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Review of the Ph.D. thesis

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Title: Modelling and Optimization of Traffic Flow in Urban Areas

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Branch of study: Control Engineering and Robotics

On-line control of urban traffic networks forms a challenging problem, both due to the size of the plant and due to the complexity of the dynamics to be taken into account. Efficient control of urban traffic requires the implementation of a sufficiently accurate model, prediction of the effects of various control and optimization.

Ing. Milan Kutil has tackled all of the mentioned problems. He designed two traffic intersection models – the simple intersection model based on a new queue model, and the general traffic intersection model based on a constant speed of continuous Petri net. Two controllers were applied to the intersection model. At first a linear quadratic regulator based on a linearization of the state equations around an equilibrium point, and at second a nonlinear model predictive controller. Moreover Ing. Milan Kutil designed and programmed approximately 50% of numerous algorithms of TORSCHE Scheduling and Optimization Toolbox for Matlab (pages 67-68). The simulation results of chapters 2 and 3, intersection models and their control algorithms were successfully compared with real data of Prague traffic.

I have the following comments and questions to the thesis:

1. Page 7 The authors assume that it is possible to track every vehicle and its waiting time in the controlled extended queue intersection model. They include the mean value of waiting times and the longest waiting time is assumed to be twice the mean waiting time.
   Is it possible to derive (or to measure) the waiting times of all vehicles in the queue? How is it possible to derive the mean without the assumption(s) above? Don't they distort a little the model design?

2. Pages 19-25 Continuous Petri net models.
   Which reasons and advantages has the new type of conflict resolution algorithm of continuous Petri nets? How does it influence the traffic simulations?

3. Pages 25-29
   Would it be possible to design an intersection model of several intersections modularly? Which problems have to be solved in order to model several intersection closed to each other? (The model complexity and the interactions of sub-models?)

4. Page 64 Would it be possible to include supervisory controllers in the general continuous intersection Petri net model? If yes, which control functions could be supplied by supervisors? Could including of supervisory systems improve some intersection model properties? Which ones?

Review conclusion:

The submitted dissertation work is devoted to highly topical research problems of traffic flow in urban areas. The thesis is a relevant clearly written contribution to the scientific field of the modelling, control and optimization of urban traffic systems.

Original new scientific results were introduced in the thesis (namely in chapters 2 and 3) including new urban traffic models, new conflict resolution of continuous Petri nets, new approaches to the control. The author used appropriate and good substantiated methods and approaches to the solving of the set traffic flow problems. The achieved solutions, proposed methods and results given in the dissertation are correct, well simulated and proved.

I confirm that results of the reviewed dissertation fulfil the required goal and that the thesis meets all requirements assumed for the Ph. D. theses. I recommend to grant Ing. Michal Kutil the scientific degree Ph.D..

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