19.3.

Ao.Univ.Prof. DI Dr. Martin Kozek
Institute for Mechanics and Mechatronics
Div. for Control and Prozess-Automation
Wiedner Hauptstraße 8 / 325 A5
1040 Vienna, Austria
Tel.: 58801 325512
Email: kozek@impa.tuwien.ac.at

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Prof. Ing. Zbyněk Škvor, CSc.
Faculty of Electrical Engineering
Technická 2
166 27 Prague 6, Czech Republic

Ref.No.: 38/3951/d/12

Vienna, 17.02.2012

Review on the Doctoral Thesis of Ing. Tomáš Haniš titled

„Active control for high capacity flexible aircraft"

Content of the Dissertation

The dissertation is focused on the design of control algorithms for future flexible passenger aircraft. The contents of the thesis were developed within the ACFA2020 project, funded by the EU. Main contributions of the work are:

1. The development of an algorithm for optimal sensor placement for a large flexible structure. The method is based on the Fisher Information matrix and the Effective Independence Method. It is considerably extended by a modified criterion, which explicitly considers the avoidance of spillover from unwanted (uncontrolled) modes.
2. H_∞ optimal feedback control of flexible aircraft. Both lateral and longitudinal control problems are treated. For the lateral control, two different approaches are presented. One is a H_∞ / H_2 mixed sensitivity controller designed in a hierarchical way, the other is an H_∞ - design of a pre-described 3rd-order controller by non-smooth and non-convex optimization. The longitudinal control design is also done by the latter method.
3. Convex optimization of a feed-forward gust alleviation system. The FIR-filter of the feed-forward control is optimized using a convex optimization with a multitude of constraints.

Appraisal and Discussion of the Dissertation

The topic of the thesis of Mr. Haniš is clearly of high interest for the scientific community. The development of new methods and the adaptation of existing algorithms to actively control large flexible structures is a field with increasing application possibilities.

The main objectives of the work have been clearly stated in the thesis; I liked that part very much because the reader is relieved from the task of finding out by himself. Throughout the main body of

the thesis and even more explicitly in the Conclusion it becomes quite obvious that all objectives have been fulfilled to the full extent.

The work has been conducted in a methodically correct and adequate way; citations of references are sufficiently extensive and up to date. In my opinion it is a special quality of the thesis that all methods do not only achieve the set goals, but do this in a way which facilitates the engineering application (e.g. by low-order controllers).

The main results and contributions of the work have already been mentioned above, but I want to emphasize that Mr. Haniš has clearly proven that he is both capable of applying existing methods to new and challenging control problems, to adapt and extend state-of-the-art algorithms where necessary, and to develop new methods for complex application problems.

The work done in the ACFA2020 project is definitely one large step for the controls community in terms of future aircraft concepts. The thesis of Mr. Haniš is one of the main scientific contributions to that success. It is therefore out of doubt that the thesis and the related scientific publications constitute an important contribution to the further development of science.

All elements of creative scientific work are contained within the thesis; what is even more, besides peer-reviewed publications also a patent has been successfully filed. Although not necessarily of scientific value, it clearly proves the original and creative contributions of Mr. Haniš.

Due to the concise style of the thesis some specific questions related to the contents could be addressed more specifically:

- How is the EFI algorithm presented in Section 3.3 affected by model errors (e.g. parametric uncertainties)?
- The choice of \alpha in the EFI-algorithm seems to be critical. The knowledge of Fig. 3.3 is actually needed to retrieve meaningful results, which in turn would require evaluation of the criterion (3.12) for many \alphas. Is this extensive effort necessary?
- In section 4.1.3.1 (top of page 34) it is mentioned, that a high-fequency roll-off is required for not exciting flexible modes. Is this condition really matched in the case at hand? What if not?
- In section 5.3, a priori fixed transfer functions H_i(z) are utilized. How to choose these basis functions? Would it be possible to compute a minimal set of basis functions a posteriori from the impulse response of the optimal filter H(z)?

The author of the thesis proved to have an ability to perform research and to achieve scientific results.
I do recommend the thesis for presentation with the aim of receiving the Degree of Ph.D.

TECHNISCHE UNIVERSITÄT WIEN
INSTITUT FÜR MECHANIK
UND MECHATRONIK
A-1040 Wien, Wiedner Hauptstr. 8-10

Ao.Univ.Prof. DI Dr. Martin Kozek