Synchronized traffic
Microscopic modeling and empirical observations

Vom Fachbereich Physik – Technologie der Universität – Gesamthochschule – Duisburg
zur Erlangung des akademischen Grades eines Doktors der Naturwissenschaften
genehmigte Dissertation

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Tag der mündlichen Prüfung 24. Juni 2002

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Abstract

A detailed analysis of single-vehicle data is presented that sheds some light on the microscopic interaction of the vehicles in the various traffic states. Based on these results an improved cellular automaton model for traffic flow incorporating anticipation effects, reduced acceleration capabilities and an enhanced interaction horizon for braking is proposed. The model is able to reproduce the three phases (free flow, synchronized traffic, and wide jams) observed in real traffic. Furthermore a good agreement with detailed empirical single-vehicle data in all phases can be found. It turns out, that the incorporation of the human desire for smooth and comfortable driving into the driving strategy of vehicles leads to a model that exhibits synchronized traffic. Anticipation effects are responsible for a stabilization of the traffic phases and the empirically observed coexistence of wide moving jams with both free flow and synchronized traffic can be reproduced.
It is shown that the single-lane dynamics can be extended to the two-lane case without changing the basic (realistic) properties of the model. Therefore it is possible to reproduce special two-lane phenomena, like the synchronization of the lanes, the lane usage inversion and the density-dependence of the number of lane changes, without adapting the parameters of the model.
Finally, a statistical analysis of traffic data that is provided by an area-wide coverage of the highway network of North Rhine-Westfalia with inductive loops is given. The identification and characterization of the bottlenecks of the network reveal that the bottlenecks are not of topological nature but are constituted by onramps. This underscores the applicability of ramp metering systems.