

On the subject of probe data

FUJIMOTO Satoshi,

Director of the Research Center for Advanced Information Technology

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1. Introduction

Recently, we often hear talk of “probes”. The dictionary definition of a “probe” is “a slender, flexible surgical instrument used to explore a wound or body cavity”, or “a vehicle equipped to obtain scientific information (space probe)” (extracts from Collins English Dictionary). In the field of electronic devices, meanwhile, a probe can also be a lead connecting to or containing a measuring or monitoring circuit used for testing.

In the field of road traffic, a traveling vehicle fitted with sensors is called a “probe car”, and the data collected by those sensors are called “probe data”. Moves are afoot to take these data and subject them to processing and analysis, making them available for broad use in services in the road traffic sector.

2. What is a probe?

While the term “probe” is still somewhat unfamiliar in the field of civil engineering, it has long been in common use in other fields. To quote a recent case, for example, when the unmanned spacecraft Hayabusa returned to earth with microparticles from the asteroid Itokawa, the BBC reported the news with the headline “Japan probe collected particles from Itokawa asteroid”. It is also used with frequency in a social or political sense, and is often seen in English-language news (for example, in connection with ‘spy probes’ or investigations of contagious diseases).

In the road traffic sector, the use of probe data was first considered in the second half of the 1990s. In 1999, for example, the Japan Automobile Research Institute (JARI) led an initiative for a “Feasibility study on the development of an ITS probe car system”, while at around the same time the Ministry of Land, Infrastructure, Transport and Tourism started studying the use of probe cars in highway administration. An example of this was a study on the creation of a probe car system by the Chugoku Regional Development Bureau. Monitoring devices fitted with functions for obtaining positional and other data using GPS (global positioning systems) and functions for communication were attached to vehicles constantly in use, such as official vehicles and buses. Existing communication networks were then used to gather positional data from each vehicle with the passage of time.

3. Probe data

Probe data that can be obtained from a motor vehicle

include data obtainable from navigation systems, such as the time and position (longitude and latitude), i.e. data on the vehicle’s running history, and front-rear acceleration or right-left acceleration, i.e. data on the vehicle’s performance history. Since these probe data can be obtained continuously over time from each single vehicle, if a system could be constructed whereby data could be acquired from a considerable number of vehicles, it would allow us to monitor the state of road traffic at any chosen location or point in time.

Probe data on the running history mentioned above is obtained by aggregating compound technologies consisting of GPS technology, map matching technology, and digital road maps. Of these, positional measurement by GPS can take two forms, namely single point measurement and relative positional measurement, the former of which is used for car navigation systems. With this method, the position of one’s own vehicle and the time of that position are obtained by calculating the longitude, latitude, elevation and time (i.e. the time on a nuclear clock mounted on GPS satellites) by receiving transmission signal data from four GPS satellites. The data received here, however, are inconsistent in their precision, owing to ionospheric delay in the radiowave propagation pathway, the state of the earth’s atmosphere, and other factors. GPS receivers in common use are set to a standard allowing them to receive positional identification to within 10 meters from the correct longitude and latitude to a probability of 95%. In future, this inconsistency is expected to be vastly improved through the use of quasi-zenith satellites. However, it will probably be some time before quasi-zenith satellites are operating 24 hours a day over Japan; only one (“Michibiki”) is in orbit at the moment, and two more are still needed.

Map matching technology is a corrective method whereby, since cars basically only drive on roads, the longitude and latitude obtained by GPS positional measurement are plotted on the links on a digital road map. While this method has been used by various navigation system manufacturers to improve precision using their own technology, there are some complications with patents. As a result, each manufacturer uses a different specific technique producing a different level of precision, and the method is not yet in the public domain.

As shown above, probe data on a vehicle’s running

history obtained from car navigation systems currently present some problems over the inconsistency of precision when in use.

4. Verification of probe data

With a view to starting a nationwide service using ITS spots between January and March 2011, the Ministry of Land, Infrastructure, Transport and Tourism has installed about 1,600 ITS spots, mainly on expressways all over the country, in a public-private collaboration. The spot communication used in these ITS spot services has the characteristic of facilitating large-volume communication in both directions.

Car navigation systems compatible with ITS spots are fitted with GPS receivers, acceleration sensors, gyrosensors and other devices, allowing them to obtain and accumulate the vehicle's running history data and performance history data. The probe data accumulated here are up-linked every time the vehicle passes an ITS spot, and are also aggregated in the probe server. The data thus gathered are called "road probe data", to distinguish them from other probe data.

The use of road probe data is being considered in a variety of situations, but for the time being, the aim is to process them into average traveling time and average traveling speed per unit of links on digital road maps. This will make it possible to capture the daily changing state of road traffic at any time.

However, while a variety of devices are being developed and gradually starting to be used to gather

road probe data, before that, as stated in the previous section, I think the gathered data will need to be verified. Specifically, this system has been given parameters that can be set as appropriate by the administrator (for example, when calculating average traveling time and producing data on a given vehicle traveling significantly faster or slower than the average, the threshold value for removing or retaining those data). Nevertheless, I think it will be necessary to tune these to appropriate values, having verified the relevance of these parameter values using actual data. Also, it will be essential to verify whether or not the data are being processed in the sequence specified in the equipment specifications, or whether or not the data are being uplinked in accordance with the format of road probe data determined in advance.

5. Conclusion

In this modern age of advanced car electronics, many other types of data exist as probe data related to motor vehicles, besides those mentioned here. One direction for research in the ITS field in future could be to study how effective use can be made of these probe data, but verifying the data themselves will be indispensable as a prerequisite to that.

Reference

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