Innovations and Future Directions in UAV-Based Remote Sensing and Precision Pesticide Spraying for Digital Agriculture

Abstract

Ensuring global food security remains a critical challenge in the face of a growing population, climate change, and labor shortages in the agricultural sector. As traditional farming practices struggle to meet modern demands, advanced technologies are becoming essential tools in agricultural transformation. Among these, artificial intelligence-based UAV remote sensing and precision variable-rate spraying technologies are emerging as powerful solutions for enhancing productivity and sustainability. These technologies enable efficient field monitoring, early detection of crop stress or disease, and targeted pesticide or nutrient application, thereby reducing input waste and minimizing environmental impact. This speech will provide a broad overview of recent developments and practical applications in AI-driven UAV remote sensing and variable-rate spraying. Key examples and case studies will be shared to illustrate how these intelligent systems are shaping the future of smart agriculture and offering viable solutions to the global food production challenge.

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RESEARCH AREAS AND EXPERTISE
- General area: Agricultural automation
- Specific area: Precision agriculture and agricultural remote sensing based on artificial intelligence

SELECTED AWARDS AND RECOGNITION
- Editor in Chief, <Engineering in Agriculture, Environment and Food>
- Guest Editor, <Computers and Electronics in Agriculture>, <Agriculture>, <Biosystems engineering>, 2022-present
- Outstanding Teaching Award, Kangwon National University, 2023-2024
- Invited Speaker, University of Mississippi, 2023
- Invited Speaker on "Precision Agriculture," China Agricultural University and Zhejiang University, 2024
- Excellent Paper Award, 33rd Korea Science and Technology Awards, 2023 (the highest national recognition in science and technology in Korea)

Professor Xiongzhe Han earned his Ph.D. in Biosystems Engineering from Seoul National University in 2017. He was a Postdoctoral Research Associate and Assistant Research Scientist at Texas A&M University (2017–2020). He is now an Associate Professor at Kangwon National University and Adjunct Professor at Mississippi State University. His research focuses on cutting-edge agricultural technologies, including UAV spraying systems, autonomous agricultural vehicles, and hyperspectral imaging. He has published over 80 peer-reviewed papers and collaborates with leading international institutions, including CAU, ZJU, NCSU, and MSU. His research projects are supported by the National Research Foundation of Korea and the Rural Development Administration.