A Study on UAV-Based Spatial Sampling and Analytical Methods for Soil Physicochemical Properties and Gas Emission Characteristics in Agricultural Fields

Abstract

Soil serves as the foundation of agricultural cultivation. To enable faster and more convenient soil analysis, this study develops a UAV-based system for non-destructive soil sampling and analysis in agricultural fields. The proposed system focuses on the spatial monitoring and rapid assessment of soil physicochemical properties and gas emission characteristics in both farmland and flooded agricultural fields. Building upon a laboratory-developed UAV platform that integrates sensing and sampling modules, this research further designs and integrates low-cost deployable sensors, real-time data acquisition and wireless transmission units, a soil headspace gas collection and on-site analysis system, and a scanning-type surface soil redox potential sensor. Additionally, a commercially available multi-parameter soil environment sensor is incorporated to establish a robust ag-UAV platform capable of rapid deployment in rugged agricultural landscapes.

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RESEARCH AREAS AND EXPERTISE

- General area: System Integration and Specialised System Development
- Specific area: Agricultural UAV Application Platforms

SELECTED AWARDS AND RECOGNITION

- Secretary General, Taiwan Institute of Biological Mechatronics (2024–Present)
- Division Director of International Academic Cooperation, Office of International Affairs, National Ilan University (2023–Present)
- Technical Committee Member, National Standards for Electronic Engineering, Bureau of Standards, Metrology and Inspection, Ministry of Economic Affairs (2023–Present)

Chen-Wei Liang is a Professor in the Department of Biomechatronics Engineering at National Ilan University (NIU). He received his Master's and Ph.D. degrees in Electrical Electronic Engineering at The University of Manchester (UoM), U.K. . After graduating from UoM, he became a Research Associate at UoM in 2017 and a Principle Engineering at a UoM spin-out semiconductor company in 2020. His research interests include system integration and metallic non-destructive testing methods in the field of engineering. After gaining industrial experience, he decided to focus on academic research and has been with National Ilan University since 2021. His current research topics have shifted to focus on advanced system integration in the Biomechatronics field, including applied technologies involving Uncrewed Aerial Vehicles and Artificial Intelligence. Chen-Wei teaches Mechatronic Integration and Database and Data Mining at NIU. He has supervised more than 30 graduate and undergrad students and received more than 15 funded projects in the past five years.