

Enhancing Crop Yield Prediction Accuracy through UAV-Based Multispectral Imagery

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Abstract:

Unmanned Aerial Vehicles (UAVs), commonly referred to as drones, have emerged as disruptive technologies with broad applications across various domains. These remotely piloted aircraft, equipped with advanced sensors and imaging capabilities, offer unprecedented opportunities for data collection and analysis. This abstract provides an overview of the diverse applications of UAVs, ranging from precision agriculture and environmental monitoring to disaster response, infrastructure inspection, and scientific research. The versatility of UAVs is underscored in their ability to access hard-to-reach locations, providing valuable insights for decision-making processes in agriculture, conservation, and disaster management. The abstract also explores the evolving technologies associated with UAVs, including advancements in artificial intelligence, machine learning, and sensor integration, enhancing their autonomy and operational efficiency. As these technologies mature, UAVs are poised to play a pivotal role in shaping the future of various industries, prompting the need for responsible regulation and ethical considerations to ensure their safe and beneficial integration into society.

Keywords: CNN, Unmanned aerial vehicles, Vegetation Indices, Normalized Difference Texture Indices

1. Introduction

Unmanned Aerial Vehicles (UAVs), more commonly known as drones, have become revolutionary technologies with broad applications across various industries. These aircraft, operated remotely and without a pilot on board, are recognized for their versatility, agility, and capability to access areas that may pose challenges or hazards for humans. Equipped with an array of sensors, cameras, and data-capturing devices, UAVs can capture high-resolution imagery, conduct surveillance, and perform various tasks with precision.

Initially designed for military use, UAVs have expanded beyond their original purpose and are now utilized in diverse sectors such as agriculture, environmental monitoring, disaster response, infrastructure inspection, and filmmaking. Their cost-effectiveness, operational adaptability, and efficiency in covering expansive areas have led to their widespread adoption.

Within this framework, the subsequent exploration delves into the capabilities, applications, and evolving technologies associated with UAVs, providing insights into their transformative influence across various domains.

UAVs play a crucial role in precision agriculture by providing farmers with real-time data on crop health, soil conditions, and irrigation needs. This data helps optimize resource allocation and enhance overall crop yield.

Disaster response and management benefit from UAVs' rapid assessment capabilities and agility in hard-to-reach locations. In infrastructure inspection, these unmanned aircraft offer a cost-effective and efficient alternative for evaluating critical structures like bridges and power lines. The film and photography industries capitalize on drones for capturing stunning aerial shots and footage. UAVs also play a vital role in surveillance, security, and scientific research, assisting in monitoring large areas and conducting studies in remote or hazardous environments. Furthermore, UAVs are explored for potential applications in delivery services, offering faster and more efficient transport of goods, particularly in challenging terrains. As technology advances, with improvements in artificial intelligence and sensor capabilities, UAVs continue to evolve, promising increased autonomy, extended flight durations, and enhanced data collection capabilities. While these innovations bring numerous benefits, addressing regulatory, privacy, and airspace management challenges remains crucial for their widespread and responsible use.

2. Design/Methods/Modelling

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have become instrumental in modern agriculture by serving as a versatile platform for crop monitoring and management. Equipped with various imaging sensors, including RGB cameras, multispectral cameras, and sometimes LiDAR or thermal sensors, UAVs capture high-resolution[2] data during aerial surveys over agricultural fields. This data is then processed to generate

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vegetation indices (e.g., NDVI) for assessing crop health, detecting anomalies such as stress or diseases, and predicting yields. UAVs also support precision agriculture through variable rate application of resources like fertilizers and pesticides based on real-time field data. Beyond imagery, LiDAR-equipped UAVs contribute to terrain mapping and topography analysis, aiding in soil erosion management and irrigation optimization.



Figure 1: Different UAV's

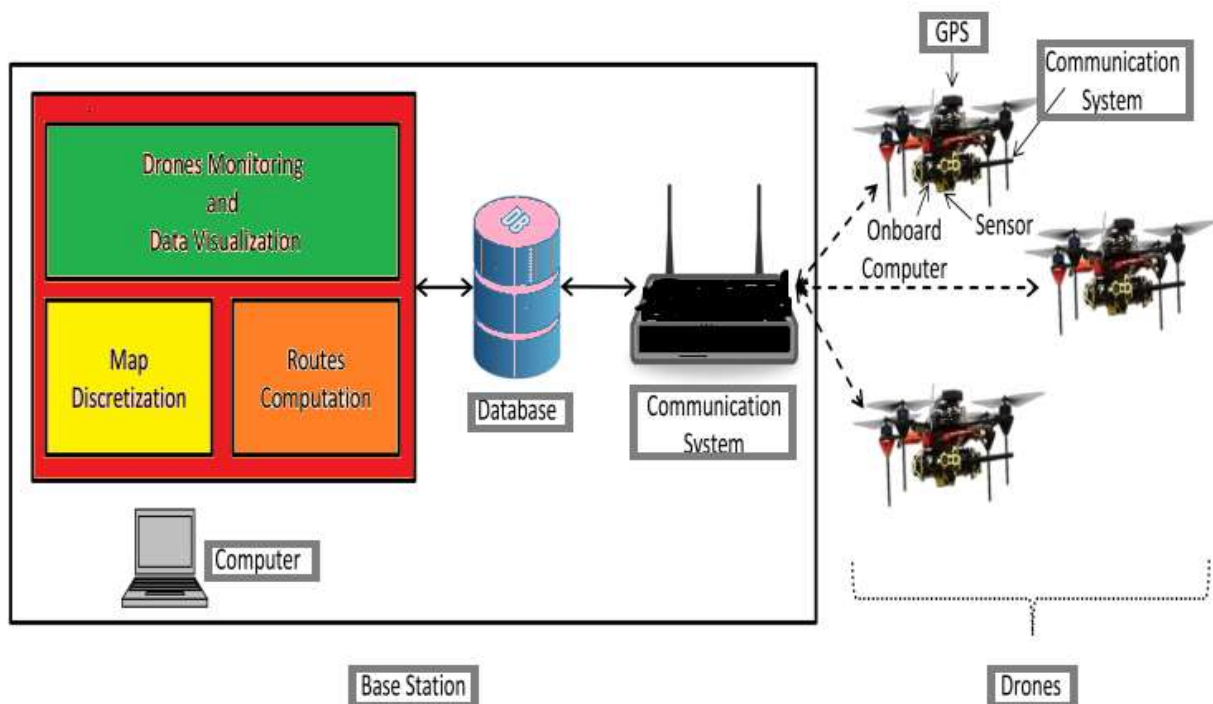


Figure 2: UAV

Vegetation indices (VIs) are mathematical combinations of spectral bands from remote sensing data, often derived from satellite or UAV imagery, that are used to highlight and

characterize vegetation properties. These indices provide valuable information about the health, vigor, and density of vegetation in a given area. Normalized Difference Texture Indices (NDTIs) extend the concept of vegetation indices to include texture information. Texture refers to the spatial arrangement of pixel values in an image and can provide additional insights into the structure of the landscape. Combining normalized difference values with texture indices enhances the ability to discriminate and characterize features within the landscape.

3. Results and Discussion

The integration of Unmanned Aerial Vehicles (UAVs) into modern agricultural practices represents a significant advancement in crop monitoring and management. The versatility of UAVs is evident in their deployment of various imaging sensors, including RGB, multispectral, and even advanced technologies like LiDAR and thermal sensors. This technology enables high-resolution aerial surveys over agricultural fields, capturing valuable data for analysis. The generation of vegetation indices, such as NDVI, from this data is particularly noteworthy as it provides a comprehensive assessment of crop health. The ability to detect anomalies, including stress and diseases, facilitates early intervention and targeted interventions. Additionally, the predictive capabilities of UAVs, especially in terms of yield estimation through machine learning models trained on UAV-derived data, offer a transformative potential for crop planning and decision-making.

Precision agriculture, facilitated by UAVs, takes center stage in resource management. The real-time monitoring capabilities of UAVs allow for variable rate application of resources, such as fertilizers and pesticides, based on the specific needs of different parts of the field. This optimization not only enhances resource efficiency but also contributes to environmental sustainability by minimizing the impact of agrochemicals. The incorporation of LiDAR sensors in some UAVs expands their utility to terrain mapping and topography analysis, providing valuable insights for soil erosion management and efficient irrigation practices.

4. Conclusions

The amalgamation of UAV technology with agriculture has ushered in a new era of precision, efficiency, and sustainability. The comprehensive data collected by UAVs empowers farmers and researchers alike, providing a nuanced understanding of crop conditions and enabling

proactive measures for optimal crop management. As UAV technology continues to evolve, its integration into agricultural practices is poised to play a pivotal role in addressing the challenges of food security, resource optimization, and environmental stewardship.

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