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Review for PhD thesis by Wojciech Tomasz Korek

Reviewer: docent Tatiana Polishchuk, Senior Associate professor

ITN department, Linköping University

Title of the thesis: Research and development of the new touch-screen based inceptors design for aircraft control

Submitted: February 2023, Gliwice, Poland

The thesis focuses on testing the applicability of two new inceptors, such as gamepad and touchscreen as alternative controllers for aircraft flight decks. In addition, the thesis covers all the stages of the development of the new engineering flight simulator, designed specifically for research purposes, used in this study as a base for the performance evaluation of the proposed inceptors. Human-in-the-loop simulation studies were performed in several scenarios, where the usability of the three inceptors was tested: a sidestick, a gamepad and a touchscreen. Participants' performance was measured using a combination of the objective and subjective metrics. The results were validated using statistical analysis. The author concluded that the touchscreen controller is not yet viable for implementation in a flight deck, while the gamepad demonstrated a potential to replace side stick in the future.

I find the topic of the thesis quite challenging and brave, as it is always difficult to question the current practices used by the pilots for more than 100 years, especially when they are connected to the safety aspect.

The document is well-structured, containing all the necessary parts, each of which is properly elaborated. It is very well-written using good English in a clear and understandable technical style. All the figures and tables provided in the thesis are of high quality.

The introduction and motivation part of the thesis contain significant background information which helps the reader to understand the purpose of the proposed research and the methods used in this work. The related work is deeply and thoughtfully studied, and the overall amount of references (more than 400) is very impressive. The reviewer especially appreciates the timeline Figure 2.3 (p.15).

The thesis features a very detailed description of the components of the flight simulator developed, as well as the whole process of the design and construction of the simulator, which may be advised as documentation information and good reference material for the future users.

The author's participation in the development of the simulator, which is a large collaborative project, is clearly outlined. The author programmed all the software needed for the preparation of the simulation studies, and he also used programming for statistical analysis of the results. The author designed the flight display for the simulator and the alternative flight inceptors. The whole design process is carefully documented. An innovative approach to brainstorming was utilized in the process of decision making concerning physical design of the simulator. However, the extent to which the author was involved in the brainstorming and in which role, as well as the level of his involvement in the data collection process during human-in-the-loop are not clear to the reviewer.

The methodology and all the setup for data collection are carefully described. A new scoring system was designed for the simulation trials, which allowed to connect temporal and spatial components of the performance evaluation. I suggest this could be stressed as an additional contribution of this work. The participants selection is clear, and the sample size seems to be sufficient for the purpose of this study. Heart Rate Variability monitor and eye tracker were mentioned in the trial procedure, but never used in the main simulation setup. The reason is to be clarified in the thesis.

The results obtained from the simulation studies are thoroughly analyzed using a variety of statistical methods and tools. The correctness of the chosen measures and resulting scores was carefully validated, excluding the redundancies. The reviewer did not completely understand the metrics used in the Results section, %p, and why the traditional percentage (%) was inappropriate for comparing the results collected using different scales.

Another questionable moment to be mentioned is that the author focuses on the analysis of “between the subjects” results, but never questions the “within the subject” aspect, which may also be interesting to mention in the work.

The final results are not very surprising, that the most of the participants preferred to use the traditional sidestick, especially the ones having significant experience flying; and that the participants with gaming experience were open to using the gamepad as the control. However, the usability of the alternative control such as the gamepad is definitely new. I would suggest stressing in the conclusions that high learnability of the gamepad may contribute to the improvement in training times and competence development, which is critical in the aviation sector.

Minor comments on the text:

Abstract: In addition, the analysis aimed to determine “if” > replace with > “whether” participants’ demographic,...

P.2 line 3 I cannot understand the statement:” there is less need for a sidestick or a central yoke as they become an unnecessary weight”... Does the sidestick weigh a lot? Or did you mean that it is too large? Please, clarify in the text.

P.3-4. The author uses past tense when referring to the thesis work, which I suggest replacing with the present:

Therefore, a second goal of this thesis was > is the development...

The third aim of this study was > is to investigate

P.32 The last paragraph starting from: “Some previous tests ...” seems to be completely disconnected from the content of the subsection, and needs to be moved or removed.

P.39. In the first paragraph the author mentioned the expression “optimize human”, which I would suggest to avoid as it does not have any technical meaning and is not clearly defined.

P. 42 Line 5: the design ... was designed (redundant word usage)

P.47 Fig. 3.5 the caption to the figure is way too long. Try moving some text to the section body.

P.66 contains strange early break in the first line

P. 73 Figure 4.12 caption may be improved by the reference to which airport is illustrated in the picture.

P.75 contains hanging header in the last line

P.197. The phrase "in this study" is used twice in the same sentence in the last paragraph.

To summarize, the overall quality of the thesis is high, it's novelty and scientific quality, as well as the author's contribution to the work are unquestionable. The thesis clearly demonstrates the candidate's general theoretical and practical knowledge in the discipline and the ability to conduct the scientific work independently. I recommend the thesis for the defense.



08.05.2023

Tatiana Polishchuk

