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Advanced UAV - based leaf disease detection: Deep Radial Basis Function Networks with multidimensional mixed attention

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Abstract

Plant disease causes a highly significant impact on production due to its destructive characteristics. A variety of chemical techniques should be applied to agriculture at different stages of disease infestation to enable precise plant protection. The integration of unmanned aerial vehicles (UAVs) for obtaining high-resolution images has become necessary due to the growing demand for precision agriculture, making crop health monitoring more efficient. In this study, we developed an innovative approach that combines the Deep Radial Basis Function Network (DRBFN) with the Multidimensional Mixed Attention (MMA) method. Since DRBFNs use radial basis functions as effective feature extractors, the model can detect even the smallest changes in the composition, color, and texture of leaves. This capability is particularly helpful when dealing with a diversity of plant species and pathogens exhibiting different symptoms. By deliberately considering pertinent spatial and spectral attributes, MMA is applied to enhance the discriminatory abilities of the network. By integrating spatial and spectral attention, the network can efficiently acquire information from both local and global sources, thereby enhancing the overall resilience and precision of the detection system. Our proposed model leverages UAV-captured images to achieve a classification accuracy of 96.95% in identifying leaf diseases across two different plant species. The integration of mixed attention mechanisms improved feature representation, leading to a 47.63% reduction in Root Mean Square Error (RMSE) compared to traditional methods. Furthermore, our model demonstrates significant efficiency by processing 2000 images, making it suitable for real-time applications. These results underscore the potential of UAV-based systems combined with advanced deep learning techniques for precision agriculture, offering scalable solutions for early disease detection and management.

Keywords Deep learning (DL) · Leaf disease · UAV images · Precision agriculture · Multidimensional mixed attention · Deep Radial Basis Function Networks

Extended author information available on the last page of the article

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