Automated lane identification using Precise Point Positioning
An affordable and accurate GPS technique

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Contribution

• New technique for dm-accurate gps position
  • Cost: ~ 100 USD
  • Easy to set up
• More accurate than a lane width
• Automatically create maps with lane positions:
  proof of concept
Motivation

- Large focus on lateral management (cooperative active cruise control)
- Lane-specific freeway advice can improve flow
- Next step towards automated vehicles
- 2 steps:
  1) find lane positions
  2) determine lane of veh

Regular GPS

- Three dimensions => 4 satellites
Errors in positions

- Sources:
  - (Predicted) trajectories of satellite
    US airforce provided
  - Atmosphere
- Resulting accuracy:
  - ~5-10 meters horizontally
  - 10-20 meters vertically

Differential GPS
Precise Point Positioning

- Hundreds of base stations
- Sharing measured GPS signals
- Accurate satellite trajectories (+atmospheric distortions) calculated and published

=> used to correct GPS measurement

Testing

- Set-up on a (small European) van
- Real-life freeway test
- Compare with ground truth (D-GPS)
- 4 sessions of each 5 runs
Accuracy

(a) Precise Point Positioning for 4 sessions – different colors – with each 5 runs

(b) Ground truth D-GPS for one run, accurate at centimeter level
- Systematic for a time of day: ~50 cm off
- Random: ~35 cm off
- Accurate enough to identify the lane, if lane positions are known.

Mapping lanes

- Systematic error \(\text{Normal}(0;50\text{cm})\)
- Random error \(\text{Normal}(0;35\text{ cm})\)
- Position in vehicle \(\text{Uniform}(1.8\text{m})\)
- Vehicle position in lane \(\text{Normal}(0;20\text{cm})\)
- Lane changing position during LC 10% of the vehicles uniform over lane width
- Simulation of passings
Simulation results

Fits of results

- Estimated combined normal
  - Offset \((20 \pm 12\text{cm})\)
  - One standard deviation
  - Lane distribution

- For 3-7 lanes: 3 lanes fit best
Sensitivity with fewer observations

- useful estimation if >100 vehicles

(Practical) conclusions & future work

- ~100 USD receiver detecting at ~dm accuracy
- Easy implementation in-car
  (mobile phone a bit more difficult)
- Lane mapping is possible
  - Many vehicles passing =>
    Collect trajectories (openstreetmap, TomTom)
- New possibilities for management and intelligent vehicles
- Proof of concept shows feasibility
- Now: field test for ~100 vehicles
Regular GPS

- One dimension => 2 satellites