Diploma Thesis Review
- supervisor -

Name of student: Adam Smialek

Thesis topic: Simulation and control toolkit for small satellite projects

Supervisor: Doc. Ing. Martin Hromčík, Ph.D.

Adam came to me in October 2019. He presented to me his idea of a MATLAB toolbox dedicated specifically to small satellite projects and asked me to supervise such a diploma thesis. When formulating this project proposal, Adam took into consideration his previous experience with small satellite projects he participated in at the Warsaw University of Technology.

I requested Adam to investigate existing related software products, and after some discussions we came to the conclusion that such work makes sense indeed and I agreed to serve as Adam's supervisor in this job. The goal of the diploma project was to build and provide a ready to use open source toolbox for small and low budget satellite projects. The toolbox features allow conducting initial design of spacecraft's attitude determination and control system, providing tools for simulation of spacecraft orbit, testing the feasibility of various actuators and testing effectiveness of various control algorithms in selected case studies. That software allows smaller and inexperienced teams of spacecraft designers to better prepare for design milestones.

In my opinion Adam made a very good job. All essential functionalities have been either programmed by Adam, or adopted using related suitable and generally available software products. The toolkit is intuitive and easy to use and provides interface to other programs and toolboxes the potential users may want to use in companion with Adam's toolkit. I appreciate the quite complex case studies Adam elaborated in order to demonstrate functionality and possibilities of his toolkit. The use cases are motivated by projects where Adam actively participated, and by generally popular and well known recent missions.

Regarding consultations and cooperation with the student, I evaluate it positively also. Although there was a lack in communication during February and March of 2020, caused by Adam's work-related duties and then by the starting covid period, it was established properly by Adam at the right time and I had the chance to formulate my recommendations and objections which Adam promptly addressed. I must say I quite enjoyed the consultations and appreciated the progress of the work, in spite of the fact that things were complicated of course due to the epidemic limitations.

Based on the above arguments, my suggestion is **grade A, excellent.**

2020/08/25

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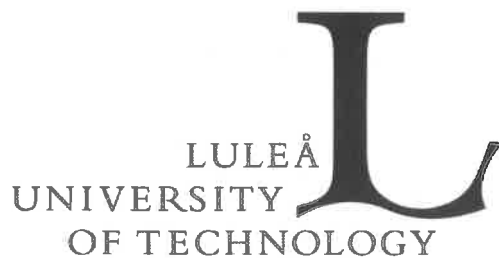
Czech Technical University
Faculty of Electrical Engineering
Department of Control Engineering

**CTU Diploma Project review- 2ⁿᵈ reviewer's evaluation of master thesis with title
" Simulation and control toolkit for small satellite projects" by Space Master student Adam Smialek.**

I find that the goal of the thesis project fulfills the requirements of a master thesis in space technology. The work concerns implementation of an open source AOCS toolbox, mainly for inexperienced users for small and low budget satellite projects.

Chapter one includes a review of some available tools within the field. This is a very important part of a project like this, since this part motivates the whole project. The review is not extensive and some already existing open source software is left out. Since the chosen solution is partly based on existing libraries (Matlab, Simulink, STK) the review could have been broader, seareching for other libraries with existing components in for example python etc.
The requirements for the projects are not stated explicitly in this chapter, but are implicit (partly) in the comparison table and are then listed somewhat different as objectives. Starting with requirements before review and comparison would have been better.
In the comparison open source is listed, but this is not a requirement, and the solution chosen is based on Matlab/Simulink tools.

Chapter 2 presents the software architecture and the different components of the software. I find the architecture to be neat and clean, and the idea to have a common signal bus is good for modularity and extension of the component database.
The main drawbacks of this chapter are the lack of references to the mathematical models of the components, and the lack of verification of the individual models.
References shall always be given, but as the author consider the thesis as documentation for the software, it is even more important to give the user references to the mathematical background for each component. It is a very good idea to provide information attached to the model itself as described in chapter 4, but this is not enough.
It is also of importance for the user to trust the software, and it need to be tested and verified component for component (and as an integrated model). Moreover it is important to know possible limitations, accuracy etc.,both for each component and for the complete system. This is not discussed in the thesis.
The base models should capture the most important characteristics of the components. This is not always the case, for example is noise an important issue for accelerometers, and drift for gyros. This is not included in the models.

Chapter 4 includes three example simulation models. The examples are not verifications of the models, but shows how models can be set up and used in the design process.
The overall trend of the graphs shows a correspondence to what would be expected, and can be seen as a 2sanity check" but there are some issues that should have been commented: what is the reason for the similarities of the shape for the different graphs in fig. 4-9 and 4.22?

Summary:
The student has put in a sufficient effort into the task: he has implemented complete model including a

baseline database with relevant components. The result of the thesis project may contribute to a future solution to the problem addressed, but the model needs to be verified as a whole and for each component.

Based on the review above I recommend to grade the thesis by C(good). 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.

Kiruna, September 25 2020

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