

Opponent's review of the Doctoral Thesis

Candidate Jan Hanuš

Title of the doctoral thesis Processing of hyperspectral data

Study Programme Geodesy and Cartography

Tutor Dr. Ing. Karel Pavelka

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Topicality of the doctoral thesis theme

Commentary: The processing of hyperspectral imagery is undoubtedly one of the critical issues of remote sensing. Information consisting of each pixel could be revealed and interpreted correctly under the premise of adequate processing. The processing strategy, in turn, depends on the task for which remote sensing data will be used. Therefore, various applied problems will determine different processing approaches. Among the problems that are characterized by huge variability of studied parameters are environmental monitoring tasks. Indeed, these tasks require hyperspectral data to monitor environmental changes. Moreover, the correctly processed hyperspectral data allow for revealing the hidden relationships between reasons and aftermaths of miscellaneous environmental processes. The tasks and problems mentioned above are especially relevant for the case of data fusion (satellite, aerial, UAV, and LiDAR data). Given the above, I consider the chosen topic of dissertation research relevant and one that has not only scientific value but, first of all, great practical significance.

excellent above average average below average poor

Fulfilment of the doctoral thesis objectives

Commentary: Based on the author's topics, one may define the following objectives that were rationale and achieved in the doctoral thesis.

1. The concept development of hyperspectral laboratory.
2. The approach development for the fusion of airborne hyperspectral and LiDAR data.
3. The refinement of airborne imaging spectroscopy workflow.
4. The in-depth study of hyperspectral data for forest monitoring.
5. The examination of hyperspectral data for wetland studies.

excellent above average average below average poor

Research methods and procedures

Commentary: Validity and reliability are ensured by a detailed analysis and theoretical developments, which are confirmed by the results of experimental research. The author has refined, studied, and applied different methods and approaches to achieve the thesis's goals. A powerful research methods was used, including: methods of mathematical statistics, regression analysis, artificial neural networks, and radiometric calibration approach. To confirm the scientific

results, the thesis presents a significant amount of experimental observations, which confirm the theoretical results obtained by the author.

excellent above average average below average poor

Results of the doctoral thesis – dissertant’s concrete achievements

Commentary: 1. Development of ground reference panels for airborne, UAV and ground based image acquisition. 2. Testing of usability of the apparent reflectance methods for Specim as well as Itres hyperspectral sensors. 3. Development and establishing of hyperspectral data pre-processing chains for daily data processing, especially for VNIR and SWIR spectral regions. 4. Support and development of applications involving hyperspectral data for number of topics (water, soil, archaeology, oil contamination, etc.).

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Importance for practice and for development within a branch of science

Commentary: The primary practical value of the work is the development of valuable recommendations and technological workflows. All practical results relate to the functional improvement of the various hyperspectral data processing and their applications. In this context, the following hands-on achievements should be noted:

- establishing of the Flying Laboratory of Imaging Systems;
- establishing a radiometric calibration laboratory and radiometric calibration of imaging sensors;
- establishing a facility equipped for supportive ground measurements for airborne campaigns;
- establishing a joint UAV/laboratory facility;
- rules development for further operation of hyperspectral sensors;
- improvement of ASD integrating sphere for transmittance measurements.

The critical application of the work can be environmental monitoring. The doctoral thesis results can be primarily recommended for implementation in the work of the state services in charge of ecology, water resources, agriculture, etc.

excellent above average average below average poor

Formal layout of the doctoral thesis and the level of language used

Commentary: I do not have any remarks regarding the thesis formal layout. The work is well-structured. The scientific language and English particularly are understandable and clear. The application of scientific terms and definitions is correct.

excellent above average average below average poor

Statement on compliance with citation ethics

The results presented in the thesis are fully covered in peer-review publications. Two or more publications with identical content are missing. I have not noticed any violations of citation ethics.

Remarks

1. The theme of the study is chosen too broad. As for me, I think the title should be more specific.

2. In Article 1, the author considered boresight calibration, but no information was provided - namely, values of boresight parameters, calibration accuracy, etc.
3. In Article 3, what was the reason for using the feed-forward perceptron for ANN, being that there are many other options?
4. Regression equations in Article 4 need a more detailed explanation. What were the correlation coefficients and reliability criteria for them?

Final assessment of the doctoral thesis

Based on the study of the doctoral thesis, I believe that the dissertation of Jan Hanuš, "Processing of hyperspectral data" is a completed scientific work devoted to solving an important and topical scientific task of remote sensing data processing and their application for various environmental monitoring tasks. The carried out studies have scientific novelty and practical value. The dissertation corresponds to the topics and scientific directions of the study program "Geodesy and Photogrammetry", and its author, Jan Hanuš, deserves the Doctor of Philosophy degree award.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree

yes <input checked="" type="checkbox"/>	no <input type="checkbox"/>
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Date: November 17 2023

Opponent's signature: