JOHANNES KEPLER
UNIVERSITY LINZ

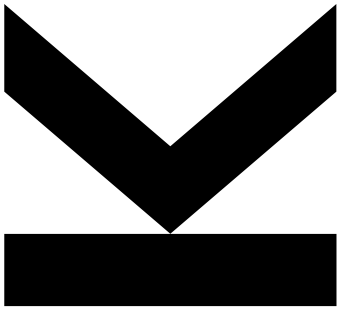
Author
**Markus Hiesmair**

Submission
**Institute of Telecooperation**

Thesis Supervisor
**Karin Anna Hummel**

March 2017

# ROBUST DRIVE-BY ROAD SIDE PARKING DETECTION ON MULTI-LANE STREETS USING AN OPTICAL DISTANCE SENSOR



Thesis Outline

**JOHANNES KEPLER**
**UNIVERSITY LINZ**
Altenberger Str. 69
4040 Linz, Austria
www.jku.at
DVR 0093696

# 1 Initial Situation and Motivation

Currently the road side parking situation in most cities is rather untransparent. Except from parking garages and the like information about the availability of parking spaces is rarely available. However, such information can help to reduce traffic by a tremendous amount. Studies have shown that in urban areas about 30% of traffic congestion is created by drivers looking for free parking spaces [3] and that in 2007 a loss of about $78 billion U.S. dollars was created by the use of about 2.9 billion gallons of gasoline alone in the USA [1]. Furthermore, about 4.9 billion hours were wasted by drivers while looking for parking spaces during that year.

# 2 Problem Definition

Detection of road side parking spaces and their states is a challenging task. Of course an obvious approach to the problem would be to put sensors to every parking space in the city, which check, if the corresponding parking space is occupied or vacant. This, however, has the drawback to be very expensive as, for big cities, thousands of sensors would have to be bought, installed and maintained. Furthermore, because the parking situation does not change often, the high frequency of sensing with such a system would be rather inefficient.

Another option to sensing a city's parking situation is the use of mobile sensors instead of static ones. This approach has the advantage to be usually more cost effective and can provide sufficient accuracy. There has already been done some work on cars which analyze parking availability while they drive through the city. For instance, Mathur et al. [2] developed a system which uses distance information from the vehicle to the right side of the road to reason about parking spaces. Another approach, which was done by Zhou et al. [4] looks for car bumper shaped signal parts in the distance measurements to identify parking cars.

However, all of the mentioned mobile sensing approaches only work in single lane scenarios. Multi lane streets bring much more complexity in the recognition of parking spaces. There are many special cases which have to be addressed to work properly on multi lane roads. For example, the recognition of other driving vehicles and the recognition of the lane the sensing vehicle is on at the moment.

# 3 Detailed Approach and Goals

The overall aim of this thesis is to evaluate if it is possible to reach a sufficient high accuracy in road side parking detection on multi lane roads using a sensing vehicle which drives through the city. For the parking detection an optical distance sensor will be used to measure the distance to the nearest obstacle on the right side of the road (in many cases a parking car). This sensor will be mounted on the co-driver's side of the car and will continuously measure the distance while the car is driving. Furthermore, a

GPS sensor will be used to include the spatial information of the vehicle. Using these measurements, the prototype should reason about the parking situation at the right side of the road.

In a first step, the sensor will be tested on accuracy and reliability. Then, after all sensors are mounted on the car, test measurements will be collected while driving through some selected streets in Linz, Austria. The test scenes should include single lane as well as multi lane streets and measurements in all streets should be done several times. To determine the ground truth of the parking availability a camera will be used which takes pictures of the parking situation at the street during the tests.

After these measurements have been taken, first an algorithm should be developed which only works for single lane streets. The algorithm should be evaluated on the test measurements and the result of the evaluation are parking space count accuracy and parking occupancy rate accuracy. This can later be used as baseline in comparison to multi lane road detection.

On multi lane streets, the situation is much more complex. There are many special cases which have to be considered. First of all, the lane in which the sensing vehicle is going has to be detected and has to be incorporated in the parking detection algorithm. Furthermore, the system should also detect when the car overtakes another driving car, because this could lead to falsely detected parking spaces. To address all of these issues, another algorithm should be developed which is able to detect parking spaces on all lanes. For this to work it has to be able to detect the lane the vehicle is going in and to handle special cases based on the distance sensor measurements.

In the end, the results of the single- and multi lane detection should be evaluated and compared in terms of parking space count accuracy and parking occupancy rate accuracy. Furthermore, the lane detection algorithm based on the distance sensor will be evaluated on its performance.

# 4 Milestones

| *Date* | *Milestone* |
|---|---|
| 07.04.2017 | Hardware is available |
| 28.04.2017 | Hardware parts work together and sensor data can be retrieved. Tests regarding the accuracy and range of the optical distance sensor are taken. |
| 12.05.2017 | The sensors are mounted on the car. |
| 19.05.2017 | Test data has been collected on a single lane road. |
| 31.06.2017 | Single lange parking detection is implemented and has been evaluated. |
| 15.07.2016 | Test data has been collected on multi lane roads in different scenarios. |
| 01.09.2016 | Lane detection algorithm has been implemented and evaluated. |
| 31.10.2017 | Parking detection on multi lane road has been implemented and evaluated |
| 01.12.2017 | Submission of the thesis |

Table 1: Milestones

# References

[1] Texas Transportation Institute. Urban mobility report. 2007.

[2] Suhas Mathur, Tong Jin, Nikhil Kasturirangan, Janani Chandrasekaran, Wenzhi Xue, Marco Gruteser, and Wade Trappe. Parknet: Drive-by sensing of road-side parking statistics. In *Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services*, MobiSys '10, pages 123–136, New York, NY, USA, 2010. ACM.

[3] Sarfraz Nawaz, Christos Efstratiou, and Cecilia Mascolo. Parksense: A smartphone based sensing system for on-street parking. In *Proceedings of the 19th Annual International Conference on Mobile Computing & Networking*, MobiCom '13, pages 75–86, New York, NY, USA, 2013. ACM.

[4] J. Zhou, L. E. Navarro-Serment, and M. Hebert. Detection of parking spots using 2d range data. In *2012 15th International IEEE Conference on Intelligent Transportation Systems*, pages 1280–1287, Sept 2012.