APPLICATION OF THE QUANTITATIVE HIERARCHICAL MODEL TO COORDINATED RAMP METERING

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ABSTRACT: Transportation is a basic necessity in human society and it has gained increasing importance during the last decades. The subsequent effect of this development is traffic congestion caused by the tension between expanding demand for transportation and limited infrastructure capacity. At present, the most effective way to alleviate traffic congestion is to fully utilize the available resources via appropriate traffic control measures. Ramp metering is considered as the most efficient approach to the control of freeway networks and coordinated ramp metering (CRM) is the prevalent strategy. Current implemented CRM strategies are based on heuristic rule-based approaches, of which the most prevalent algorithm is called HERO. HERO works by balancing the queues of a consecutive series of on-ramps, which lacks flexibility in assigning priorities to certain ramps. Besides, CRM still works locally within a restricted area, but many traffic problems are network related. A new traffic management framework named Quantitative Hierarchical Model (QHM) inspired from Systems Engineering theory is a potential solution to ramp metering issues. The basic concept of QHM is the network. The key components of this framework are recursive partitioning of networks (hierarchical) and priority set tings (quantitative). Therefore, the aim of this thesis is to design a new algorithm by applying the QHM theory to Coordinated Ramp Metering. The research is conducted via simulation. A microscopic traffic simulator, VISSIM, is applied, which is controlled by Matlab via VISSIM COM. The general idea of the algorithm is to distribute inflows among different entries based on the allowed outflow, then examine whether the actual outflow follows the allowed value. Meanwhile, the network should still maintain a desired speed. The main discovery of this research is the feasibility of QHM to CRM in our system settings. To be specific, the distribution of priorities among different entries is possible and the real inflow conforms to the corresponding priority. Beside, by distributing priorities, the allowed outflow can be achieved, while the network can still maintain the desired speed. Though the research objective is achieved in this case, it is still far to go to draw the conclusion that QHM can be a substitute to current CRM strategies. In my research, many assumptions and simplifications have been made, which may deviate from reality. In future research, more realistic system settings should be added and a stepwise bigger network should be built. Moreover, feasibility of this framework in practical deployment should also be investigated.

Key words: Coordinated Ramp Metering (CRM), Quantitative Hierarchical Method (QHM), HERO algorithm, priority distribution

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