Opponent's review of Master's thesis

Thesis title:	Distributed control of a platoon of wirelessly communicating slotcars using a Simulink generated code
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Thesis opponent:	Ing. Michal Sojka, Ph.D. ČVUT CIIRC, Industrial Informatics Department

The goal of the presented thesis was to provide and evaluate a framework for rapid prototyping of distributed control algorithms for a slot car platoon. The framework is based on Matlab/Simulink software and uses automated code generation to generate code for BeagleBone Blue boards embedded into the individual cars. The work builds on prior work by several other students, and a big part of it has integration character. As integrating the work of other people, especially students, is never easy, I consider the assignment as of higher complexity.

The results of the work look good, and according to the experimental results, the provided framework seems to work as expected. Its code is well organized and reasonably documented. In addition to that, the author also mentions possible improvements that were out of the scope of his work.

The work is written in English, and the text is mostly easy to read. The main part of the work spans 25 pages (with dense line spacing) and five pages of appendices. There is only an insignificant amount of grammatical errors – most often missing commas in sentences. At a few places, the text is a little informal, vague or represents author's opinion without any reasoning, e.g., "it is better to be tuned more robust than fast" (why?) at page 17. Some parts would benefit from better formalism – for instance, a paragraph about the Kalman filter for friction compensation at page 21 would be more understandable when the calculations were given as equations rather than described in plain English. Another weak point of the text is sometimes unclear notation: r_x seems not to be defined, it is not clear whether $r_v(k)$ in Eq. (3.11) is the same as $r_{v,k}$ in Fig. 4 or what exactly is $V(s)$ and $D(s)$ in Eq. (3.7) (is it Laplace transform of $v_c(t)$ and $d(t)$?).

From the graphical and typographical point of view, the work is at a very good level. The author uses a not so common font and style, which make the work look interesting. Unfortunately, the font selection is not ideal, because zero and small "o" look almost the same, which is problematic at least in the expression $\dot{v}_c = 0$ below Eq. (3.10). The graphs in the thesis are plot with unnecessarily thick lines. This is especially disturbing in Fig. 3.8, where (what I believe are) line joins hide the real level of noise in the signals. I have also been disappointed that the work contains a lot of diagrams and graphs but no picture of the real car.

From the technical point of view, the weakest point of the whole platforms seems to be very high velocity noise (see Fig. 3.9). The noise could be reduced by equipping the car with a higher-resolution encoded or by decreasing its sampling frequency. The work discusses only the latter option, and then the sampling frequency of 200 Hz is "magically" selected. My questions to the author are:

1. How were the sampling frequencies in Table 3.3 selected? The fundamental one seems about 100 times higher than the cut-off frequency of the car transfer function. The text mentions that the frequency should be 10 (or more) times higher. Would lower sampling frequencies with less noise in velocity give better results?

2. What is the resolution of the encoder and would it make sense to equip the car with a higher-resolution encoder?

3. The author implemented two different communication protocols – one based on UDP and the other on TCP. These were not evaluated in the work. Did the experiments confirm the well-known fact that TCP, especially on the wireless network, is not well suited for real-time communication?

Despite the few weak points mentioned above, I rate the presented work with grade **A – excellent**.

In Prague, June 4, 2019

Ing. Michal Sojka, Ph.D.