Assessment of the master thesis by Sören Böttger

# Development and Prototypical Implementation of a Universal Concept for a Trailer Rear View Camera

Ing. Tomas Pajdla, Ph.D.
thesis supervisor

The goal of the thesis was to develop and implement principles of a driver assistance system for predicting and visualizing the trajectory of a tractor plus trailer vehicle using a rear camera. This is a non-trivial engineering task requiring expertise in vehicle kinematics, image processing, geometry of cameras and engineering integration.

The thesis presents a number of contributions. First, it re-derives and adjusts the kinematic model of tractor and trailer systems for practical situations and compares the new model with the literature. Secondly, it studies the computation of the vehicle trajectory prediction and suggests a practical approach suitable for maneuvering in low velocities. Third, it studies the properties of the model and demonstrates its behavior as well as critical limiting parameters. Fourth, the model is thoroughly validated in simulations demonstrating its functionality on simulated and as real data. Next, trajectory visualization in live image is developed, including camera calibration and faithful trajectory projection. Next, experimental protocol including repeatable evaluation using computer vision is developed and the functionality of the system is verified and demonstrated. Finally, a complete system has been implemented and demonstrated in real and practical driving scenarios.

The thesis is going beyond a standard master thesis by the result as well as by the quality of its presentation. It is well structured and written clearly and with very balanced technical detail. It is clear that Sören mastered elements from vehicle kinematics, computer vision, experimentation and engineering integration. The key theoretical contribution of the thesis can be seen in the analysis of vehicle kinematics, synthesis of a suitable model and its analysis. The key engineering contribution is in extensive and convincing validation and testing of all models, assumptions and components of the system. Last but not least, it is clear that a complete system has been developed within the thesis, which is truly matured engineering work.

Sören Böttger was a very motivated, capable, and hard working student. He was very professional in planning as well as executing his work. We had very regular meetings discussing particular technical elements of his work but Sören clearly demonstrated that he is a fully matured and independent engineer who comes with his own new ideas and solutions.

Sören Böttger presented an excellent engineering work and fulfilled all the goals set in the assignment. He mastered advanced engineering techniques and contributed by new results. Therefore, I recommend grade the thesis by the *excellent grade*.

Prague, September 14 June 2016

Ing. Tomas Pajdla, Ph.D.
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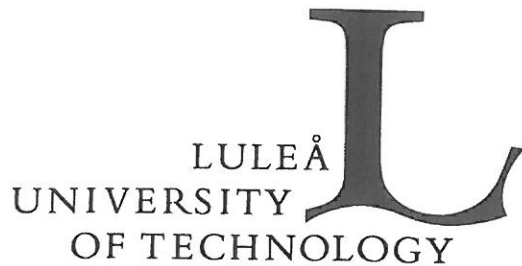
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CTU Diploma Project Review
Kiruna,  September 7 2016

CTU Diploma Project review- 2<sup>nd</sup> reviewer's evaluation of master thesis with title
"Development and Prototypical Implementation of a Universal Concept for a Trailer Rear View
Camera " by Space Master student Sören Böttger.

I find that the goal of the thesis project well fulfils the requirements of a master thesis in
space technology. The work concerns development of a system for prediction and
visualization of a trajectory for a tractor with multiple trailers.

Automobile and trailer support systems often is property of companies and research results
are confidential. Despite this the student has managed to include a few and important
references in the thesis and have been able to use previous work and extended the results
during the thesis.

The thesis includes both analysis and modelling of the kinematics of the system. The student
has by performing relevant simplifications studied the kinematics of the system and also been
able to decouple system parts in order to be able to extend the model to multiple trailers.

The thesis also concerns correction of camera artifacts to help the driver when interpreting
the rear camera images and trajectories.

The model is tested and the results are presented and discussed in a clear way. The thesis as
a whole is easy to follow. The thesis is clear and consise and also well written. The student
has put in a sufficient effort into the task.

From the presentation in the thesis the student shows a deep understanding of the subject
and he has been able to perform the analysis and modelling independently.

The result of the thesis project contributes to the future technology of autonomous driving
and driving support.

Based on the review above I recommend to grade the thesis by A( *excellent).* The oral
presentation is still to be graded.

This review serves solely for the purposes of the diploma project defense at CTU. LTU official evaluation for the SpaceMaster double degree will follow the thesis defense and may differ from this review report and suggested grade.

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