

Review of a Doctoral Thesis at FIT BUT

Doctoral thesis (hereinafter referred to as "thesis"), title of the thesis:

Modelování chování pro výcvik taktických pilotů/ Behavior Modeling For Tactical Pilot Training

Name of the doctoral student (hereinafter referred to as "student"), name and surname:

Ing. Jiří Hanák

Name and institution of the reviewer (full name of the reviewer, full name and country of the institution):

Univ.-Prof. Dr.-Ing. Peter Stütz, Department of Aerospace Engineering, University of the Bundeswehr Munich, Werner-Heisenberg-Weg 39, 85577 Neubiberg, Germany

Please state your opinion on the following aspects of (I) the student's thesis and (II) the student's overall achievements, and (III) state your conclusion (a minimum of approx. 300 characters for each item below is recommended):

I. Thesis

Appropriateness and relevance

Is the area addressed by the thesis appropriate to the particular scientific discipline of the thesis and does the thesis address relevant problems within the chosen area?

The topic and the general aim of the work are absolutely relevant and topical. In view of the current challenges of future complex airborne weapon systems, increasingly expensive development costs and budget constraints in many countries, it is foreseeable that the training of flying military personnel will increasingly have to be shifted to cost-effective and efficient virtual training environments. Technical possibilities to extend the applicability of such training systems and make them more realistic are necessary technical steps. In this context, this work sets itself the task of making appropriate contributions in terms of aviation systems technology. The basic features of a new type of training system are very well designed, methodically underpinned and successfully examined in terms of its performance and handling behavior.

A summary of the contributions of the thesis

From your point of view, please summarize what the goal of the thesis is, what the main contributions of the thesis are, and whether the thesis has achieved the chosen goal.

Please indicate also specific contributions of the student.

The aim of this thesis is to design and investigate a software framework to synthesize tactical pilot and platform behavior based on cognitive agents and to simulate training opponents in virtual simulators.

His solution is obviously a comprehensive functional complex. The author has succeeded in creating a suitable concept for this and evaluating its essential parts experimentally.

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The objectives of the work were set as follows:

- *Identification of a suitable simulation environment for the high-fidelity simulation*
- *Identification of a relevant cognitive processes that influence the DM of pilots*
- *Modeling a cooperative expert tactical agent*
- *Synthetization and evaluation of representative cognitive processes based on experimental data from simulations with human pilots*

While all objectives were successfully achieved in general, specific remarkable scientific contributions were made within these objectives:

- *The identification and description of a functional model for the description of the cognitive paradigms attention, perception and long-term memory of information intake on the constructive threat side.*
- *The implementation of a corresponding functionality for limiting and modulating information acquisition, the setup of a workflow for the creation and management of these functions and their integration into a virtual training system.*

Please assess the level of novelty of the results and their significance for the given scientific area, for its further development, and if applicable for possible applications in practice.

The work described contributes to the improvement of currently used tactical training simulators for fighter aircraft crews. As rightly pointed out, systems currently in use usually only allow the modelling of this fine behavior with rigid, often scripted behavior. Similarly, the representation of the dynamic characteristics of enemy aircraft and their armament often leaves much to be desired.

The author's concept includes a very innovative approach that is not currently followed in training simulation systems. It comprises the modelling of limitations of human cognitive information processing on the threat side. Therefore, the author develops a new technical process flow that models visual information acquisition and the limiting working memory of fighter pilots and integrates it into the training system. The process uses and combines established methods from the domain of ergonomics and computer science to create the desired innovative system solution. These include the generation of an attention map or the use of a learnt surrogate model based on PCE, which maps flight status situations to successful attack decisions and thus establishes complex experience-based relationships. The results demonstrate the feasibility and benefits of the approach.

Since this work is strongly application-oriented, it should be possible for relevant industry to pick up the yielded results for realization without major risk and detours.

Evaluation of the formal aspects of the thesis:

Please evaluate formal qualities of thesis and its language level.

The thesis is written in very good and easily understandable English. The structure and the logical sequence of the contents are clearly structured. The figures and tables are of excellent quality. The sources cited are up-to-date and describe the technical field comprehensively.

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Quality of publications

Has the core of the thesis been published at an appropriate level? Please judge the quantity and quality of the publications. When judging the quality, please take into account internationally recognized standards (WoS/Scopus quartiles, CORE ranks, specific knowledge of flagship publication channels of agiven community, etc.) in a way appropriate for the given area of the thesis.

The author lists 7 publications related to his work. He is the first author of 4 of them, which have been presented at peer-reviewed conferences such as DASC or ICAS. These conferences are well established in the aircraft (systems) engineering community. This ensured that the content has been communicated to the relevant community where it definitely received attention.

II. Student's overall achievements

Overall R&D activities evaluation:

Does the student's thesis, the results included into it, and possible other scientific achievements listed in the list of scientific activities indicate that he/she is a person with scientific erudition and creative abilities?

This dissertation describes scientific work in which a new system solution must be developed and then analyzed in accordance with an existing problem. This is often accompanied by extensive conceptualization and implementation work before the critical aspects can be validated, which is also the case here. It is often a challenge to find or adapt a suitable experimental procedure or corresponding V&V process. The author decided in favor of a pointillistic approach in which critical functional components were investigated in terms of their functionality and performance. With a comprehensive system at hand, this automatically leads to a correspondingly subjective selection of the experimental scope and procedure. Against this background, the author has succeeded extremely well in providing the reader with a revealing insight into the functions he has developed, thus providing a scientific basis for further development or industrial exploitation and showing Jiri Hanak to be an ambitious and committed scientist.

Assessment of other characteristics (optional):

More characteristics of the student may be added here (e.g., awards, grant participation, international collaboration, etc.).

At this point, Jiri Hanak's involvement in a large number of projects, some of them with international partners, which are related to his scientific work and demonstrate its applicability, must be recognized. This picture is rounded off by two 'Best Paper' awards at conferences.

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III. Conclusion

The conclusion should contain an explicit statement saying whether, in your opinion, the thesis and the student's achievements until now meet the generally accepted requirements for the award of an academic degree (in accordance with Section 47 of Act No. 111/1998 Coll., on higher education institution).*

* Short overview of both the Act and corresponding internal BUT regulations is enclosed.

To summarize, it can be said that the submitted thesis represents an outstanding piece of scientific work. The doctoral project is characterized by an ambitious objective, which was pursued with a scientific approach and in which new scientific contributions were made.

Jiri Hanak demonstrated his ability to work on high scientific level and therefore, the statement can be made without reservation that the thesis and the student's achievements until now meet the generally accepted requirements for the award of an academic degree (in accordance with Section 47 of Act No. 111/1998 Coll., on higher education institution). I recommend to accept the thesis and to proceed with its defence.

Neubiberg 18.01.2025

Signature of the reviewer: