Integration of Floating Vehicle Data for Online Traffic Signal Control Optimization

Master's Thesis of Stamatia Politi

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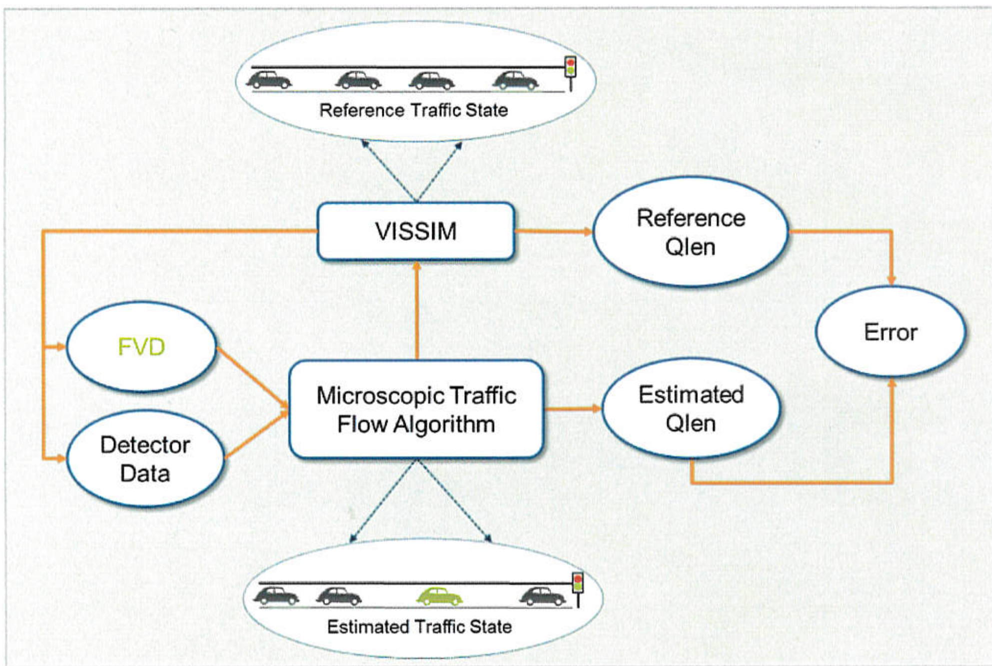
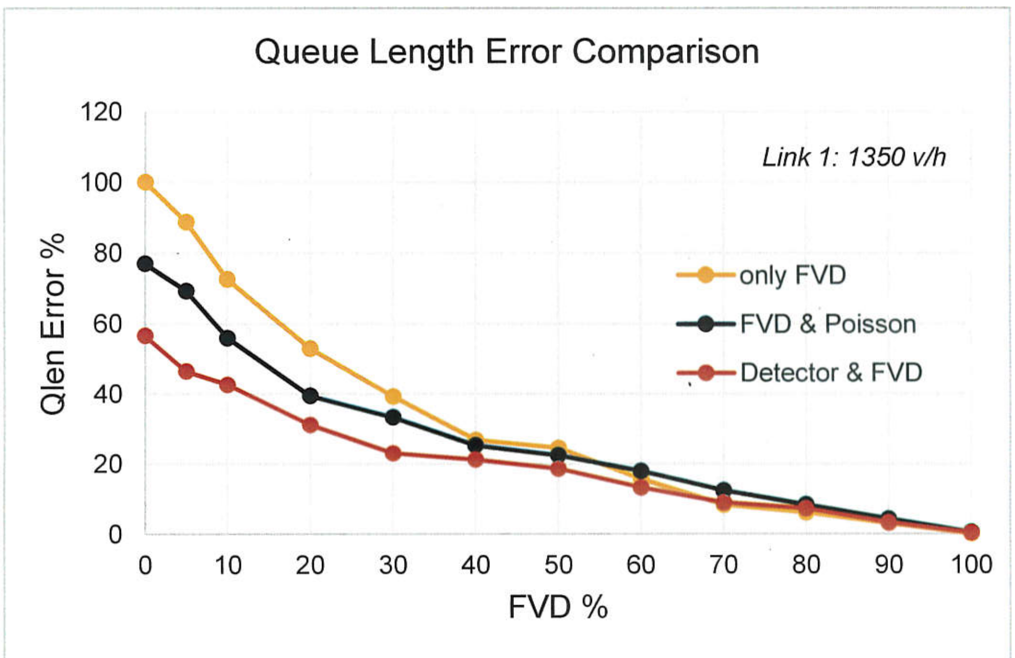


Inductive loop detectors are the most common traffic data collection technique for traffic flow optimization at signalized intersections today. In light of arising communication technologies, information from vehicles become available and can be used as an additional data source. In the near future it is expected that connected vehicles will generate 200-300MB of data per second arising new perspectives for the traffic optimization. Hence, the scope of this work is to explore the potentials that rely in the high amount of data from connected vehicles in relation to adaptive traffic control systems in urban areas. Mainly two research questions are set in this work. First, the extent to which Floating Vehicle Data (FVD) can improve the traffic state estimation and in particular queue length estimations by offering more accurate inputs to signal control algorithms similar to UTOPIA. Second, the minimum FVD penetration rate needed to reduce stationary detection while maintaining a comparable performance of the traffic signal control algorithm.

A queue length estimator has been developed that integrates data from stationary detection as well as connected vehicles. While the aforementioned approaches are designed for near stop line detectors, a new type of algorithm has been developed for detectors that are located at the beginning of a signalized approach. This detector configuration is used for UTOPIA. The queue length estimator is based on a microscopic traffic flow algorithm and includes online detector data and data from connected vehicles in order to improve the estimation of queue lengths. Furthermore, the algorithm can be operated relying on data from connected vehicles only. In this case, a stochastic arrival pattern is assumed for non-equipped vehicles which can be enhanced with offline traffic counts. In this study area, different scenarios have been scrutinized within a microscopic simulation environment involving VISSIM and UTOPIA, in order to evaluate the possible benefits of an integration of FVD depending on the penetration rate.



The results from a study area in Verona, Italy show that queue lengths estimation can be improved greatly with the use of data from connected vehicles, comparing the VISSIM measurements and the estimated values derived from the relevant algorithm developed in this study. It appears that on links with high traffic volume, 10% additional probe penetration rate leads to accuracy improvements between 20 and 30%. Aiming at the deployment of ATCSs requiring less stationary detectors, queue lengths are also estimated relying only on offline counts and data from connected vehicles. The results suggest that to reach a mean estimation error equivalent to the one obtained with detectors only, a 20% penetration rate is needed when using a naive algorithm that relies only on FVD data for estimating the queue length. When using an improved algorithm that also accounts for empirical traffic volumes and randomly adds cars following a Poisson distribution, only 10% FVD is needed to reach the accuracy obtained with detectors only.