Estimation of the Traffic State on a Multisensory Basis Using a Kalman Filter

Master‘s Thesis of Isabel María Armas Guadalupe

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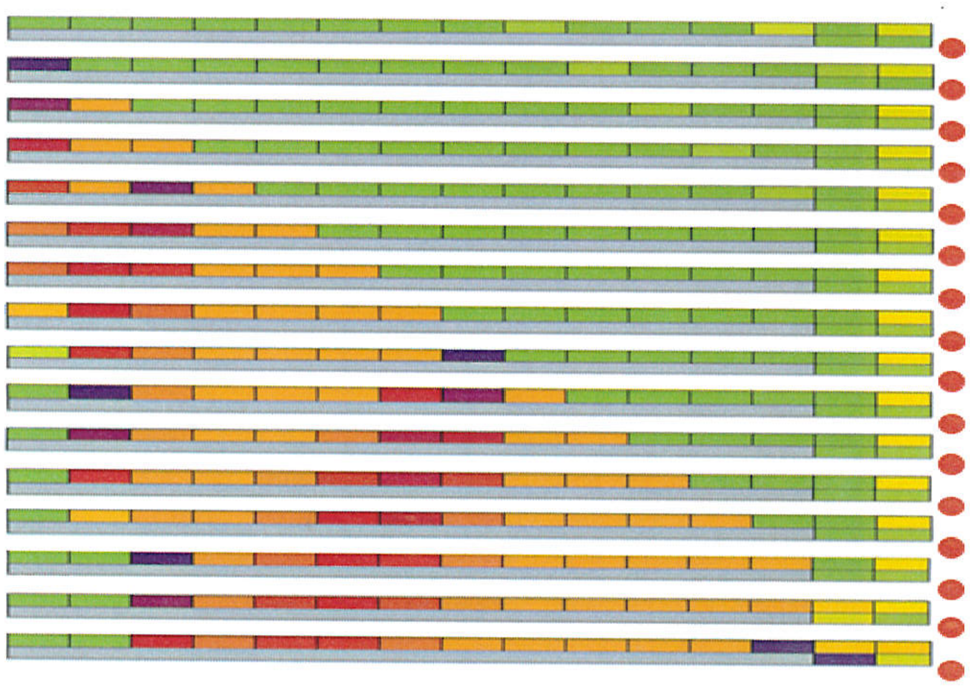
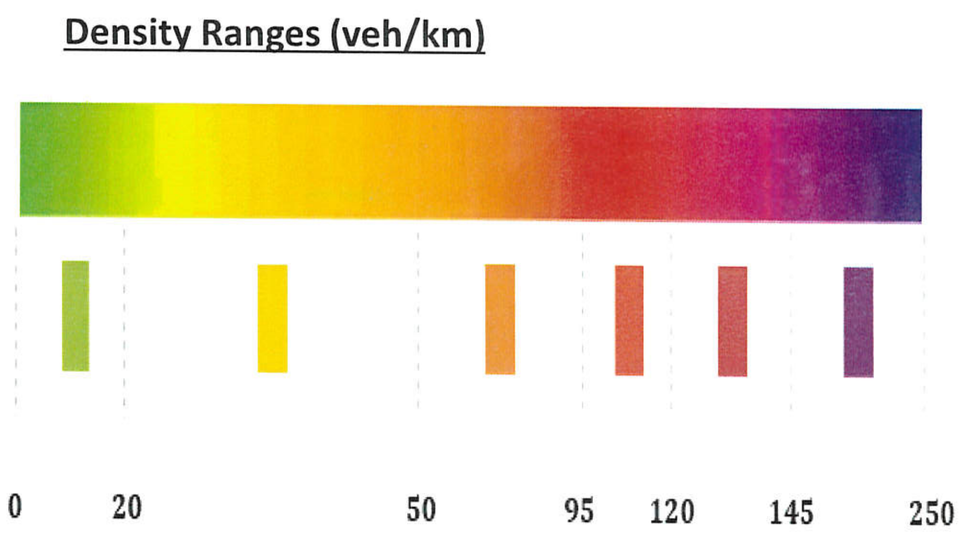
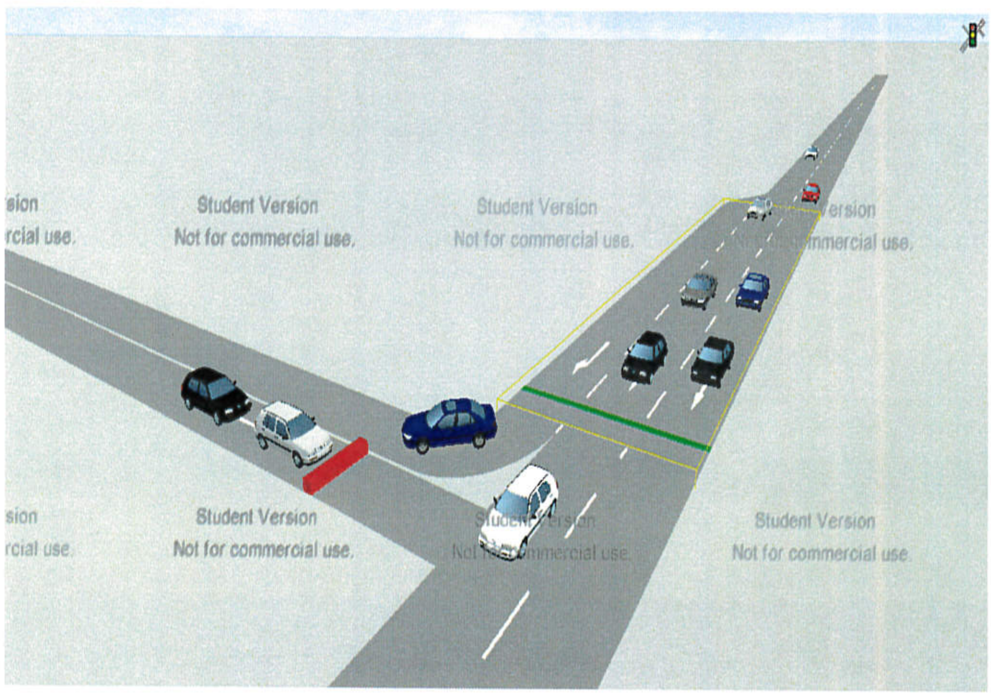


An online traffic flow model for the traffic state estimation of an urban link with two lanes in Ingolstadt is elaborated. For this purpose, four macroscopic traffic flow models are compared. After an objective ponderation of the characteristics of each alternative, the Cell Transmission Model results to be the optimal, and is, therefore, selected. Due to the fact that the CTM is normally used in highway networks, its adaptation to urban conditions became a challenge. A brief explanation of the model is given.
Field data from the German research project VinstaR is included, for which a Kalman filter is integrated. The Kalman filter processes all the available information regardless of their precision, to estimate the current value of the variables of interest. Different data sources (inductive loops and ANPR cameras) are combined in such a way that the mean squared error is minimized.
An estimation of the traffic state at each time step is first predicted with the CTM and corrected whenever measurements are taken by means of the Kalman filter.

This implies that within a prediction-correction cycle the CTM calculates an a priori traffic state estimation, after which the measurements from the different data sources are filtered from noise, and are combined together with the traffic model to obtain an a posteriori, improved predicted traffic state estimation.
The online traffic model is elaborated with MATLAB. The developed algorithm is parametrized, tested and evaluated. The steps for the modelling and programming are described.
Since detailed single data is not available, a microsimulation with VISSIM is calibrated and executed. A comparison between the results obtained in the microsimulation and in the macroscopic online model is realized.
By means of the Kalman filter, the integration of the data obtained by different detectors together with the CTM allows a better approximation of the current traffic state, and is advantageous for online traffic flow models in relation to the microsimulators, although individual entity simulation is not executed.





In conclusion, although the macroscopic models do not simulate each entity individually, they execute the traffic state evolution according to macroscopic variables. With the help of the Kalman filter, data obtained from different detectors can be integrated, and a better approximation of the traffic state at a given time can be obtained. This correction update allows implementing real traffic conditions in the model. Data can be gathered by different sources, but they are all combined in such a way that the estimation of the real existing state with the available data becomes optimal. The microscopic simulation is based on a stochastic vehicle behaviour along the network considering different parameters which are first fixed, but has no relation to the real particular circumstances of the traffic state at a given time and is not updated online according to real measurements collected by the detectors. Because of this, in order to run an online-traffic model, the studied CTM with the implementation of the Kalman filter to correct the predicted state variable seems appropriate, and a better decision than running a microsimulation with no real-time data implementation.