Opponent's review to Ondřej Špinka's Doctoral Thesis

RAMA – a Low-Cost Modular Control System for Unmanned Aerial Vehicles

The dissertation thesis is elaborated in 102 pages of describing text plus about 30 pages of accompanying parts. The work is divided into 8 chapters followed by Appendices, Bibliography, List of publications and author's Curriculum Vitae. The text division to chapters and subchapters is logical and well balanced. The text is written in high-quality English and is easy-to-read. The graphical and stylistic quality of the thesis is very high, it contains minimum of typing errors.

The work is aimed to development and testing of a system for Unmanned Aerial Vehicles (UAVs) control. The task is to make the system highly reliable, universal and lightweight. This research topic is of **major relevance** to the field of research.

Although the research goals and objectives defined in the beginning of the thesis are considerably difficult, and moreover the author decided to evaluate the gained theoretical knowledge by practical implementation on the real flying helicopter, all of the **goals were completed**.

The author proved his ability to work with literature, namely in Chapter 1 and 2. The work, without doubts, **contains novel parts**, mainly in Modular Control System design, but also in the testing and evaluation phase of the project.

I would like to emphasize author's approach to non-successive parts of the research. He is not only able to denominate the problems, but also analyze them and find appropriate solutions.

I also highly evaluate author's attitude to research results' sharing. The whole project is well described at the project website - http://rtime.felk.cvut.cz/helicopter/. The pages are well elaborated with deep technical details, and even source code. There have been more people working on the project, which exposes author's ability of cooperation on a complex problem, as well as his ability to lead students.

As the author states in the conclusion, the project is far from being finished and will continue. Even in the current state it represents a **valuable research output** that might be potentially practically used in the future.

I have no hesitation to **RECOMMEND** the work defense.

Questions to the candidate:
1. How the horizontal accelerations affect the inclination measurement by accelerometers? Can you describe the errors it causes and possibilities of its compensation?
2. What is the magnetometer performance in real operation? What is the azimuth precision, how it is affected by electro-magnetic field of the helicopter and how do you cope with inclination?
3. In Chapter 3.2 you mention only 2% of WiFi bus utilization. Have you considered lowering the bandwidth to acquire wider range or even using different wireless technology?
4. In Chapter 8.2 you propose the use of ultrasonic proximity sensor. Can you describe the application in more details?

In Brno, 19. 4. 2010

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