Automated Palm Tree Counting Based on Orthoimage Using Machine Learning and Deep Learning Approach

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The counting and monitoring of trees from aerial imagery present significant challenges with applications in various fields such as forest inventory, crop estimation, and irrigation policy. Traditional manual counting methods are laborious and expensive, making palm tree counting on large plantation area to be a difficult task. Leveraging advancements in machine learning and deep learning, we propose a transformative approach for reliable palm tree detection using high-resolution aerial photos captured by unmanned aerial vehicles (UAVs).

In this study, we employed a machine learning approach based on template matching using Normalized 2-D cross-correlation for palm tree detection. The input data comprised ortho-mosaic photos, and a carefully selected set of trees served as template images. To facilitate the template matching process. The similarity between templates and input data was assessed using normalized two-dimensional cross-correlation, employing correlation coefficients and bounding box criteria for detection. The template matching process successfully detected 1162 trees out of a total of 1892, accurately identifying 1146 trees, resulting in an overall accuracy of 79.597%.

Subsequently, we employed Mask R-CNN, a prominent Deep Learning model, for the purpose of detecting palm trees through instance segmentation. The performance evaluation of the trained model, which achieved a loss value of 1.9, demonstrated its proficiency in successfully detecting palm trees. In order to rigorously assess the accuracy and efficacy of the palm tree detection model, we conducted an accuracy assessment. The comparative analysis revealed that the Deep Learning method outperforms traditional Machine Learning approaches, exhibiting a higher F1 score (97.5). This substantiates our claim that the Deep Learning method stands as the most proficient model in terms of the F1 score when employed for the task of palm tree detection.

Our findings showcase the potential of machine learning and deep learning techniques in revolutionizing palm tree counting and monitoring from aerial imagery. The proposed Deep Learning model offers superior accuracy and efficiency, making it a promising tool for addressing challenges in tree counting, especially on large farms with numerous palm trees.

Furthermore, this study emphasizes the importance of using high-resolution aerial imagery captured by UAVs, which provides the necessary granularity for reliable tree detection and monitoring. As technology continues to advance, and data availability increases, the potential for applying machine learning and deep learning techniques in this domain is vast, opening up new opportunities for precision agriculture and environmental monitoring.

In conclusion, our research demonstrates the efficacy of employing deep learning methods, specifically the Mask R-CNN model, for palm tree detection in high-resolution aerial imagery. The proposed approach surpasses traditional machine learning methods in accuracy and efficiency, offering a promising solution for tree counting and monitoring applications in diverse domains. Deep learning techniques have the potential to revolutionize tree counting and monitoring practices, enabling more

sustainable and effective resource management strategies.

Keywords: remote sensing, machine learning, palm tree counting