

OPINION

on doctoral dissertation for obtaining the educational and scientific degree of Doctor, within doctoral program “Applied Mechanics”, in professional field: 5.1 Mechanical Engineering.

Author of the doctoral dissertation: Asparuh Ivanov Atanasov

Topic of the doctoral dissertation: “Investigation of the applicability and effectiveness of sensor systems in precision agriculture”

This Opinion has been prepared by Prof. Dr. Darina Dimitrova Valcheva, Institute of Agriculture - Karnobat, Agricultural Academy – Sofia, in my capacity as a member of Scientific Jury for the defense procedure of the doctoral dissertation according to Order No 874/12.12.2023 by the Rector of Technical University of Varna.

1. Relevance of the problem studied in the doctoral dissertation

Research on the possibility of monitoring and obtaining information about the state of agricultural crops through the use of unmanned aerial vehicles and multispectral cameras is increasingly entering agricultural science and practice. The answers to the questions posed in the dissertation work will achieve informed decision-making and development of national policies for food security and production management strategies. Timely and accurate information on the development of cultivated crops is of paramount importance to the agricultural producers. This information helps address the issue of food security and sustainable agricultural development. Various vegetation indices obtained with the help of multispectral cameras serve for qualitative and quantitative assessment of the agricultural crops. This expands the possibility of creating maps of the spatial distribution of the production potential. All of these provide sufficient reasons to determine the topic of the dissertation work as relevant, and the set scientific research tasks as a very well-chosen methodology for solving a number of unclear moments in this direction.

2. Scientific and applied scientific contributions of the dissertation work

I agree with the drawn conclusions and contributions resulting from the conducted experiments. The **scientific contributions** regarding the existing correlation between spectral reflectance data from agricultural crops and phenological, biometric, and physiological indicators are highly valuable for the agricultural science and practice. It is crucial for the applicability and effectiveness of the sensor system for remote monitoring. The created database for trends and dynamics of changes in vegetation indices: NDVI, EVI2, and SAVI for different wheat varieties in the Southern Dobrudzha region is the basis for selecting suitable ones for remote monitoring. An important scientific contribution is the analysis of factors determining the process of registering the reflection of solar radiation from the crop. It has been established that color peaks had the most significant impact in terms of the number of pixels with which they are registered by the photo sensor.

As for the **methodological scientific contributions**, I would specify the conclusions regarding planning and conducting of field campaigns for remote monitoring and studying the impact of meteorological conditions on the possibility of conducting UAV flights; creating a database for trends in the change of vegetation indices; the developed methodology for studying the applicability and effectiveness of the sensor system through a non-destructive method for remote monitoring.

Applied scientific contributions come down to establishing the range of variation within -1 to 0.5 in the Southern Dobrudzha region for the NDVI vegetation index for wheat, based on data obtained through remote monitoring with UAVs; modern statistical methods which have determined factors with the greatest impact on the NDWI moisture index - relative air humidity, air temperature, and solar radiation. A methodology for remote monitoring with UAVs has been developed for practical application in breeding improvement work on cereal crops, as well as in agricultural production to identify certain trends in the development of crops for a given region of the country.

The **applied contributions** in Assist. Prof. Atanasov's dissertation work include:

- Original approach to extracting information with the MatLab software platform, which is useful for tracking plant vegetation using data from pixel matrices created by digital technologies for each image. This method is suitable for small areas in breeding activities where information cannot be extracted from standard photogrammetry software products.

-An original prototype of a WiFi sensor for soil moisture and air temperature has been created, which is autonomously powered by solar energy, representing an analog of professional meteorological stations and is a very important element for the practice of precision agriculture. Its potential use in practice has been studied.

- Similarity has been established between the calculated NDVI values obtained from data collected by UAV flights and satellite observation data. UAV data are more easily applicable and effective for the purposes of precision agriculture, allowing for a more timely and detailed image.

- Phenological data have been established through registration of reflection from specific spectral ranges (i.e., the possibility of calculating vegetation indices), which provide reliable preliminary information for predicting biomass content and the potential of the studied plants.

- Assist. Prof. Atanasov skillfully summarizes and analyzes the achieved results, as published in 10 scientific articles in renowned national and international conference proceedings and journals. He is the sole author of one of them, while the rest are written collectively. He is the first author in seven of them.

3. Critical notes

My critical notes refer to some technical errors in the text - commas, definite article, and others, as well as agricultural concepts. For example, an area with wheat is called "sowing" not a "plantation." Of course, this in no way diminishes the value of the dissertation, but it is good to consider these in future work.

4. Conclusion

I consider that the dissertation work meets the requirements of the Development of Academic Staff in the Republic of Bulgaria Act, the Regulations for its Implementation, and the respective Regulations of the Technical University of Varna, as well as the requirements for obtaining the academic and scientific degree of Doctor. The discussed topic concerns a relevant area, the author has fulfilled the set goals and tasks in the dissertation, based on which scientific, applied scientific, and applied contributions have been achieved, as reflected in scientific publications. I give a positive evaluation of the presented dissertation work and recommend that the esteemed members of the Scientific Jury award the educational and scientific degree of Doctor to Asparuh Ivanov Atanasov in scientific specialty: "Applied Mechanics", in professional field: 5.1 Mechanical Engineering.

06.02.2024

Prof. Dr. Darina Valcheva
(Member of the Scientific Jury according to Order
No 874/12.12.2023 by the Rector of Technical
University of Varna)