Pattern recognition in pedestrian movement trajectories

Colin Kuntzsch Colin.Kuntzsch@ikg.uni-hannover.de
Monika Sester Monika.Sester@ikg.uni-hannover.de

Institute of Cartography and Geoinformatics (ikg)
Hannover, Germany

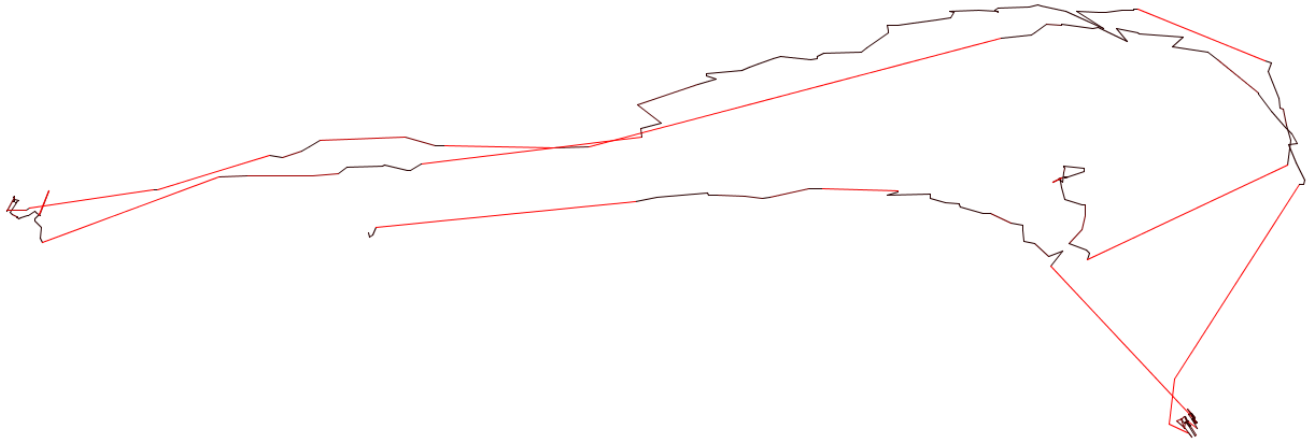
Overview

- BMBF project CamInSens

- Self-organized smart-camera network in a surveillance scenario
- pattern analysis on trajectory data
- collaborative camera tracking: generation of 3D-models
- user interface: visualization of observed anomalous behaviour (large amounts of spatial data)
- investigation of legal boundary conditions

Challenges

- work with huge amounts of spatially distributed trajectory data
- real-time processing → need for incremental algorithms
- deal with limited precision, temporal/spatial resolution, short-term loss of tracking
- identify anomalous behaviour from small sample sizes
- build a scene-specific, spatio-temporal model of common behaviour



Geometric analysis: trajectory attributes

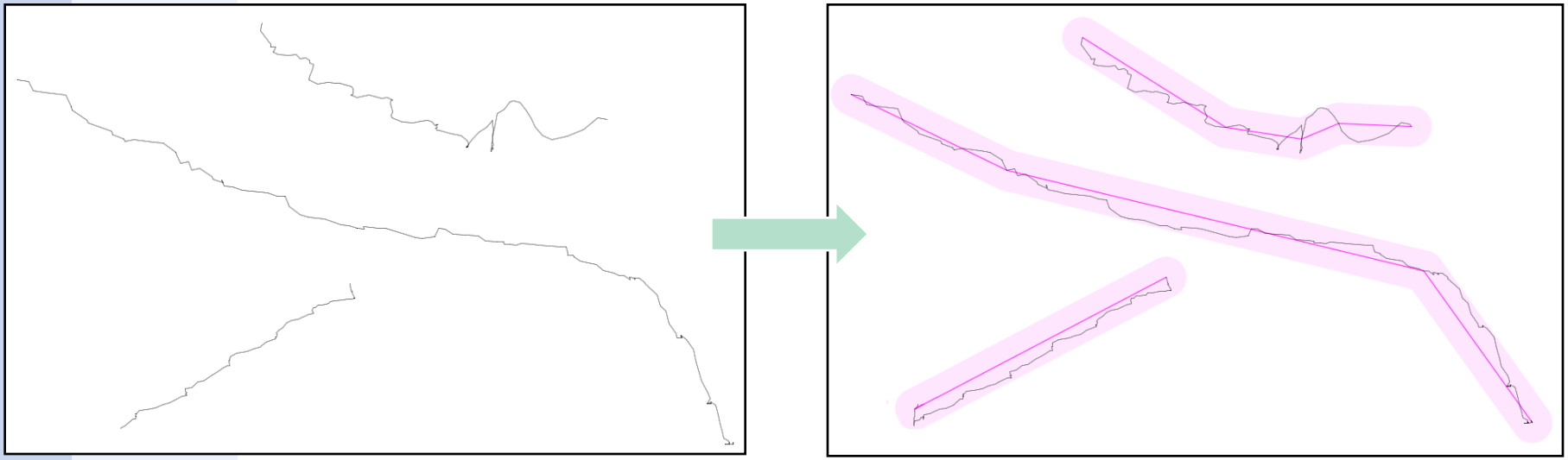
- position, heading
- speed
- periodic lateral movement: frequency, step length

movement prediction

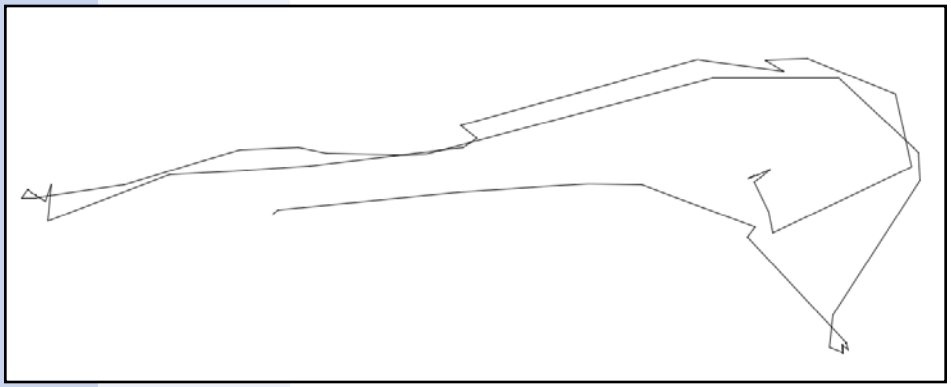
matching of unconnected trajectory segments

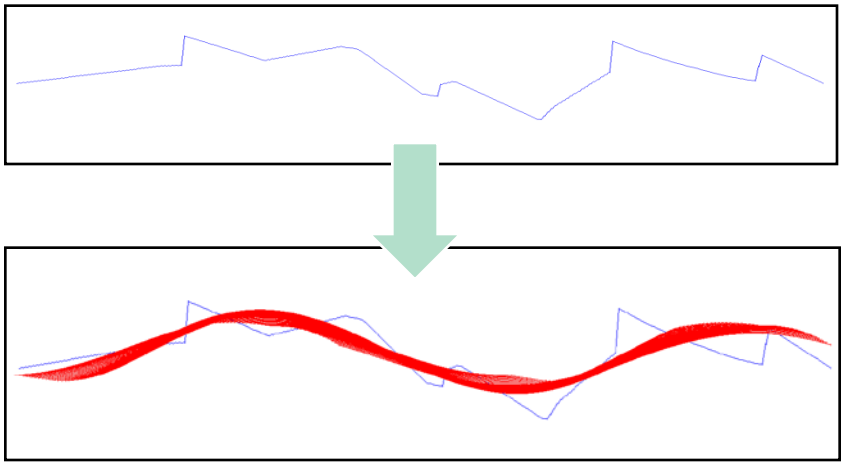
Geometric analysis: trajectory pre-processing

- reduction of noise from trajectory data
- separate significant movement from fine-granular movement
  - piece-wise linearization utilizing a corridor width resembling the average width of human pedestrian movement (0.71 m)
  - swaying: lateral oscillation of trajectories due to alternating foot movement
  - indexing of trajectory with piecewise linear approximation



Geometric analysis: trajectory pre-processing

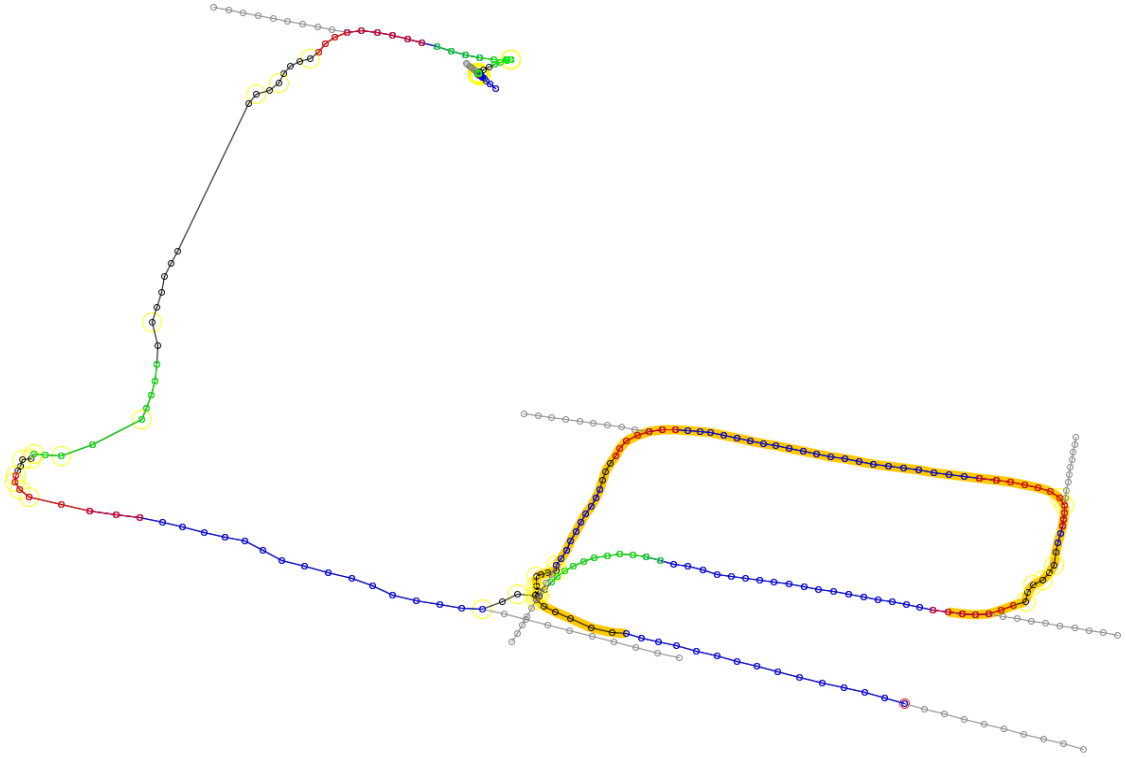




Geometric analysis: segmentation

- Split trajectory up into
  - left/right curves
  - straight movement
  - circular movement
  - stops

semantic interpretation in combination with prior knowledge and other trajectories



Geometric analysis: search for circular structures

- our approach: utilize list of cumulative turn angles
  - sum greater 360 degrees between fixes i and j: at least one (full) circle contained in trajectory segment t[i,j]
  - search innermost circle
  - remove circle from turn angle list
  - repeat until no more circles are found
  - use angle and distance between first/last circle segments for classification of circle

Geometric analysis: search for turns

- similar for turns
  - cumulative angles greater 45 degrees labeled as left/right turns
  - straight segments do not contain turns or circles
  - additional length criterion

Outlook: trajectories within spatio-temporal context

- very few pre-defined patterns to actively look for (hard to identify most patterns from short trajectory samples)

- unsupervised learning of common behaviour within scene
  - typical trajectory attributes (space and time dependant)
  - typical low level patterns (e.g. stops, circles, turns, exits and entries)
  - detection of uncommon behaviour: raise visual notification
  - feedback-mechanism: security personnel manually classifies specific uncommon behaviour as relevant/irrelevant