remote sensing

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Editorial

Editorial for Special Issue: "Recent Progress in UAV-AI Remote Sensing"

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1. Introduction

The development of unmanned aerial vehicles (UAV) and artificial intelligence (AI) techniques has drawn increasing interest and started a novel area of research applications. Combining the advantages of UAV and AI, automatic and fast processing and modelling can be achieved, instant and spatially and temporally varying knowledge of target areas can be obtained, and the workload of operators and instructors can be greatly reduced. This Special Issue aims at studies covering the uses of AI techniques to interpret data obtained using different UAV sensors, providing references for the application of UAV imagery in various fields.

This Special Issue consists of 15 articles, focusing primarily on vegetation monitoring and target tracking using UAV imagery. These articles analyze the potential applications of UAV multispectral and hyperspectral imagery in vegetation growth monitoring and dynamic target tracking. The topics covered include the inversion of key physical and chemical parameters of crops, crop growth monitoring, building extraction, target tracking, and crop pest and disease monitoring and forecasting, among others. Additionally, these articles present numerous novel methods for extracting valuable information from UAV imagery.

2. Inversion of Crop Physical Parameters and Biomass Estimation

The majority of articles focus on how to use UAV imagery for the accurate estimation and monitoring of crop physical parameters and biomass. In the inversion of crop physical parameters, Ref. [1] focuses on comparing various spectral indices to estimate the nitrogen content of potato plants during different growth periods. This study evaluates the effectiveness of different indices in predicting nitrogen levels, which is crucial for optimizing fertilizer applications and enhancing potato crop yield. Ref. [2] compares the use of UAV RGB imagery and hyperspectral remote-sensing data for monitoring the growth of winter wheat. This study evaluates the capabilities of both data sources in capturing relevant information about wheat growth, such as vegetation health and biomass, to inform agricultural decision-making. Ref. [3] investigates the assessment of maize canopy and leaf chlorophyll content using leaf spectral reflectance data. This study examines the accuracy of estimating chlorophyll content at different growth stages and vertical positions within the maize canopy, providing insights into the crop's physiological state and potential yield.

In the estimation of crop biomass, Ref. [4] uses UAVs equipped with hyperspectral imaging to estimate the above-ground biomass of potato plants. This study employs machine-learning regression techniques to analyze the hyperspectral data and accurately

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estimate potato biomass, providing valuable information for crop management and yield estimation. Ref. [5] also utilizes UAVs to estimate potato above-ground biomass. In this case, this study explores the use of vegetation indices and green-edge parameters obtained from UAV data to assess the biomass of potato plants. This information can help farmers and researchers monitor potato growth and health. Ref. [6] focuses on extracting characteristic variables from UAV hyperspectral imagery to estimate the aboveground biomass of potato plants. This study uses specific spectral features and patterns to develop a reliable estimation method for potato biomass, contributing to precision agriculture and crop management.

3. Object Detection and Tracking

Some of the articles focus on research into object detection and tracking technology based on drones. In the field of object detection and extraction, Ref. [7] explores a comprehensive approach for building extraction and floor area estimation in rural Chinese villages using UAV photogrammetry and a novel deep learning network called EDSANet. This study aims to efficiently and accurately analyze building structures and floor areas to support rural development and land-use planning. Ref. [8] focuses on weakly supervised learning to detect transmission lines in UAV imagery. This study introduces a novel algorithm based on unpaired image-to-image translation that requires only image-level labels. The attention module improves detection accuracy, making it effective for detecting transmission lines in UAV images. Ref. [9] discusses the design of a wide-area and real-time object search system for UAVs. The system utilizes high-resolution cameras to collect aerial images with a large field of view, and parallel processing techniques to achieve real-time object search in a wide area.

In the field of object tracking, Ref. [10] addresses challenges in visual tracking for UAVs, particularly dealing with occlusion and deformation. The research proposes an algorithm based on the attention-based mask generative network to enhance the accuracy and robustness of target tracking in UAV imagery. Ref. [11] focuses on using UAVs equipped with AI capabilities and edge computing for remote sensing observation. This study introduces the AERO system, which utilizes deep learning models for object detection and tracking. The edge computing based on UAVs enables real-time data analysis and transmission without relying on cloud computation. Ref. [12] presents a method for multiple object tracking in drone videos using a temporal-association network with a separated-tasks structure. This study aims to improve the efficiency and accuracy of object tracking in drone videos. Ref. [13] proposes a method for designated target anti-interference tracking in UAVs by combining the YOLOv5 and SiamRPN algorithms. This research work focuses on enhancing tracking and landing control performance in UAV operations.

4. Crop Disease Monitoring and Forecasting

In addition, two articles in this Special Issue explore the feasibility of using UAV imagery for crop disease monitoring and forecasting. Ref. [14] proposes a monitoring approach for wheat rust using UAV imagery. This study utilizes the mRMR-XGBoost algorithm, which combines feature selection (mRMR) and the XGBoost machine learning algorithm. The goal is to accurately detect and monitor the occurrence and spread of wheat rust using remote sensing technology. Ref. [15] combines disease mechanism knowledge with machine learning techniques to develop a forecasting model for wheat fusarium head blight. This study aims to improve the accuracy of disease forecasting and enhance early warning systems to mitigate the impact of the disease on wheat.

5. Conclusions

This Special Issue presents innovative applications of UAV and AI techniques in the field of Earth observation. By leveraging the advantages of UAV and AI, rapid and automated data processing and modeling can be achieved, facilitating the acquisition of spatio-temporal information in target areas and reducing information acquisition costs. This Special Issue

comprises 15 articles, primarily exploring methods to utilize AI techniques for interpreting UAV imagery data. The majority of the articles focus on accurately monitoring crop growth parameters and biomass. Additionally, there are studies dedicated to UAV-based object detection and tracking technologies, covering building structures, power transmission lines, etc. Furthermore, this Special Issue discusses methods of using UAV imagery to monitor and forecast crop diseases, including wheat rust and fusarium head blight.

The above-mentioned studies have built UAV-AI systems to address complex problems, promoting the development of UAV-AI and providing references for the application and advancement of UAV technology in various fields.

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References

1. Fan, Y.; Feng, H.; Yue, J.; Liu, Y.; Jin, X.; Xu, X.; Song, X.; Ma, Y.; Yang, G. Comparison of Different Dimensional Spectral Indices for Estimating Nitrogen Content of Potato Plants over Multiple Growth Periods. *Remote Sens.* **2023**, *15*, 602. [CrossRef]
2. Feng, H.; Tao, H.; Li, Z.; Yang, G.; Zhao, C. Comparison of UAV RGB imagery and hyperspectral remote-sensing data for monitoring winter wheat growth. *Remote Sens.* **2022**, *14*, 3811. [CrossRef]
3. Yang, H.; Ming, B.; Nie, C.; Xue, B.; Xin, J.; Lu, X.; Xue, J.; Hou, P.; Xie, R.; Wang, K.; et al. Maize Canopy and Leaf Chlorophyll Content Assessment from Leaf Spectral Reflectance: Estimation and Uncertainty Analysis across Growth Stages and Vertical Distribution. *Remote Sens.* **2022**, *14*, 2115. [CrossRef]
4. Liu, Y.; Feng, H.; Yue, J.; Fan, Y.; Jin, X.; Zhao, Y.; Song, X.; Long, H.; Yang, G. Estimation of Potato Above-Ground Biomass Using UAV-Based Hyperspectral images and Machine-Learning Regression. *Remote Sens.* **2022**, *14*, 5449. [CrossRef]
5. Liu, Y.; Feng, H.; Yue, J.; Fan, Y.; Jin, X.; Song, X.; Yang, H.; Yang, G. Estimation of Potato Above-Ground Biomass Based on Vegetation Indices and Green-Edge Parameters Obtained from UAVs. *Remote Sens.* **2022**, *14*, 5323. [CrossRef]
6. Liu, Y.; Feng, H.; Yue, J.; Li, Z.; Jin, X.; Fan, Y.; Feng, Z.; Yang, G. Estimation of aboveground biomass of potatoes based on characteristic variables extracted from UAV hyperspectral imagery. *Remote Sens.* **2022**, *14*, 5121. [CrossRef]
7. Zhou, J.; Liu, Y.; Nie, G.; Cheng, H.; Yang, X.; Chen, X.; Gross, L. Building extraction and floor area estimation at the village level in rural China via a comprehensive method integrating UAV photogrammetry and the novel EDSANet. *Remote Sens.* **2022**, *14*, 5175. [CrossRef]
8. Choi, J.; Lee, S.J. Weakly Supervised Learning for Transmission Line Detection Using Unpaired Image-to-Image Translation. *Remote Sens.* **2022**, *14*, 3421. [CrossRef]
9. Li, X.; He, B.; Ding, K.; Guo, W.; Huang, B.; Wu, L. Wide-Area and Real-Time Object Search System of UAV. *Remote Sens.* **2022**, *14*, 1234. [CrossRef]
10. Bai, Y.; Song, Y.; Zhao, Y.; Zhou, Y.; Wu, X.; He, Y.; Zhang, Z.; Yang, X.; Hao, Q. Occlusion and Deformation Handling Visual Tracking for UAV via Attention-Based Mask Generative Network. *Remote Sens.* **2022**, *14*, 4756. [CrossRef]
11. Koubaa, A.; Ammar, A.; Abdelkader, M.; Alhabashi, Y.; Ghouti, L. AERO: AI-Enabled Remote Sensing Observation with Onboard Edge Computing in UAVs. *Remote Sens.* **2023**, *15*, 1873. [CrossRef]
12. Lin, Y.; Wang, M.; Chen, W.; Gao, W.; Li, L.; Liu, Y. Multiple Object Tracking of Drone Videos by a Temporal-Association Network with Separated-Tasks Structure. *Remote Sens.* **2022**, *14*, 3862. [CrossRef]
13. Wu, D.; Zhu, H.; Lan, Y. A Method for Designated Target Anti-Interference Tracking Combining YOLOv5 and SiamRPN for UAV Tracking and Landing Control. *Remote Sens.* **2022**, *14*, 2825. [CrossRef]
14. Jing, X.; Zou, Q.; Yan, J.; Gao, W.; Li, L.; Liu, Y. Remote Sensing Monitoring of Winter Wheat Stripe Rust Based on mRMR-XGBoost Algorithm. *Remote Sens.* **2022**, *14*, 756. [CrossRef]
15. Li, L.; Dong, Y.; Xiao, Y.; Liu, L.; Zhao, X.; Huang, W. Combining disease mechanism and machine learning to predict wheat fusarium head blight. *Remote Sens.* **2022**, *14*, 2732. [CrossRef]