Adaptive Traffic Signal Control Using Vehicles' Delay Times

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Introduction

Effective traffic management in signalized road networks is mainly based on an efficient allocation of available green times. At isolated intersections this task is usually realized by fixed time or vehicle actuated controllers. The fixed time controllers are cost-efficient and reliable, but offer no opportunity to handle rapidly changing demand patterns.

In this case a vehicle actuated controller performs better because a running green phase is only terminated if a queue on an approach is completely dissolved. The optimal moment for the phase shift is characterized by the first vehicle time gap larger than a critical value. If all went well, this scheme minimizes the accumulated delay times.

Delay Based Signal Control

Controlling Scheme

Beside the usage of time gaps, the presence of a queue can also be detected by processing vehicles' delay times: Bounded by a minimum and a maximum green time, a running green phase is terminated as soon as the last vehicle with a delay greater than zero passes the stop line.

Data Sources

The strong benefit of this approach is that it can be applied to all the state-of-the-art traffic data sources like FCD, C2I and cameras. Cost-intensive maintenance of conventional inductive loops can be avoided, while at the same time the redundancy of the traffic signal increases.

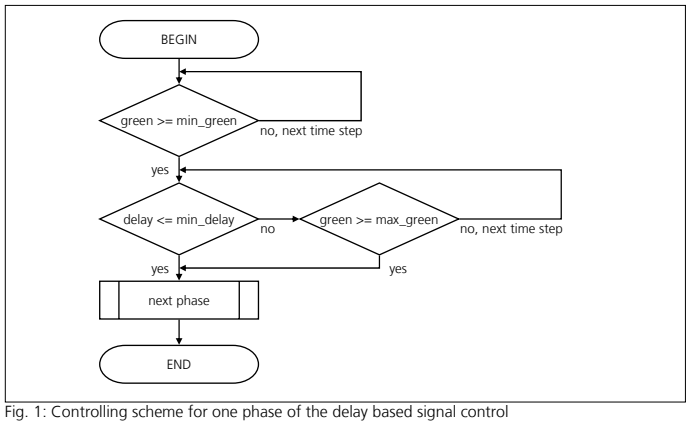

Fig. 1: Controlling scheme for one phase of the delay based signal control

Simulation Study

Study Area

To benchmark this new method a simulation study was done. An intersection consisting of two crossing one-way roads was modeled and various demand scenarios were tested. The delay times were gathered from (simulated) GPS probe vehicles. We compared the new method against an optimized fixed time control, and against an adaptive control, actuated by the time gaps of the arriving vehicles.

Results

Depending on the rate of probe vehicles and the demand, a significant gain in travel time towards the two reference control schemes can be obtained. Especially high degrees of equipped vehicles induce positive effects.

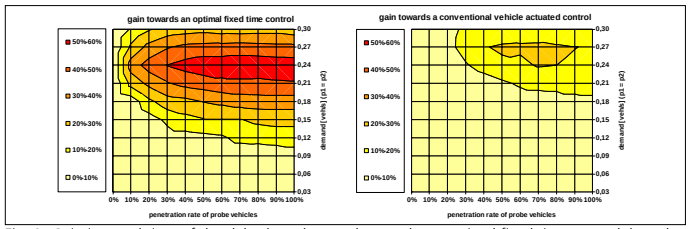

Fig. 2: Gain in travel time of the delay based control towards an optimal fixed time control, based on the Webster equation, and a conventional adaptive control, actuated by time gaps

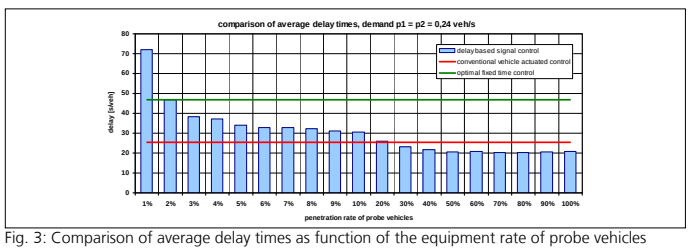

Fig. 3: Comparison of average delay times as function of the equipment rate of probe vehicles

Conclusion

The presented signal control scheme promises to be another efficient approach to fight congestion. To consolidate the first simulation-based results, some more complex scenarios, including a network of intersections, have to be simulated and if this turns out to be successful, a test in the field should be the final step.

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