Floating Car Data for Traffic Monitoring

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Abstract
This paper describes a complete prototype system that uses Floating Car Data (FCD) for both automatic and manual detection of queues in traffic. The system is developed under EU’s Tempo program. The systems consists of hardware units placed in mobile traffic report units (taxis) and backstage databases that collect all data send from the report units. The communication between the taxis and the databases is based on a very compact wireless protocol. A one month field test using ten taxis shows that the system is operational and that communication costs are very low (33 euro per taxi per year). This paper is a shorter version of research previously presented in [1]. The project is described in a documentation report in Danish [2].

Project Background
Sensors embedded in a road network have shown to be able to provide precise and timely information on the current traffic situation. This information can for example be broadcasted via public service and private radio stations. Of the highest interest is reporting of queues in traffic, i.e., traffic jams. The main problem with sensors is that they are expensive to install and maintain and it is therefore interesting to look a cheaper alternatives.
The purpose of the REMOTE project is to look at using FCD as an alternative to road sensors for traffic monitoring. In particular, the purpose is to use FCD for both automatic and manual detection of traffic queues. The automatic detection is based on analyzing GPS data from mobile traffic report units (we use taxis therefore these units are called taxis in the following). The manual detection is based on taxi drivers reporting traffic queues by using new equipment installed in the taxis. This equipment has been developed as part of the project.
The members of the projects are two private companies and two research groups from Aalborg University. The company M-tec has developed the equipment installed in the taxis and the company Euman has handled the storing and retrieval of the FCD data in the backstage databases. The two research groups involved are the Traffic Research Group and the Department of Computer Science’s Database Group.

System Architecture
The overall architecture of the system used in the REMOTE project is shown in Figure 1.
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To the right the taxis with special hardware are shown. Note that the taxis communicate with a dedicated receiver server via a special compact wireless protocol. Every 5 seconds all taxis send a small message to the receiver server reporting on each taxi’s position, speed, and so on. In addition, the taxi drivers can manually report traffic queues using the small display shown in Figure 2. When a taxi enters a traffic queue the driver presses the right (red) button. When the taxi is no longer in a traffic queue the driver presses the left (green) button.

The receiver server communicates with a backstage server (upper right corner in Figure 1) that collects and stores all data from the taxis. The communication between the receiver server and the backstage server is based on the standard HTTP protocol and uses the standard Universal Resource Indicators (URIs) message format. A URI message contains the same information as the compact messages send between the taxi and the receiver server but is 10-20 times larger. The backstage server stores and indexes all the data received from the taxi using Oracle database technology this includes extensions to handle spatial data.

To report traffic queues and related information to clients currently driving or are planning to drive the backstage server can deliver information to three different types of clients that are shown in the bottom right of Figure 1. The first type of client is a pc that can receive real-time tracking information on taxis but also statistical information, e.g., time, date, and number of traffic queues. These clients are assumed to have large displays. The second type of client is the smartphone that can receive basically the same information as the pc clients but the protocol used to distribute the information can be tailored, e.g., to a specific smartphone platform such as the Nokia’s Series60. To be able to communicate with the broadest range of clients the last type of client supported is a simplephone. These clients can only receive simple messages with real-time road traffic reports.
such as “Queue on Highway E45 North Direction between passage 26 and 27”. These messages are sent as SMS messages.

Field Test
A one month field test of all the components in Figure 1 was conducted in March 2004 using ten taxis in the Aalborg city region. The taxi drivers were briefly instructed on how to use the system. In particular, the drivers were instructed on how and when to use the manual queue reporting display shown in Figure 2. Because not all roads are interesting with respect to traffic queue detection only the main roads in the city of Aalborg are used. The actual road network used is shown in Figure 3.

Results
For the entire field test the system worked without hardware or software failures. During the test 465,000 messages were sent that formed the basic for the automatic queue detection. Further, the taxi drivers reported manually 176 queues entered but only reported manually 151 queues exited.

The field test showed that it is possible to operate a single taxi that sends messages every 5 seconds for only 33 euro/year. This is possible due to the very compact communication protocol. The messages that maps to road network was analyzed for morning and afternoon rush hours queues. As an example, Figure 3 shows the number of automatic messages received between 7.00 and 10.00 on workdays. The dark blue color indicates more traffic. The field test showed that ten taxis are too few to do automatic queue detection in real-time. However, the automatically collected data can be used to generate statistical visual report that shows when and where traffic queue occur. The manual queue detection worked, however, it is a problem that in some cases the drivers reports a queue but forgets to report that the queue dissolved.

Conclusion
Floating car data (FCD) is an interesting new wireless technology that can be used to report traffic queues. In this paper, we have shortly described a complete prototype system that demonstrates that FCD can be used for traffic queue detection. A field test has shown that the system is functional and very cheap to use in terms of communication costs. However, the field test also generated a number of new questions. In particular, how many taxi are need to do real-time traffic queue detection, how to combine automatic and manual queue detection, and how to integrate the FCD data with existing traffic queue detection systems such as sensor embedded in the roads.

References