Estimating dynamic roadway travel times

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We consider the problem of estimating the time required to travel a route between two points. Large traffic volume, road construction work, accidents and adverse weather may cause delays. Thus, the travel time varies with time. We wish to construct a dynamic estimator based on samples of individual travel times. A challenge is to create a robust travel time estimate that is not affected by vehicles that pause or run detours. For road sections with public-transport lanes, we want our travel time estimate to be representative of the lanes provided for the ordinary traffic.

Electronic toll collecting systems provide background data for high quality travel time estimation. From such data vehicles driving in public-transport lanes are easily identified. However, electronic toll collecting systems are expensive, and installation may require undesirable road closing. Therefore, alternative sources for collecting data have been considered.

We have, in cooperation with the Norwegian Public Roads Administration, studied the use of Bluetooth technology to calculate travel times. This technology is based on Bluetooth antennas mounted at points along the road detecting Bluetooth devices in passing vehicles. The equipment needed for collecting data is relatively cheap and easy to install. However, this kind of data may lack information to distinguish the vehicles in the various lanes. Therefore, in order to facilitate the task of estimating travel times, we need to impose some conditions on the probability distribution of individual travel times. In this study, we assume that the mode of this distribution is a representative travel time for the ordinary traffic lanes.

Our suggested procedure for estimation of travel times is nonparametric and consists of two steps. In the first step, we estimate the probability density of individual travel times. The density estimate at time t is based on travel times of vehicles arriving at the endpoint of the route within a certain time interval ending at t. In the second step, we determine the travel time that maximises the estimated probability density at time t. We have investigated properties of the proposed estimator.

The methodology has been tested on data from a highway in Norway with multiple lanes. The results show that our approach in periods with a sufficient number of passing vehicles yields reasonable travel time estimates. In particular, delays due to heavy traffic can be detected.

Keywords: Time-varying probability distribution, Nonparametric mode estimation, Roadway travel times.