Modelling of Multi-Lane Traffic Flow for Different Types of Vehicles

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Abstract

The main objective of the present work is to model different drivers behaviours or types of vehicles like cars and trucks. Based on the paper *A Hierarchy of Models for Multi-lane Vehicular Traffic* by A. Klar and R. Wegener [1], a new hierarchy of models for the different types of vehicles are developed. Moreover, the behaviour of entrances and exits are treated.

1 Introduction

The hierarchy for multi-lane models [1] consists basically of three types of approaches to model traffic flow phenomena. First, we consider the microscopic model. Then, we describe a kinetic multi-lane model, and on the last level we obtain the macroscopic multi-lane model, all for different types of vehicles. The links between the models are shown in Figure 1.

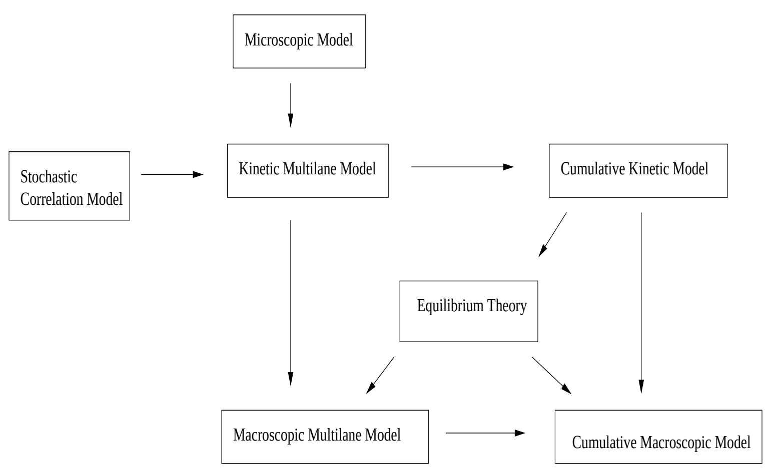

Figure 1: *Links between models given from [1]*

2 The Microscopic Model

The first and most basic one is the microscopic or following the leader model. This model is constructed under the assumption that the time scales allow an instantaneous treatment of the interactions like braking or accelerating between the individual vehicles. This is done with the help of reaction thresholds for lane changing to the left (H_{iL}), lane changing to the right (H_{iR}), braking (H_{iB}), and acceleration (H_{iA}) :

$$H_{iX}(v_i) \quad = \quad H_{i0} + V_i T_{iX}$$

where $X = A, B, L, R$ and i denotes the type of the vehicle under consideration. T_{iX} are the reaction times and H_{i0} is the minimal space a vehicle of type i needs.

3 The Kinetic Multi-Lane Model

Based on the microscopic model a new kinetic multi-lane model is developed. We assume a highway with N lanes. Instead of describing the individual vehicles we use the single vehicle distribution $f_{i,\alpha}(x, v_i)$ defined by the number of vehicles of type i at x with velocity v_i on lane α. Using similar procedures as in the theory of gas we obtain the following kinetic equations for the distribution functions $f_{i,\alpha}$ on the N lanes for the i different types of vehicles:

$$\partial_t f_{i,\alpha} + v_i \partial_x f_{i,\alpha} \quad = \quad \sum_j C_{ij}(f_\alpha) + e^+_{i,\alpha} + e^-_{i,\alpha}$$

where C_{ij} is the interaction operator for a vehicle of type i with a leading vehicle of type j, based on the microscopic interaction rules. $e^+_{i,\alpha}$ and $e^-_{i,\alpha}$ describe the rate of incoming and outgoing vehicles of type i.
Here correlations between the different vehicles are taken into account. The leading vehicle distribution is used to determine the probability for lane changing.

4 The Macroscopic Multi-Lane Model

The third and last level of the hierarchy is the macroscopic model given by a fluid dynamic description on the basis of the moments density and velocity. The stationary solution of the homogeneous cumulative kinetic equation is used to determine the coefficients, like traffic pressure, equilibrium mean velocity and the Enskog coefficient, in the macroscopic equations, which are used to simulate for example queuing effects in bottleneck situations. The macroscopic equations for one type of vehicles are solved and results for a highway with reduces number of lanes, entrances and exits are presented.

References

[1] A. Klar, R. Wegener, *A Hierarchy of Models for Multilane Vehicular Traffic I + II*, to appear in SIAM J. Appl. Math.