FACULTY OF INFORMATION TECHNOLOGY CTU IN PRAGUE

Review report of a final thesis

Student:	Vojtěch Tomas
Reviewer:	doc. Mgr. Michal Švanda, Ph. D.
Thesis title:	Visualization of 3-dimensional solar surface data
Branch of the study:	Web and Software Engineering

Date: 27. 5. 2019

Evaluation criterion:	*The evaluation scale: 1 to 4.*
1. Fulfilment of the assignment	***1 = assignment fulfilled,*** *2 = assignment fulfilled with minor objections,* *3 = assignment fulfilled with major objections,* *4 = assignment not fulfilled*

Criteria description:
Assess whether the submitted FT defines the objectives sufficiently and in line with the assignment; whether the objectives are formulated correctly and fulfilled sufficiently. In the comment, specify the points of the assignment that have not been met, assess the severity, impact, and, if appropriate, also the cause of the deficiencies. If the assignment differs substantially from the standards for the FT or if the student has developed the FT beyond the assignment, describe the way it got reflected on the quality of the assignment's fulfilment and the way it affected your final evaluation.

Comments:

The bachelor's thesis of Vojtěch Tomas more than fulfilled the assignment. I have to say that the history of this thesis dates back a few years, when a requirement came from our group in the Solar Department of the Czech Academy of Sciences for a visualisation tool. Thus the goal of the thesis was to design, implement and test the visualisation software suitable for visualisations of vector fields in physics, particularly the vector flows for solar physics applications. This goal was successfully achieved. I personally was present twice during a presentation of the software and from the potential user point of view, I have to say I was astonished by the possibilities and output quality.

Evaluation criterion:	*The evaluation scale: 0 to 100 points (grade A to F).*
2. Main written part	*95 (A)*

Criteria description:
Evaluate whether the extent of the FT is adequate to its content and scope: are all the parts of the FT contentful and necessary? Next, consider whether the submitted FT is actually correct – are there factual errors or inaccuracies? Evaluate the logical structure of the FT, the thematic flow between chapters and whether the text is comprehensible to the reader. Assess whether the formal notations in the FT are used correctly. Assess the typographic and language aspects of the FT, follow the Dean's Directive No. 26/2017, Art. 3. Evaluate whether the relevant sources are properly used, quoted and cited. Verify that all quotes are properly distinguished from the results achieved in the FT, thus, that the citation ethics has not been violated and that the citations are complete and in accordance with citation practices and standards. Finally, evaluate whether the software and other copyrighted works have been used in accordance with their license terms.

Comments:

The extent of the thesis corresponds rather to a master's thesis than to the bachelor's one. The main part is written in good English, when reading I did not find typos and incorrect language use, but I did not specifically search for them. One typo I could not miss, however, because it is in one of the chapter titles. The text is accompanied by tables and figures that support the claims in the text.

The thesis first gives a very comprehensive overview of the vector data visualisation techniques and the author discusses thoroughly the advantages and disadvantages of each technique. The available software is also discussed. As a regular user of the "Computational Software" (IDL, Matlab) and only an occasional user of "Visualisation Software" (Paraview) I really appreciated this introductory sections, where I saw in a written form exactly the experience I had from using this software in practice. The student then describes the design of his own FlowApp, its implementation and also some testing.

The individual sections follow in the logical order, the reader is guided from the introduction to the design of the application smoothly. The author advocates some selections he had to make in implementing his application and refers back to the introductory parts. The text is very easy to read and follow.

I found only a few minor issues, mostly with the notations in the equations, which does not follow the rules for the equations in physics. For instance, in the equations, the functions should be typeset as roman. That involves also a "div" operator in (1.2) or "rot" operator in (1.3). Also, vectors are usually typeset in boldface, which the author follows only partly. For instance, in (1.1) the left-hand-side of the equation is scalar (according to the generally accepted typographical rules), whereas the right-hand-side is a vector. From that point of view, equation (1.1) in invalid.

These issues are only minor a may even be irrelevant for the computer-science literature. In total, without a doubt, the thesis fulfils all the criteria posed to bachelors' theses.

Evaluation criterion:	*The evaluation scale: 0 to 100 points (grade A to F).*
3. Non-written part, attachments	*95 (A)*

Criteria description:
Depending on the nature of the FT, comment on the non-written part of the thesis. For example: SW work – the overall quality of the program. Is the technology used (from the development to deployment) suitable and adequate? HW – functional sample. Evaluate the technology and tools used. Research and experimental work – repeatability of the experiment.

Comments:

The project of this thesis is essentially a development of the software. I'm writing this review in my capacity of a potential user and also the capacity of a user of similar software with seemingly equivalent functionality. That is IDL, Matlab, Paraview, as compared to FlowApp by Vojtěch Tomas. IDL and Matlab have visualisation options that are limited and do not provide the user with "nice" outputs, but are easy to use, especially when the user is fluent in the respective languages. Paraview has much better rendering options and provides "nice" outputs, but it is not really user-friendly to use. FlowApp offers a trade-off between these two. It is easy to use thanks to a web-based interface and the client-server technology. Just by moving the mouse the user may construct a visualisation pipeline that leads to the desired output. The outputs are visually attractive. More importantly, the selection of various rendering options allows the user not only to produce "nice" figures, but also to use the FlowApp to investigate the structure of the flow interactively. The prize to pay is in a (nowadays) zero connection to some of these "Computational-Software" tools, where the interaction is only via a very specifically formatted file. FITS format is common in the community of astronomical research, it is less common in other branches of physics. Thus from the user's point of view, FlowApp seems to be a significant step forward in properly analysing the vector fields in physics.

Evaluation criterion:	*The evaluation scale: 0 to 100 points (grade A to F).*
4. Evaluation of results, publication outputs and awards	*100 (A)*

Criteria description:
Depending on the nature of the thesis, estimate whether the thesis results could be deployed in practice; alternatively, evaluate whether the results of the FT extend the already published/known results or whether they bring in completely new findings.

Comments:

The FlowApp software could definitely be deployed in practice, actually I myself am just designing research that will hopefully benefit from FlowApp. The approach taken in developing FlowApp and the implementation should also be published either in a peer-review journal or at a topical meeting and in its proceedings.

Evaluation criterion:	*No evaluation scale.*
5. Questions for the defence	

Criteria description:
Formulate questions that the student should answer during the Presentation and defence of the FT in front of the SFE Committee (use a bullet list).

Questions:

* In Section 1.3 you discuss issues with spatial derivatives of the flow. Have you considered using the derivatives computed using a Fourier transform? It should be possible to use those at least in the horizontal (x,y) domain, where the boundary conditions are roughly periodic. Fourier-based derivatives can't be used in the vertical (z) domain due to the vertical stratification. Maybe a paper by Lele [Journal of Computational Physics 103 (1992) 16-42] may give additional thoughts about the implementation of the finite differences.

* Similar question concerns the interpolation. Fourier-based interpolation is quite common in physics. Have you considered using those?

Evaluation criterion:	*The evaluation scale: 0 to 100 points (grade A to F).*
6. The overall evaluation	*98 (A)*

Criteria description:
Summarize which of the aspects of the FT affected your grading process the most. The overall grade does not need to be an arithmetic mean (or other value) calculated from the evaluation in the previous criteria. Generally, a well-fulfilled assignment is assessed by grade A.

Comments:

The bachelor's thesis of Vojtěch Tomas is a very good piece of work, well above the average. The minor issues indicated above are overweighted by the overall strengths. That is by the thesis length, by a very comprehensive introduction, by the discussion of the user's needs, and in the end by the rather unconventional implementation in the form of the FlowApp. I'm convinced that the main parts of this thesis desire a publication either in the topical peer-reviewed journal or at a topical meeting and in its proceedings. The thesis and the bachelor's project overall meet the criteria for the bachelors' theses. Thus I recommend the thesis for defence and propose its evaluation by grade A -- excellent.

Signature of the reviewer: