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Delay Based Signal Control for an Isolated Intersection

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Effective traffic management in urban areas is done by adapting traffic signal times to current traffic conditions. At isolated intersections this task is usually realised by fixed time or by conventional vehicle actuated signal controllers. The fixed time signals use predefined green times, they are reliable and cost-efficient but offer no opportunity to adapt on-line. Especially with rapidly changing demand patterns, the vehicle actuated controllers perform better because decisions whether to keep or to switch a phase are based on measurements of in-road equipment. However, being more flexible although means reduced availability if detection equipment gets out of order, leading to increased maintenance costs. Concluding, an improved signal control should combine high flexibility with sufficient reliability.

One possibility to reach this aim could be the usage of alternative traffic data sources (Wagner et al., 2009). The idea is to shift the detection to the vehicles themselves, do measurements on-board and send the values via a wireless connection to the traffic light controller. Each vehicle equipped with capturing technology is an independent sensor and increases redundancy, while no stationary in-road detectors are required anymore. Capable systems are already in the field (GPS probe vehicle data) or on the verge of rollout (vehicle-to-infrastructure communication).

For this purpose a new controlling approach has been developed (Oertel, 2009) which uses probe vehicle data to identify vehicles' delay times at intersections. These delay times are utilized to extend or to terminate a running green phase in the following way: As soon as the last vehicle with a delay greater than zero passes the stop line, the waiting queue caused by the previous red phase must be cleared and the phase is terminated. Considering minimum and maximum green times, a complete dequeuing for each arm is done sequentially. However, the penetration rates of probe vehicles may vary and are usually close to zero. To handle this common case in an appropriate manner, the original idea had been enhanced.

To benchmark this new approach a simulation study was done. A simple intersection, consisting of two crossing one-way roads was modelled and various demand scenarios were tested. The performance metric was the average delay time per vehicle which was used to compare the new approach with a conventional fixed time control, optimized for each demand combination (Webster, 1958) and with an adaptive control, actuated by the time gaps of the simulated vehicles. As an example, the case with two equal moderate demands of 756 veh/h is displayed in figure 1, showing the benefits for the proposed method.

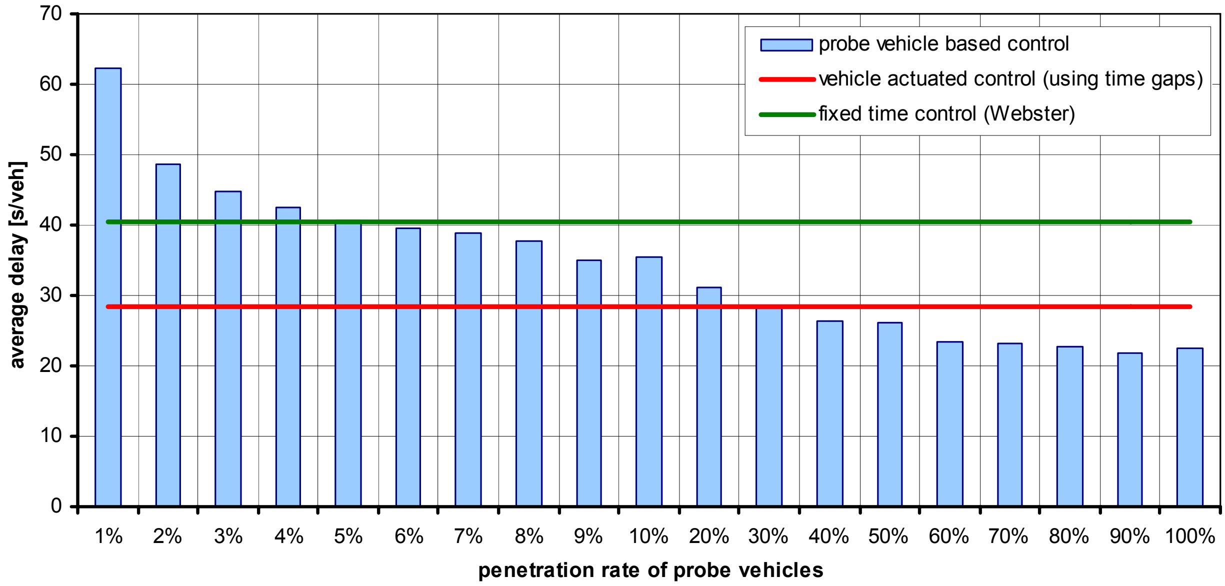

Figure 1: Delay times (average of 10 simulation runs) for the probe vehicle based approach in comparison to an optimized fixed time control (Webster, 1958) and to a state of the art vehicle actuated control gathering time gaps, demand q = 756 veh/h in each direction

The next steps will be the further consolidation of these promising but simulation-based results and a real-life application. If this test in practice turns out to be successful, the traffic management of the 21th century has another cost-efficient means to fight congestion and to improve mobility.

References

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