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Qeios

Peer Review

Review of: "Plantation Monitoring Using Drone Images: A Dataset and Performance Review"

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1. Scientific and Methodological Rigor

Strengths

The manuscript effectively integrates UAV-based remote sensing with deep learning, demonstrating:

A novel dataset specifically designed for tree health classification, annotated with CVAT.

Experimental evaluation of state-of-the-art CNN models for tree classification.

Analysis of model overfitting issues and the impact of depth-wise convolution on classification accuracy.

Areas for Improvement

Mathematical Justification of Model Selection: The study should provide detailed equations describing the CNN architectures and explain why certain models are expected to perform better on UAV imagery.

Computational Complexity Analysis: Include Big-O complexity estimates for the CNN models to assess their feasibility for real-time UAV-based monitoring.

Data Augmentation and Generalization: Investigate whether augmentation techniques (e.g., rotation, flipping, synthetic noise) can improve model robustness.

A relevant study on AI-driven optimization for environmental monitoring can be cited:

https://doi.org/10.54216/JAIM.060205.

2. Experimental Validation and Comparative Benchmarking

Strengths

The study presents a comprehensive evaluation of CNN models on the proposed dataset, including:

Performance comparison of multiple CNN architectures (AlexNet, VGG16, XceptionNet, etc.).

Evaluation using key classification metrics such as accuracy and loss.

doi.org/10.32388/6DXU4L

Analysis of overfitting using train vs. test loss and accuracy curves.

Areas for Improvement

Statistical Significance Testing: Conduct Wilcoxon signed-rank tests or ANOVA to determine whether performance differences between CNN models are statistically significant.

Comparison with Transformer-Based Models: Extend the comparative analysis to include Vision Transformers (ViTs) and Swin Transformers, which have outperformed CNNs in remote sensing applications.

Evaluation on Additional UAV Datasets: Validate the proposed dataset and CNN-based classification models using additional UAV-based datasets for other tree species and plantation environments.

A study on deep learning-based environmental data analysis can be referenced:

https://doi.org/10.54216/MOR.030203.

3. Theoretical Contributions and Algorithmic Justification

Strengths

The manuscript introduces:

A novel RGB dataset for tree classification with three health categories.

A benchmark evaluation of CNN models on UAV plantation images.

An observation that depth-wise convolution operations improve CNN performance on the dataset.

Areas for Improvement

Explainability of CNN-Based Predictions: Utilize SHAP (Shapley Additive Explanations) or Grad-CAM visualizations to interpret which image regions contribute most to classification decisions.

Convergence Analysis of CNN Models: Provide learning curve plots comparing the convergence rates of different CNN models on the dataset.

Hybrid AI Optimization Strategies: Investigate whether combining CNNs with reinforcement learning or metaheuristic optimization (e.g., Genetic Algorithms, Grey Wolf Optimizer) can further enhance classification accuracy.

A study on AI-based decision optimization in agricultural monitoring can be cited:

https://link.springer.com/article/10.1007%2Fs00704-021-03843-2.

4. Visualization and Interpretability

Strengths

The manuscript includes:

Confusion matrices comparing the classification performance of different CNN models.

Accuracy and error rate comparisons across different model architectures.

Figures illustrating sample annotations and tree classification categories.

Areas for Improvement

Feature Importance Analysis:

Use heatmaps to show which image features contribute most to tree health classification.

Provide t-SNE or PCA projections to visualize feature separability between different health categories.

Comparison of Model Decision Boundaries:

Include visualizations comparing how different CNNs segment tree health regions in UAV images.

Introduce error analysis visualizations highlighting common misclassification patterns.

A study on deep learning interpretability in environmental monitoring can be referenced:

http://dx.doi.org/10.3390/math10162912.

5. Practical Applications and Future Research Directions

Strengths

The study highlights:

The potential of UAV-based RGB images for plantation health monitoring.

The advantages of deep learning-based classification for automated precision agriculture.

The scalability of the dataset for future AI-driven agricultural applications.

Areas for Improvement

Deployment in Real-World Agricultural Systems: Discuss how the CNN-based classification system can be integrated into UAV-based monitoring platforms for real-time decision-making.

Scalability to Multi-Modal Data: Evaluate whether the dataset and models can be extended to include hyperspectral and thermal imaging for improved tree health assessment.

Federated Learning for Distributed UAV Monitoring: Investigate how federated learning techniques can enable decentralized training across multiple plantation regions while preserving data privacy.

A study on AI applications in real-time environmental monitoring can be cited:

http://dx.doi.org/10.3390/bioengineering10010018.

6. Conclusion

Strengths

Summarizes the impact of UAV-based RGB imaging for tree health classification.

Demonstrates the potential of CNN models for automated plantation monitoring.

Highlights the importance of dataset standardization and benchmarking in precision agriculture.

Areas for Improvement

Addressing Model Limitations:

Discuss computational trade-offs in deploying CNN models on UAV systems for real-time monitoring.

Highlight potential biases in dataset annotations and their impact on model generalization.

Future Work Recommendations:

Explore meta-learning techniques for adaptive CNN model selection based on different plantation conditions.

Investigate multi-objective optimization techniques to balance classification accuracy and computational efficiency.

Declarations

Potential competing interests: No potential competing interests to declare.