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Determination of the parking place availability using manual data collection enriched by crowdsourced in-vehicle data

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Abstract

Many cities around the world have to deal with severe parking problems as the continuously increasing demand cannot be served by the existing supply. Research has showed that a high percentage of the overall traffic in cities derives from the parking place search causing additional traffic problems and time loss. The present work describes a field trial on detecting free parking places, using vehicles equipped with ultrasonic sensors. To validate the sensor results from those vehicles a manual measurement was undertaken in two German cities which will lead to a further improvement of the current system.

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Keywords: Parking place availability; Crowdsourcing; In-Vehicle data; Parking duration, Parking sensors

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1. Introduction

Parking is one of the most common and critical traffic problems cities are facing nowadays. The increase in private transport, due to the raise in car ownership and the unattractiveness of public transport, along with the limited parking places that are not adequate to serve the existing and growing demand, magnifies the problem especially in large and dense cities. Drivers cruising for parking are going through frustration and anxiety as surveys conducted by Bosch (2012) and Continental (2013) revealed while time loss is also considered to be an important consequence, as the average time for finding a free parking place has been estimated to be around 8.1 minutes (Shoup, 2006) and 7.8 minutes (Arnott et al., 2005). According to a survey conducted and presented in Margreiter et al. (2015) about typical parking behavior, drivers have to spend between 3 and 10 minutes for parking search but more than 50 % of the participants are not willing to spend more than 5 minutes for this purpose. For this reason, many of them quite often drive on a detour where the availability of free parking places could be significantly higher, even if this means higher travel time and longer travel distance (Margreiter et al., 2015). Additionally, 25 % of the overall average travel time in urban areas is wasted in parking search (Polak and Vythoulkas, 1993) whereas May and Turvey (1984) estimated, that between 30 % and 40 % of the travel distance is covered during this process. Cruising traffic has been found to be a significant percentage of the overall traffic within urban areas (Arnott et al., 2005, Axhausen et al., 1994, Bulan et al., 2013, May and Turvey, 1984, Polak and Vythoulkas, 1993) and the determination of its proportion is a challenging issue for many researchers. Many surveys (Shoup, 2006, Allen, 1993, Arnott et al., 2005) estimated that around 30 % of the prevailing traffic is searching for parking places whereas Axhausen et al. (1994) showed that this proportion can be up to 40 % or even 50 % in rush hours (Arnott et al., 2005).

The traffic caused by vehicles searching for parking places is always mixed with the normal traffic resulting in traffic congestion phenomena in many city centers. This contributes to additional time loss and fuel consumption not only for the drivers cruising but also for those who are still travelling towards their destinations. According to Shoup (2006) vehicles searching for parking in a business district of Los Angeles burn approximately 178,000 liters of petrol and produce 730 tons of carbon dioxide per year while in San Francisco almost half of the fuel consumed is generated from this type of traffic (Bulan et al., 2013).

It is clear that there is a need of reducing the cruising traffic as the various consequences are affecting the drivers, the environment as well as the smooth traffic in urban areas. One solution would be the creation of new parking places in order to serve the increasing demand. Since this is difficult due to lack of space, economical reasons or no political will to further increase the parking supply, the best way to solve the parking problem would be the accurate provision of information about the existence as well as the location of free parking places. The survey of Margreiter et al. (2015) also asked the participants about their attitude towards having an assisting technology as well as their expectations from such a service. Around 70 % of the drivers are willing to use an application for receiving information about the availability of free parking places around their destination but they request for a really reliable technology that will ensure the validity of the indicated parking place and will not turn out to be an exit or a driveway or prohibited parking. Additionally, most of the participants prefer on-street parking instead of public or private parking garages and as a result the information provision should focus more on this type of parking facilities, a type of information which is still quite poor in most cities.

In order to reduce the unnecessary additional traffic and therefore the resulting emissions and traffic congestions, as well as satisfying the above mentioned user requirements, this work presents an approach of using crowdsourced data of in-vehicle sensors for a reliable detection and prognosis of the availability of on-street parking in cities. The approach aims at determining free parking places by using vehicles as floating detectors based on in-vehicle ultrasonic, radar or camera-based sensors observing both street sides when passing by. For the evaluation of the proposed approach, three residential study areas were defined and mapped in terms of parking facilities and parking data was collected manually and via equipped test vehicles. The data analysis resulted in determining the occupancy as well as the non-occupancy time gap of each parking place in the three defined areas. The above described data collection aims at creating a historical database in order to develop a prognosis to compute the parking availability for these areas in one minute intervals. For this reason, the occupancy and non-occupancy time gap are further used as the main input parameters of the parking place availability prognosis and for the further validation of this approach.