OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG | INF | FAKULTÄT FÜR INFORMATIK

Distributed and Operating Systems Group

Development of an obstacle detection mechanism for the autonomous oTToCar model car

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Type of work:	Teamproject
Estimated work time:	180 Hours
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1 Introduction

One of the current developments in the automotive domain is automated driving. The automotive companies promise increased comfort for the passengers and the driver as well as reduced emissions. However, these technologies need to be developed and integrated into the cars that needs competent personal. Therefore, the institute of automotive computer science of the University of Braunschweig started together with some industrial partners the Carolo Cup. The cup provides students with the opportunity to develop, test and enhance technologies of automated driving in a smaller scale. To participate in the cup, a team, consisting purely of students, needs to develop and build a 1:10 scale model car, which is able to drive autonomously on a static track. The track consists of straights, curves and crossings with and partially without markings. Additionally the car needs to be able to avoid obstacles on the track and park itself.
Since 2013 the Otto-von-Guericke University has its own Carolo Cup team, the oTToCar Team[2]. The team achieved a 2nd rank in the junior cup in 2014 and aims for the senior cup in 2015. Currently, the car is able to follow the track autonomously and find and drive itself in parking slots. However, there are no means to detect obstacles on the road and avoid them.
This team project aims to provide the car with a robust obstacle detection that may be used by other components of the car. The components of the car are linked using the Robotic Operating System (ROS) and heavily use the existing frameworks of ROS like the OpenCV (Open Computer Vision). As a result of the project an obstacle detection component shall be implemented that is able to detect the obstacles on the road as defined by the rules of the Carolo cup and provide the current road condition via ROS to other components like lane following and automated parking. The currently available hardware on the car are a Hokuyo Laser scanner, some infrared distance sensors, an odometer, an IMU and an industrial camera.

2 Related work

During the work on this project students need to revise the Robot Operating System[7][4] including its communication framework and the accompanying algorithm libraries for vision (OpenCV[1]) and point cloud operations (PCL[8][3]). The students shall select the appropriate sensors used for obstacle detection based on the sensors available in the car. Following this existing algorithms of obstacle detection are to be searched and evaluated. Especially the decision between vision-based[5] or laser-scanner-based[6] obstacle detection shall be cleared. Afterwards the algorithm need to be integrated into the existing framework of the oTToCar.

3 Detailed task description

The individual work consists of the following subtasks:

Review of existing solution : Existing algorithms shall be evaluated according to their usability in the Carolo Cup.

Integration concept : The selected algorithms needs to be integrated into the current framework of the oTToCar. Especially important is the modularity of the implementation to provide flexible usage of the component in future developments of the oTToCar.

Implementation : The algorithm needs to be implemented together with needed message translations and abstraction sub-components. The code and the design decisions need to be carefully documented to provide knowledge transfer for future team members.

Evaluation : The selected algorithms need to be evaluated in the Carolo Cup scenario using the training track of the oTToCar team. The most important evaluation criteria are robustness of the detection and ressource consumption of memory and CPU time.

References

[1] Open source computer vision (OpenCV). Online: http://opencv.org/.

[2] ottocar team. Online: http://ottocar.cs.ovgu.de/.

[3] Point cloud library (PCL). Online: http://pointclouds.org/.

[4] Robot operating system. Online: http://www.ros.org/.

[5] Massimo Bertozzi, Alberto Broggi, and Alessandra Fascioli. Vision-based intelligent vehicles: State of the art and perspectives. *Robotics and Autonomous systems*, 32(1):1–16, 2000.

[6] Abel Mendes, L. Conde Bento, and Urbano Nunes. Multi-target detection and tracking with a laser scanner. In *Intelligent Vehicles Symposium, 2004 IEEE*, pages 796–801. IEEE, 2004.

[7] Morgan Quigley, Ken Conley, Brian Gerkey, Josh Faust, Tully Foote, Jeremy Leibs, Rob Wheeler, and Andrew Y. Ng. ROS: an open-source robot operating system. In *ICRA workshop on open source software*, volume 3, page 5, 2009.

[8] Radu Bogdan Rusu and Steve Cousins. 3d is here: Point cloud library (PCL). In *IEEE International Conference on Robotics and Automation (ICRA)*, Shanghai, China, May 2011.