YEAR2010
The Young European Arena of Research

Floating-Car Data for Urban Traffic Monitoring – A new Approach, its Applications and Future Visions

Thorsten Neumann
German Aerospace Center, Institute of Transportation Systems, Berlin, Germany
thorsten.neumann@DLR.de

Traffic and mobility are important ingredients of our daily lives. However, as for road traffic, people and environment are suffering from inefficiency, air pollution and noise, for example. Especially in urban areas, the problems are quite obvious. That is why national and local authorities are (re-)discovering traffic management as an integrated component of traffic planning and control to overcome or at least reduce these negative effects.

But, there is no efficient traffic management without reliable traffic information. Despite that, urban traffic monitoring is still underdeveloped due to financial and technological constraints. Because of complex traffic dynamics and road networks in urban areas, it is hardly possible to obtain good area-wide traffic information based on conventional local detectors only. On the other hand, mobile approaches such as floating-car data often suffer from low penetration rates.

That is why a new data fusion method has been developed which theoretically provides relevant information about traffic states at all crucial locations of urban road networks. Mainly based on floating-car data, it yields good results even at low penetration rates ρ by the opportunity to integrate arbitrary additional information about current traffic states where available (cf. Neumann, 2009a). Regarding queue lengths at signalized intersections, Figure 1 shows that high accuracies are obtained for the whole range of traffic demand. Moreover, based on real traffic volumes, Figure 2 depicts an estimated daily curve of queue length compared to simulation.

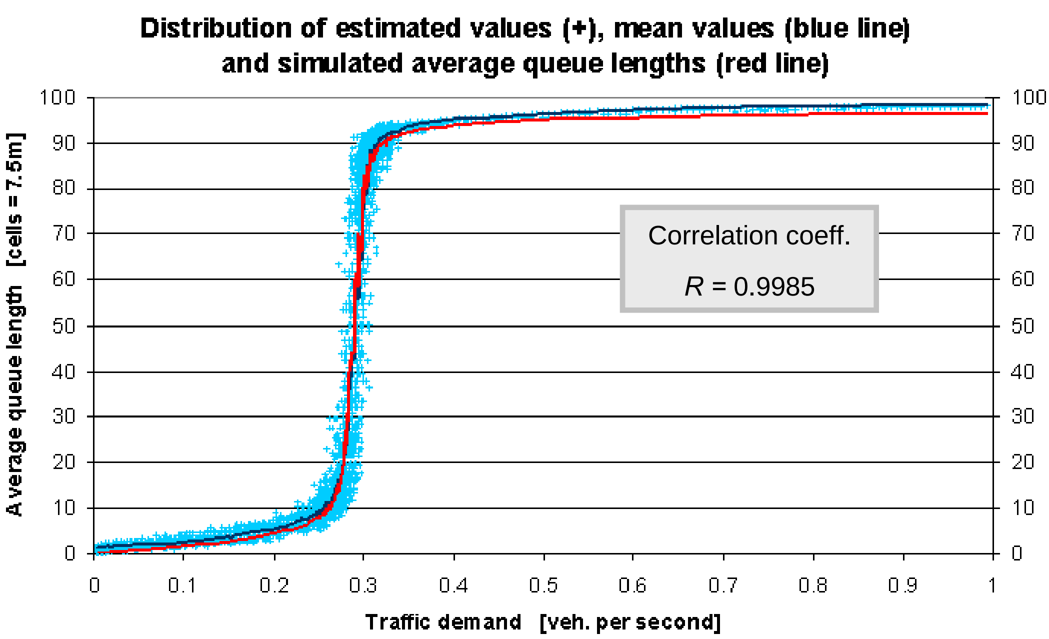

Figure 1: Queue length estimation (ρ = 10%) in case of constant traffic demand.

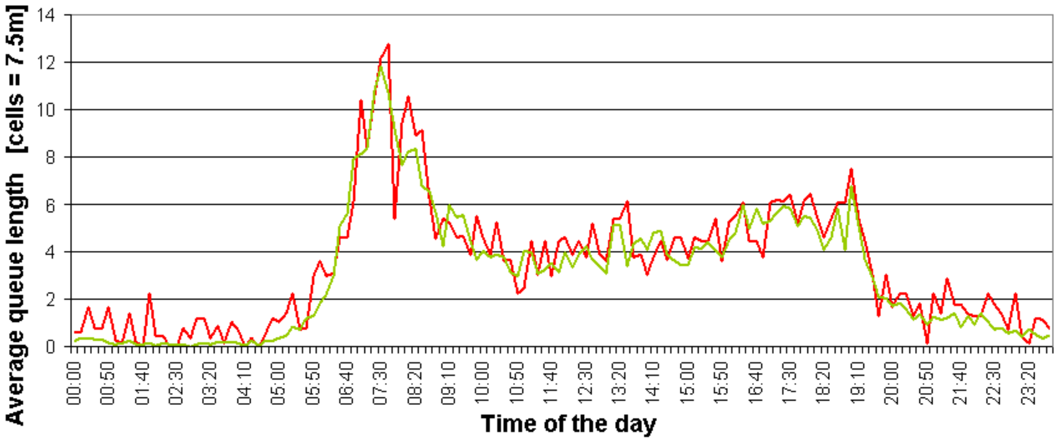

Figure 2: Queue length estimation (ρ = 2%) in case of real daily curves of traffic demand. (Estimation = red line, Simulation = green line)

Now, the new idea of the proposed method is to compare spatial distributions of observed floating-car positions to some model-based profiles of local traffic density (cf. Fig. 3). Favourably in view of privacy concerns, there is not even the necessity for vehicle tracking or similar things as needed for common floating-car approaches (cf. Schäfer et al., 2002).

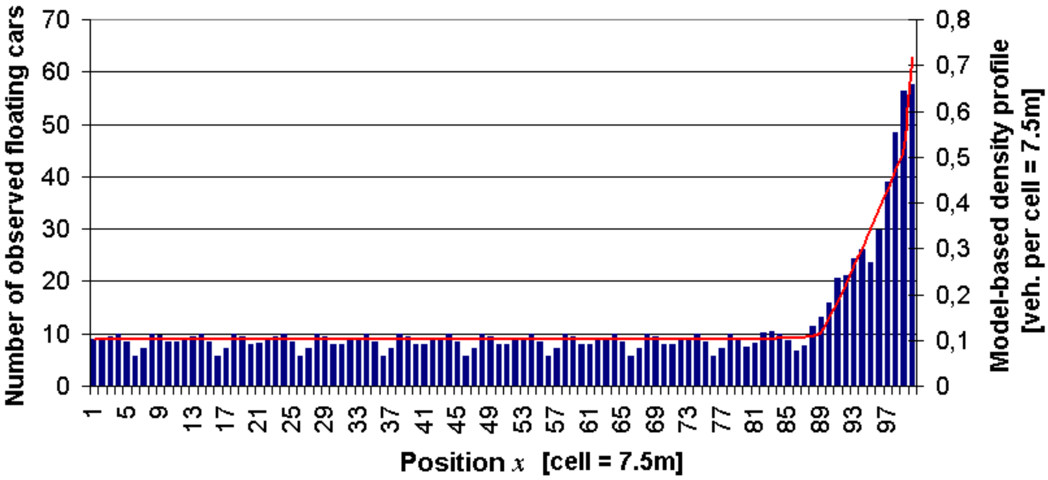

Figure 3: Correlation between spatial distribution of floating-car data and local traffic density.

In reality, of course, just very few data points are available (cf. Fig. 4). Nevertheless, the interesting point is that the density profiles are directly related to other traffic state variables such as traffic demand or queue length via the used traffic flow model. Hence, the only thing to do is finding the correct density profile based on measured floating-car positions which is realized by generalized maximum-likelihood estimation (see Neumann, 2009b). The effectiveness of this approach is demonstrated in Figure 5. Even with penetrations rates less than 0.2%, seasonal effects like a missing morning peak hour because of holidays can be detected explicitly from real data.

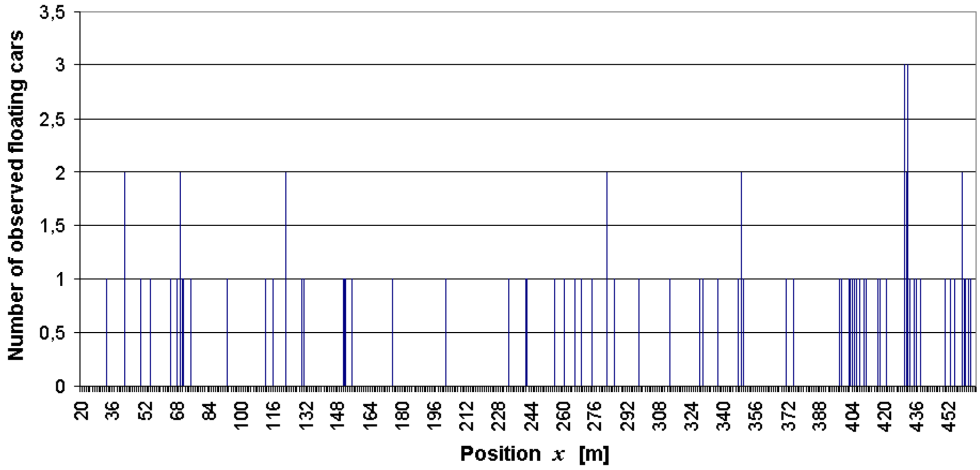

Figure 4: Spatial distribution of real floating-car data.

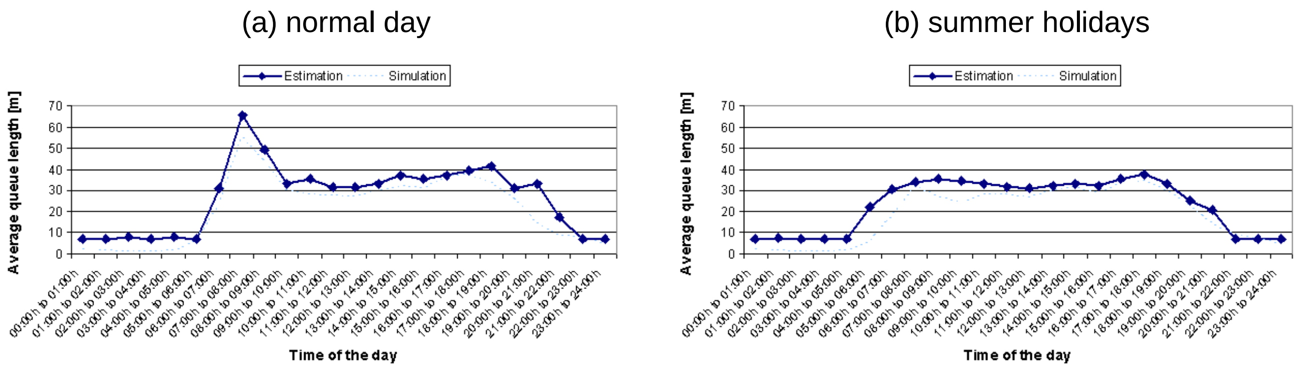

Figure 5: Detection of seasonal effects (summer holidays) from real floating-car data (slightly smoothed).

Needless to say, such information is very useful to many applications concerning traffic management. Starting with offline traffic signal planning and quality management, the area-wide results can also be used to detect long-term shifts of traffic streams, for instance. Furthermore, traffic volumes can be estimated even where conventional traffic counts from local detectors are not available yet. Improvements of traffic assignments which play a major role in traffic planning might be possible. Finally, the proposed method will be able to integrate also future kinds of traffic data (i.e. C2X) very easily due to its high flexibility and the minimal requirements regarding indispensable data information.

References

Neumann, T. (2009a), 'Efficient queue length detection at traffic signals using probe vehicle data and data fusion', *16th ITS World Congress, 21-25 September 2009, Stockholm, Sweden*.

Neumann, T. (2009b), 'High-quality urban traffic monitoring – Theory and evaluation of a promising data fusion methodology', *European Transport Conference, 5-7 October 2009, Leeuwenhorst, The Netherlands.*

Schäfer, R.P., Thiessenhusen, K.U., Brockfeld, E., Wagner, P. (2002), 'A traffic information system by means of real-time floating-car data', *9th ITS World Congress, 11-14 October 2002, Chicago, USA*.