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 Normal(0;50cm)
- Random error Normal(0;35 cm)
- Position in vehicle Uniform(1.8m)
- Vehicle position in lane Normal(0;20cm)
- 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

(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