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Review on the Doctoral Thesis of Ing. Martin Řezáč titled

„Inertial stabilization, estimation and visual servoing for aerial surveillance"

Content of the Dissertation

The dissertation treats the problem of controlling inertially stabilized platforms for aerial surveillance. The contents focus on the practical problems and the implementation issues of setting up an experimental system for validation. Specific parts of the thesis are:

1. Introduction to the field of research, definitions, basic notions and concepts for general motion control.
2. Analysis and design of line-of-sight stabilization under presence of carrier motion.
3. Augmentation of the aforementioned design by image based pointing and tracking.
4. Solution to the delay introduced by image processing by several compensation schemes.
5. Attitude estimation in the presence of disturbing accelerations.

Overall, the dissertation is clearly dedicated more to solving the problems of the practical implementation than on the theoretical background of the related control problems.

Appraisal and Discussion of the Dissertation

The topic of the thesis of Mr. Řezáč is of high interest for the scientific community. The development of a complete system for controlling the inertially stabilizing platform calls for several solutions of different problems all of which are necessary to be solved on a high scientific level.

The main contributions of the work have been clearly stated in the thesis (Chapter 1); correspondingly, the scientific publications are listed and the individual author's contribution is detailed. All objectives have been fulfilled, and the resulting performance is validated with experimental data in most cases.

The work has been conducted in a methodically correct and adequate way; citations of references are extensive and up to date. The wide area covered by the thesis poses a challenge by itself, since it

is difficult to come up with solutions of high quality in different research areas. Nevertheless, the publications in peer reviewed quality journals prove that the scientific quality of the work meets international standards.

Mr. Řezáč has clearly proven that he is capable of applying existing methods to new and challenging mechatronic control design problems, and that he can adapt and extend state-of-the-art algorithms where necessary (e.g. smith predictor extension by lifting, Section 6.4).

The problem posed in the thesis is of high interest in the scientific community, and due to the nonlinear problem nature and strong technological constraints (actuators, sensors) control design is inherently complex. Mr. Řezáč tackles the associated problems in an efficient and structured way, moreover, he has a practical solution for each of the associated sub-problems. It is therefore out of doubt that the thesis and the related scientific publications constitute a significant contribution to the further development of science.

All elements of creative scientific work are contained within the thesis. Additionally, Mr. Řezáč has proved that he is able to produce sound results with complex methods and tools with real-world data from an existing setup, despite of the inevitable organizational and technical problems such a project brings about.

Some specific questions related to the contents could be addressed more specifically:

- In Section 4.2.1 from the viewpoint of complexity the roles of the individual motors were pre-assigned. What if the problem would have been stated as a general MIMO design? Please comment on optimality and achievable performance.
- An alternative to the methodology presented in Section 4.2 would have been to perform a (robust) balanced reduction on the classical H_∞ -controller. What was the order of the classical H_∞ -controller? What benefits could be expected from the alternative?
- In Chapter 6 the derivation started with the Smith-predictor. What about Model Predictive Control? This would allow for compensation of delays, and multi-rate sampling implementations are available from literature.
- In Section 7.3 EKF and feedback-linearization are considered. What about using a Sliding Mode Observer of suitable (simple) structure? Please comment on robustness and implementation issues.

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.

Best regards,

[redacted]

Ao.Univ.Prof. DI Dr. Martin Kozek

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