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Master's Thesis Review

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Title: Navigation System for Autonomous Student Formula
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The thesis studies self-localization and mapping (SLAM) problem, which is meant to be used in the autonomous student formula. The thesis first gives a deep review of the literature and an extensive technical background. The theoretical part starts from a general recursive Bayesian filter, continues with the Kalman filter and the particle filter. Then a taxonomy of SLAM algorithms is presented, and finally FastSLAM algorithm by Montemerlo et al. 2002 is described in detail. The FastSLAM algorithm is implemented in GPU using CUDA. The proposed implementation is experimentally evaluated for accuracy and computational performance. The implementation was compared with a popular Python robotics toolbox, achieving higher accuracy and several orders of magnitude faster performance.

The thesis is valuable in both theoretical and practical respects. The theoretical part is important for the systematic and in-depth presentation, which resulted in a solid educational material. Practical implementation using GPU and CUDA is not trivial and Tomas took the initiative, designed suitable data structures, and optimized the implementation. Excellent results suggest the implementation will be incorporated shortly into the CTU autonomous formula or perhaps even used more broadly.

The only weakness of the thesis, I am aware, is that the algorithm was not tested on real data acquired by the student formula. The reason is that the data were not available due to Covid-19 pandemic restrictions. Nevertheless, the thesis presents a satisfactory experimental validation using both simulated and real datasets. The algorithm was tested on high-fidelity formula student simulator, and on a real mobile robot dataset from University of Toronto.

I like that Tomáš worked fairly autonomously with only a moderate guidance. Tomáš was able to identify problems, propose a solution, and implement it swiftly. He easily reads scientific papers and finds a valid inspiration there. Tomáš was always enthusiastic in his thesis and invested a large portion of his time. Despite being a full-time employee at CERN, Tomáš kept improving his algorithms/implementation and devoted a significant effort to writing up the thesis.

Besides the thesis, Tomáš has been very active in the autonomous student formula team (eForce DV), a core member, being responsible for many tasks, including vision system, LIDAR perception, navigation, and software integration. Tomáš has always been reliable and, as a senior member of the student team, he has communicated with younger students in a friendly way and he has been able to explain them a piece of knowledge naturally and with patience. He has often been volunteering to do extra work for benefit of the team.

It was a pleasure for me to work with Tomáš. I believe Tomáš presented a great thesis and therefore I suggest assessment

A – excellent.

Ing. Jan Čech, Ph.D.
Thesis Advisor