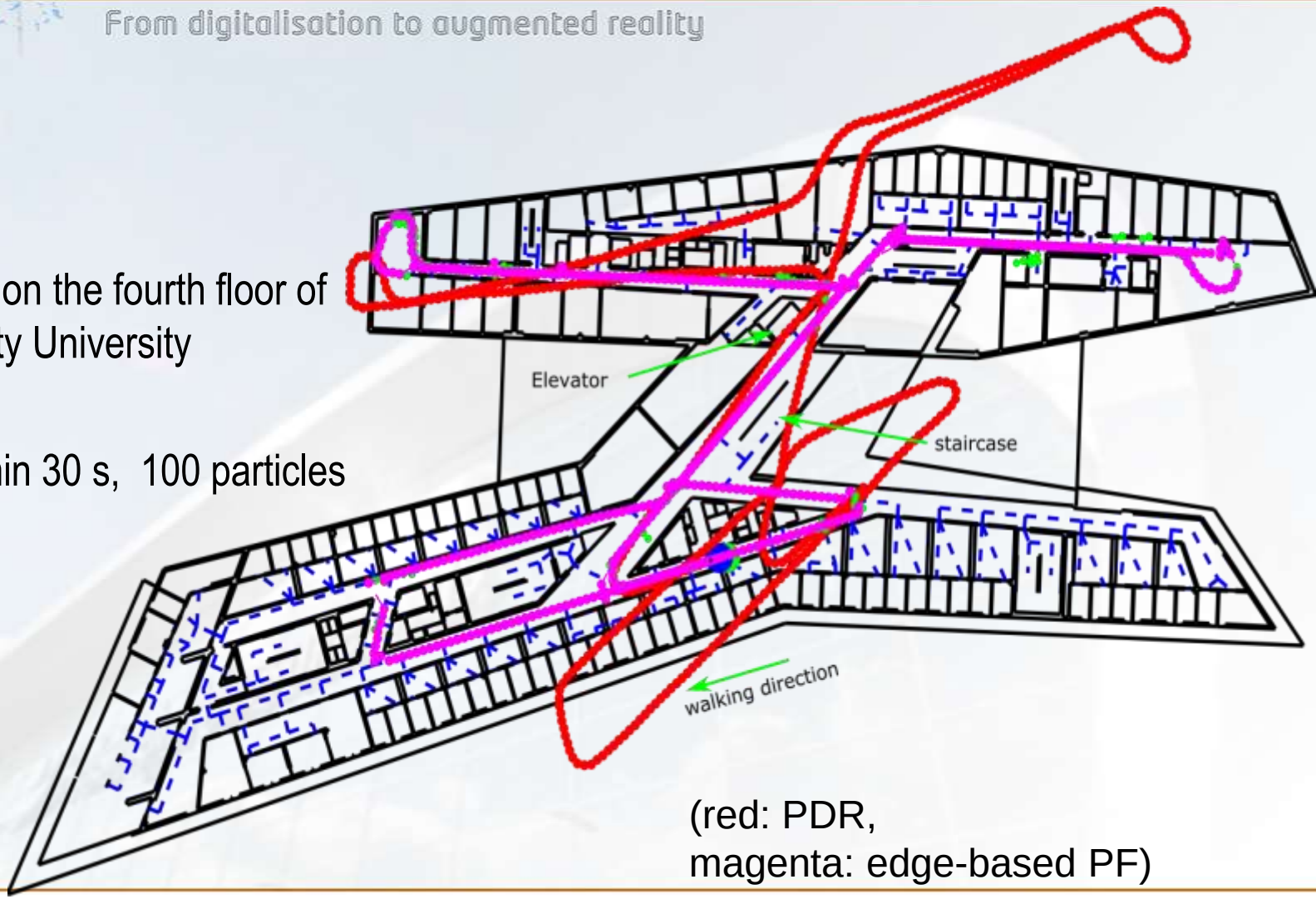
Principle of edge based particel filter



Results

Trajectories on the fourth floor of the HafenCity University

400 m, 7 min 30 s, 100 particles



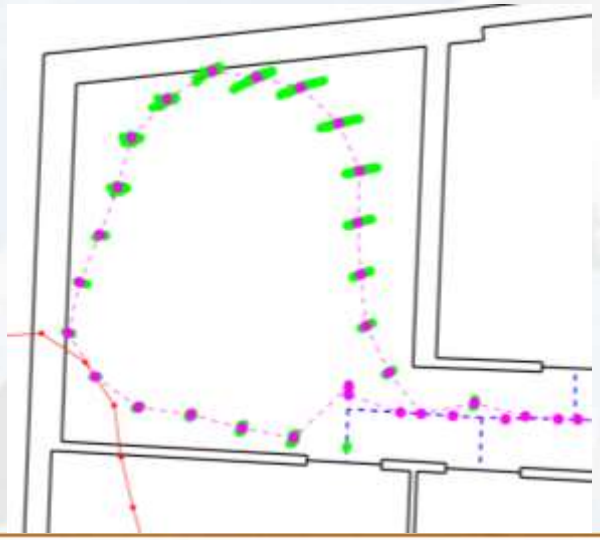
(red: PDR,
magenta: edge-based PF)

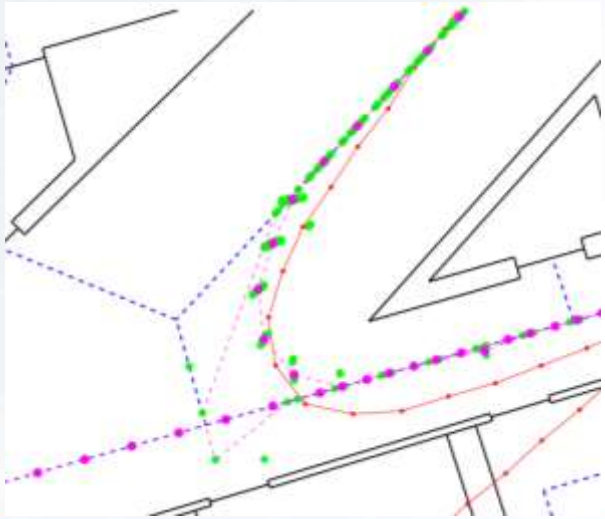
Results

Details of the trajectory

- Spreading of particles (green)
  no corrections → increasing of uncertainty

uncoupling and back coupling of trajectory (magenta)

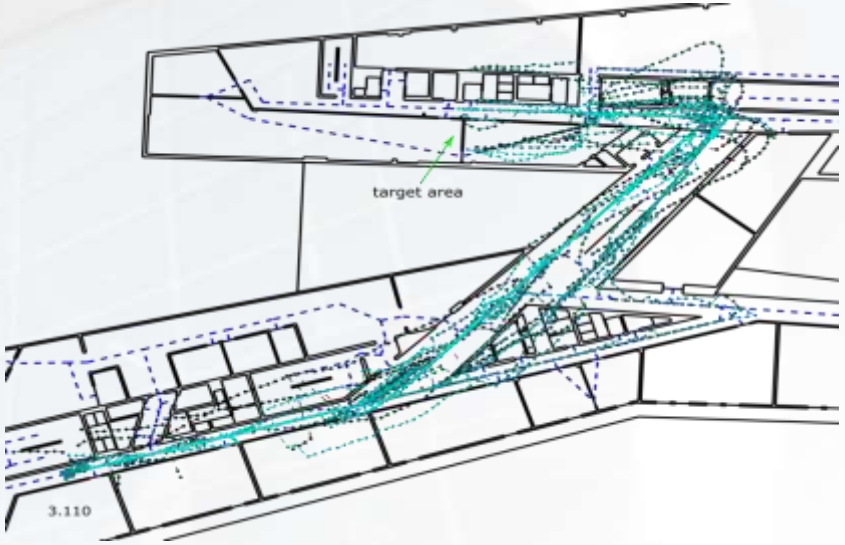


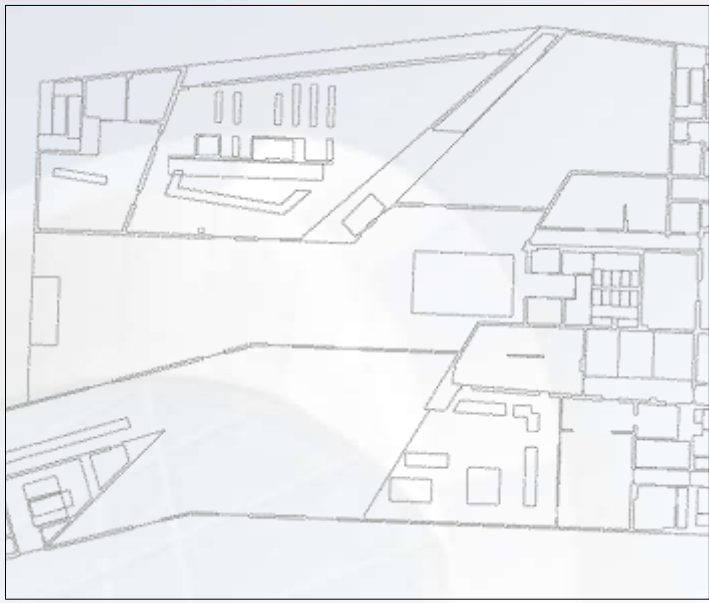


Test

Position estimation of the test data based on PDR without correction information

Position estimation based on edge based particle filter





Conclusion

- actual approach:
  - \+ MEMS IMU and routing graph
  - \+ quality of step length is less important
  - \+ minimization of orientation drift by reinitialization
  - \+ results fulfill the requirements of clear room identification (70% $\leq$ 5m)
  - – non processing of quality information
  - – a routing graph is necessary
- future work
  - – realization in 3D

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A Topological Approach with MEMS in Smartphones based on Routing-Graph

(IPIN, October 2015, Banff)

Concept for building a smartphone based indoor localization system

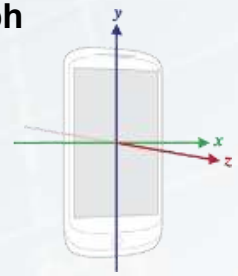
(FUSION2014, July 2014, Salamanca)

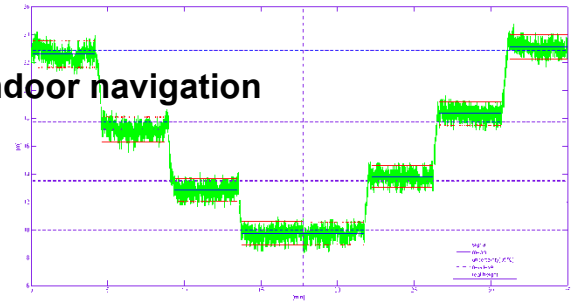
Precise indoor mapping as a basis for coarse indoor navigation

(Journal of Applied Geodesy, October 2013)

Calibration of smartphones for the use in indoor navigation

(IPIN, October 2012, Sydney)





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