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Original Research Paper

Application of GIS-Based UAV Systems for Mapping and Monitoring Agricultural Land

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Abstract: Bangladesh faces serious challenges in agricultural mapping and monitoring due to urbanization, climate change, and the limitations of manual methods. This research aims to utilize a Geographic Information System (GIS)-based UAV system for efficient and accurate agricultural mapping and monitoring. The system collects multispectral data on vegetation conditions, soil moisture, and crop growth, and identifies areas affected by drought or pest infestations. The UAV is designed to cover large areas difficult for humans to access, with data integrated into GIS for spatial analysis and precision agriculture-based recommendations. The research methodology employed a quantitative approach with experimental methods and GIS spatial analysis. It was conducted from September to December 2025 in three key agricultural districts: Gazipur, Rajshahi, and Khulna. The multirotor UAV was equipped with a multispectral camera, a high-resolution RGB camera, GPS, and autopilot for coordinate accuracy and automated flight path planning. Image acquisition was conducted two to three times during the growing season, supplemented by soil moisture measurements, weather data, visual observations, and respondent interviews for validation. The results demonstrated that the UAV-GIS system was capable of producing accurate maps of vegetation conditions, soil moisture, and crop stress areas. Field findings indicate that the integration of GIS spatial analysis can detect crop conditions with an accuracy of up to 92%, surpassing conventional methods, which only reach 70%. Furthermore, operational efficiency has increased, with work time reduced from 10 hours to just 2 hours per hectare, and costs reduced from $25 to $15. This system aligns with previous studies on the effectiveness of UAVs and GIS in monitoring hard-to-reach areas, supporting precision agriculture practices, and improving productivity and sustainability. Further research could explore fixed-wing UAVs for larger areas, the integration of LiDAR or hyperspectral sensors, the development of AI algorithms for predicting crop stress and disease, and sustainable business models for UAV-GIS adoption in developing countries.

Keywords: Bangladeshi Agriculture, Crop Stress, GIS, Precision Agriculture, UAV