

## I. IDENTIFICATION DATA

<b>Thesis title:</b>	Using Julia language for automatic control of an educational laboratory model
<b>Author's name:</b>	Štěpán Ošlejšek
<b>Type of thesis :</b>	master
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering (FEE)
<b>Department:</b>	Department of Control Engineering
<b>Thesis reviewer:</b>	Ing. Michal Sojka, Ph.D.
<b>Reviewer's department:</b>	ČVUT, CIIRC

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	<b>challenging</b>
<i>How demanding was the assigned project?</i>	
I consider the project as challenging because Julia in a relatively new language and its ecosystem of packages and tools is in heavy (and sometimes hectic) development. Users often have to resolve technical difficulties and fix bugs in 3 <sup>rd</sup> party code. Furthermore, the last part of the assignment – rapid prototyping – is not well established in the Julia community and probably requires using a lot of experimental code.	

<b>Fulfilment of assignment</b>	<b>fulfilled</b>
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
All points of the assignment were fulfilled. The final experimental evaluation is brief due to encountered problems with the hardware, but this is acceptable because fixing hardware problems was not a part of the assignment.	

<b>Methodology</b>	<b>outstanding</b>
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
The methodology is correct. Individual steps of the overall solution are described in the thesis and lead to the desired outcomes. The selection of Julia packages is correct and represents the state-of-the-art in the Julia world.	

<b>Technical level</b>	<b>B - very good.</b>
<i>Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?</i>	
Technical level is good, the resulting code seems to work well in the simulation. The experiment with the real hardware works too, but it has some limitations, which are explained in the text of the thesis. Minor drawback of the thesis is that it simply describes <b>what</b> has been done, but often without mentioning <b>why</b> it was done this way. Also, some of the results are included without any discussion and the reader has to guess whether the result is good or bad. For example, the graphs in Section 3 show differences of simulated and measured values, but it is not clear how severe problem this difference is.	

<b>Formal and language level, scope of thesis</b>	<b>B - very good.</b>
<i>Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?</i>	
The thesis is written in relatively good and understandable English. Some formulations could be improved, there is a few problems with articles. Sometimes, the author uses terms without introducing them first. For example, the text refers to the BallAndHoopSystem.jl package without saying that this package was developed as a part of this work. Similar problems happen with names of some functions. The meaning becomes clear only from the subsequent paragraphs or provided code. From the typography point of view, the author makes a typical mistake of using hyphens (-) at many places where dashes (–) should be used.	

## Selection of sources, citation correctness

**A - excellent.**

*Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?*

References are adequate and correct. Minor problem is that <https://gitlab.fel.cvut.cz/aa4cc/j4c/ball-and-hoop> is not publicly accessible at the time of this review.

## Additional commentary and evaluation (optional)

*Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.*

The thesis nicely presents how to perform typical control engineering tasks in Julia. I'm not aware of any other work that summarizes these things in a concise manner and evaluates them on a non-trivial example. Therefore, I believe that this thesis is a valuable input to the Julia (control engineering) community. I positively evaluate that the student submitted and got merged a pull request improving the performance and accuracy of some operations in the ControlSystems.jl package.

The downside of the work, as briefly mentioned above, is lack of deeper discussion about the problems and their solutions. Additionally, some readers would probably benefit from brief introduction to Julia, its comparison to Matlab and introduction to some of the used packages and perhaps their comparison to similar toolboxes in Matlab.

## III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

*Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.*

As some things are not completely clear from the presented text, I have the following questions for the student:

1. Table 3.1 shows the values of estimated physical parameters. Do these parameters match easily measurable parameters (ball weight and radius, hoop radius) of the physical system? If not, would fixing the known values and estimating just the unknown quantities improve the simulation accuracy?
2. You mention that it was not possible to run four Julia processes on Raspberry Pi due to lack of computational power. I'm not sure this would be the main problem. I suspect that limited memory would be a bigger problem. Each process probably needs its own JIT compiler, which needs a lot of memory and the generated code is often not small too. What was memory consumption of multiple Julia processes on Raspberry Pi? Do you load DifferentialEquations.jl (which is huge) on Raspberry Pi?
3. What was your experience with working with Julia when compared to Matlab? What was better, what was worse? Conclusion mentions only long precompilation times in Julia (which are probably much lower with current Julia 1.9). What else?

Overall, I like the work and believe that it represents a valuable input to the Julia (control engineering) community. However, due to minor deficiencies, mainly in presentation of the thesis, **the grade that I award for the thesis is B - very good.**

Date: 12.6.2023

Signature: