

REVIEW

on the thesis for obtainment of the educational and scientific degree „**Doctor**”

professional field **4.6. Informatics and computer sciences**

scientific specialty „**Informatics**”

Author of the thesis: **Ventsislav Yuriev Polimenov**

Thesis title: **Adaptive Neural Network for Processing Satellite Data with Different Spatial and Spectral Characteristics**

Member of the scientific panel: Prof. Dr. Petia Doycheva Koprinkova-Hristova

I was appointed as a member of the Scientific panel on the procedure for obtainment of the educational and scientific degree “doctor” by Ventsislav Yuriev Polimenov with the order №44/18.05.2026 of the Director of IMI-BAS. As panel member I received the following documents:

1. Doctoral thesis in English
2. Thesis abstracts in Bulgarian and English
3. Reference Contributions
4. List of papers and citations
5. Declaration of authorship
6. Publications copies
7. Application and professional CV of the candidate

The dissertation is 138 pages long, with 26 figures and 25 tables. It consists of an introduction, three chapters, a conclusion and a bibliography. A total of 127 literary sources are cited, all in English.

The abstract faithfully reflects all the main parts of the dissertation in a summary. It is 46 pages long in Bulgarian and 45 pages long in English.

The problem developed in the dissertation is related to the processing of satellite images in order to determine the leaf mass index for the purposes of precision agriculture - a topic undoubtedly relevant in view of the need to increase crop yields. For this purpose, modern technology from the field of artificial intelligence (AI) was used - convolutional neural networks with an improved structure and training strategy for the purpose of integrating multisensor remote satellite information, achieving improved accuracy of leaf mass assessment in the observed regions.

In the overview chapter, the doctoral student demonstrates in-depth knowledge of the state of the problem, presenting an analytical literature review, using current literature sources (94 of which are from the period after 2010, and 48 from the period after 2020) of the specifics of satellite observations, the features of the images obtained and their application for remote sensing of the earth's surface, and the deep neural network architectures used so far and their application for the purposes of determining the leaf mass index. The doctoral student clearly defines the unresolved problems, thereby motivating the goal and objectives of his dissertation work and choosing the methods for their solution.

In the next chapter, entitled Methodology, the doctoral student describes in detail the overall concept of work he developed, including all necessary stages starting from data labeling, filtering, enrichment (augmentation) and normalization, an original architecture called Multi-Sensor U-Net with ASPP and Conditional Batch Normalisation, a training strategy with data balancing, metrics for evaluation and validation of the trained model.

Chapter Experiments and Results presents the application of the methodology developed in the previous chapter on satellite data from two satellites - Sentinel-2 and Landsat 8/9 - from the region of the city of Burgas.

The final chapter presents a brief summary of the results obtained, a reference for the contributions, directions for future work, a list of publications related to the dissertation work, as well as information about the doctoral student's participation with reports in conferences and in scientific projects.

The contributions in the dissertation are divided into scientific, scientific-applied and applied. I accept the classification and formulation of his contributions proposed by the doctoral student. Briefly summarized, they are:

1. Scientific

- An original architecture of a convolutional neural network has been developed, combining several techniques used in deep neural models, namely: U-Net architecture with sensor-specific input projections generated by a semantic image segmentation module (Atrous Spatial Pyramid Pooling), and using scaling (Conditional Batch Normalization) between the convolutional layers of the encoder and decoder.
- A method for balanced training on multi-sensor data is proposed by enriching the data with artificially generated data (augmentation) and balancing the participation of individual sensors within the training epochs.
- A methodology has been developed to generate pseudo-reference data for the leaf mass index by ensemble combining several vegetation indices.
- A multi-level framework for validation of the trained model is proposed.

2. Scientific and applied

- A comprehensive methodology for estimating the leaf mass index from multi-sensor satellite data has been developed and applied to agricultural areas in Bulgaria using data from two satellites – Sentinel-2 and Landsat 8/9.
- Tests have been conducted proving the superiority of the developed multisensor model compared to single-sensor models and classical models for calculating vegetation indices.
- The generalization ability of the trained model was tested on images from the region used in its training, but from different time periods, as well as on images from regions that were not used in training.

3. Applied:

- The comprehensive approach developed for multispectral image processing and the training of a proprietary deep neural network architecture to generate leaf area index maps has been implemented on high-performance infrastructure.

A particularly good impression is made by the fact that the doctoral student already has ideas for the future development of his work in two directions: including new input data,

complementing satellite images in order to improve its classification accuracy and using field data for the purposes of training and testing the model.

The doctoral student has presented 3 published reports in the IEEEExplore conference database on the topic of the dissertation, all referenced in Scopus. According to the Regulations for the Implementation of the Act on the Development of the Academic Staff of the Republic of Bulgaria, these publications bring the doctoral student 18 points each or a total of 54, which has achieved and exceeded the requirement of a minimum of 30 points under indicator D for a dissertation for obtaining the educational and scientific degree "doctor". All publications are co-authored, with the doctoral student being the first author of two of them and the third out of a total of 5 co-authors of the third publication. I believe that this proves his significant contribution to all publications.

Although the procedure does not require citations, there are already data on two citations of one of the publications in refereed articles in Scopus, which is proof that the doctoral student's work is visible and considered useful by the global scientific community.

In addition, the doctoral student has presented parts of the results of his dissertation at 5 international scientific forums. He has also participated in three projects under national scientific programs.

The dissertation is written in English, thus avoiding the need for a Bulgarian translation of the terminology used in the field of deep neural networks. The abstract in Bulgarian contains quite a few foreign words or literal translations of the terms, which does not diminish its scientific qualities. There is no generally accepted translation in our scientific community, but I would recommend that the translation be refined in the future if it is necessary to present the work to a Bulgarian audience.

The presented dissertation is a completed scientific study, including the steps of obtaining raw satellite data, their pre-processing, enrichment (augmentation), training a deep neural network using data from two satellites with different characteristics, testing the model and analyzing its accuracy and its ability to generalize when using new data. I believe that the doctoral student has built serious scientific competence and skills to apply his knowledge in solving practical problems. I recommend that he continue to develop in the future in this undoubtedly relevant area of great practical importance.

The candidate fulfils all demands of the Law for scientific development of the academic staff for achievement of the educational and scientific degree "Doctor". In conclusion, I give **positive assessment** of the PhD thesis.

All aforementioned gives me a reason to recommend to the members of the Scientific panel to confer on **Ventsislav Yuriev Polimenov** the educational and scientific degree "**Doctor**" in professional field **4.6. Informatics and computer sciences, scientific speciality „Informatics”**.

Date: 30.06.2026

PANEL MEMBER:

(Prof. P. Koprinkova-Hristova)