Extended abstract for IWTDCS 2018

Title: Investigations of Electronic Toll Collection (ETC) 2.0 system -validation of map matching algorithm and analysis of spatial deviation in observed data-

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1. Introduction

This paper describes the investigations of the Electronic Toll Collection (ETC) 2.0[1] system. The ETC system was originally developed for collecting toll in expressways. Recently, the new version, ETC 2.0 is developed. The user installs an in-vehicle device and it is connected to the central system when they pass through the "ITS spot". They can get information about traffic congestion, safe driving, route guidance, and so on through the device. When the device receives the information, at the same time, it sends the accumulated trajectory data. The ETC 2.0 device with GPS logger installed in a vehicle observes vehicles trajectory, which is location, velocity and acceleration basically every 200-300 m and the data is accumulated in the device. When the vehicle passes through the ITS (Intelligent Transport Systems) spot where the Roadside Unit (RSU) is installed, the data can be uploaded by DSRC (Dedicated Short Range Communications) to the central system. The point is that the memory capacity of the ETC 2.0 device is limited. The trajectory for around 80 km can be accumulated in the devices. Unless the data is uploaded for more than that, the data is over written and deleted. The image is shown in Figure 1. Therefore, we need to clarify the spatial deviation of the ETC 2.0 data. The data around ITS spot is supposed to be much observed. In the area with no ITS spot, on the other hand, the probe data is not much observed. It causes deviation of the ECT 2.0 probe data. In addition to that, for practical use, we need to aggregate the observed dots data into link data, origin-destination (OD) data and so on, and to evaluate the quality of the data.

In order to aggregate the dot data into link data, which is called map matching, we employ the map matching method proposed by Asakura and Hato[2] because the ETC 2.0 data is a little sparse. The method is that every dot has an expected area the actual location should be included, and that the sub-network, which is the summation of the areas, is constructed. Within the sub-network, we estimate the routes, applying the shortest path search algorithm. The benefit of the method is that we can use sparse data because the main algorithm is just shortest path search.

We conducted two investigations in Matsuyama city for a month, November 2017. The one is that a car installing an ETC 2.0 device runs from given origins to given destinations with a GPS (Global Positioning System) logger and a driving recorder. The other is that 30 people are driving their cars which install the ETC 2.0 devices as usual with GPS loggers. The

purposes of the two investigations are to validate the map matching algorithm which is constructed for ETC 2.0 data and to clarify the spatial deviation in ETC 2.0 observed data respectively.

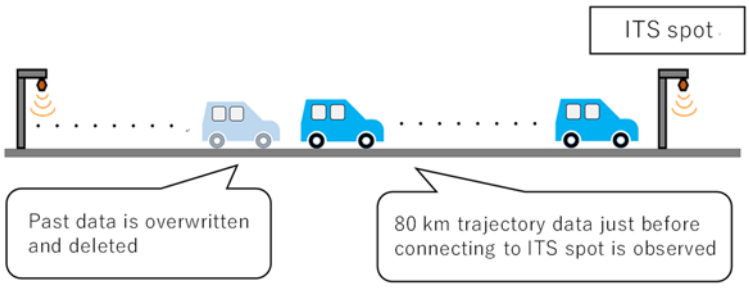

Figure 1 Deleted and observed data

2. Investigation I

The first investigation is conducted for validating the accuracy of the map matching algorithm. In order to make the data set for the validation, we borrow a car and ask a professional driver to drive it. Two GPS loggers and driving recorders are installed on the car to make sure where the car runs. The car is driven to visit the destinations one by one. The route between an origin and a destination is not given. Therefore the route choice depends on the driver. The period of the investigation is from 3rd to 29th November 2017. The car runs for eight hours from 9 a.m. to 5 p.m. every day. The destinations are chosen so as the route covers whole the city. The examples of the destinations are stations, supermarkets, temples and so on. To be sure that the ETC 2.0 probe data is obtained, the route passes through the ITS spot at least every 80 km. From the GPS logs and driving recorder's movie, we make the actual route data set. On the other hand, we make data set by conducting map matching from the ETC 2.0 data. By comparing them, we evaluate the accuracy of map matching algorithm and clarify the features of the map matching algorithm.

3. Investigation II

The second investigation is that we ask 30 peoples install a GSP logger in their car to trace their cars' trajectories. From the GPS logs, we know their actual origins-destinations of trips. On the other hand, we can make origin-destination data set from the ETC 2.0 data. By comparing them, we can know the spatial deviation of observation of ETC 2.0 system.
The period of the investigation is from 1st to 30th November 2017.

4. Discussion

In a full paper, we analyze the data from the above two investigations. As a result, the accuracy of the map matching algorithm and the spatial deviation of the ETC 2.0 data are clarified.

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References
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