Potentials and Deficits of a recent Approach for urban Traffic Monitoring based on Floating Car Data

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The method

- Periodically transmitted floating car position data (Fig. 1)
- **Basic idea:**
  - Vehicles cluster at traffic signals
  - Assumption: Floating cars homogeneously distributed amongst all cars
  - "Clustering" of floating cars in front of traffic signals
  - Clustering of transmitted floating car positions at traffic signals
  - Correlation between distribution of floating car positions and local traffic density (Fig. 2)
  - Find "correct" density profile (i.e. traffic state) via maximum likelihood estimation (Fig. 3/4)
- Flexible data fusion by a-priori weights (Fig. 5)

Future developments

- Optimized data fusion (optimization of parameters)
- Auto-calibration
- Upgrades
  - Further traffic state variables (delay, volumes, ...)
  - Unsignalized intersections

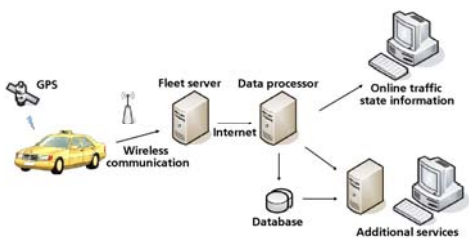

Fig. 1: Typical floating car system.

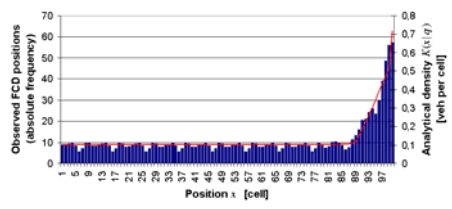

Fig. 2: Correlation between floating car positions and local traffic density.

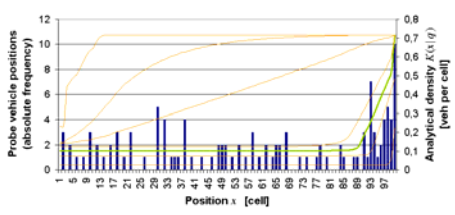

Fig. 3: Optimal fit between observed floating car data and model-based density profiles.

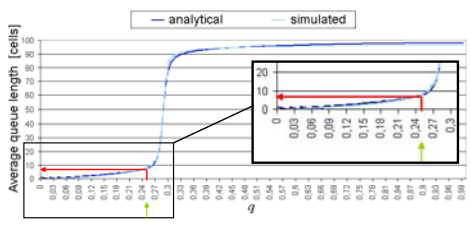

Fig. 4: Estimating the corresponding average queue length.

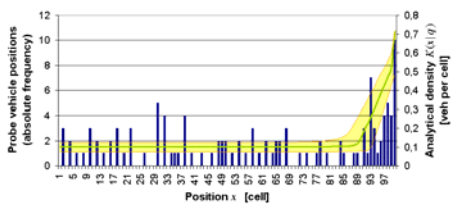

Fig. 5: Flexible data fusion by reducing and weighting the search space.

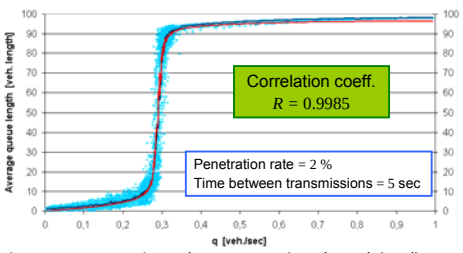

Fig. 6: Comparison between simulated (red) and estimated (blue) queue lengths.

Main results (Queue length)

- Small average error (< 2 vehicles) even at low penetration rates (Fig. 7)
- Accurate estimation of average daily curves (Fig. 8)
- Significant improvements by data fusion (Fig. 7)
- **BUT:**
  - Aggregation with historical data necessary → only offline applications at the moment
  - Calibration of data fusion parameters non-trivial

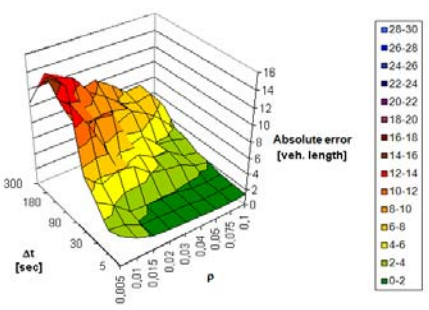

Fig. 7: Average estimation error depending on penetration rate ρ and transmission interval Δt

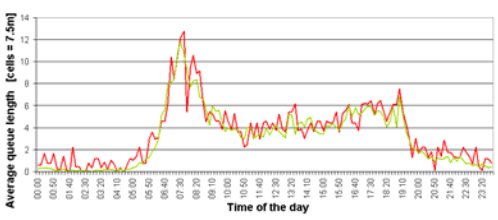

Fig. 8: Comparison between daily curves of estimated (red) and simulated (green) average queue length

Further applications (Examples)

- **Traffic planning**
  - Traffic assignment, simulation (offline)
- **Traffic control**
  - Traffic signal planning (offline)
  - Traffic signal control (online)
  - Dynamic navigation (online/offline)
- **Monitoring and quality management**
  - Long-term shifts of traffic streams (offline)
  - Incident detection (online)

Outlook

- **Integration of C2X data**
  - 2 ways:
    - as common floating car data and/or
    - via the data fusion interface
  - high penetration rates by incorporating private vehicles for traffic management
  - privacy protected as no vehicle identification or tracking needed
- **Backbone of future urban traffic monitoring systems?**

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