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Leveraging state of the art computer vision models for tree monitoring in silvopastoral systems

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Abstract

Silvopastoral systems allow the integration of trees with pastures offering a sustainable approach for livestock production. The effective monitoring of trees in this kind of system is essential for improved management in terms of productivity, follow-up, biomass estimation, livestock well-being, and environmental impact assessment. This study explores the application of recent advancements in artificial intelligence models for this purpose, particularly computer vision models applied to remote sensing imagery. Given the characteristic of the available data in the form of satellite and aerial RGB images, some models were tested for different computer vision tasks like tree detection, tree semantic segmentation and tree instance segmentation. These preliminary tasks can be used for subsequent analyses like tree counting, biomass estimation, and monitoring tree development. The general approach was to leverage pre-existing models, but depending on the model characteristics and data availability, different approaches were analyzed. Some of the tested models were specifically designed for tree analysis (DeepForest, DetectTree, TreeCrownDelineation, TreeFormer), others conformed a well-established computer vision architecture (U-Net, Mask R-CNN), and some of the most recent models were tested to assess their capabilities as foundation models (Segment Anything Model). According to the model's capabilities, the methodology involved applying either model full training, transfer learning, out-of-the-box inference, or fine-tuning. Pre-trained models like U-Net are useful for semantic segmentation, while others like Mask R-CNN perform better for instance segmentation, and DeepForest for object detection. The most recent vision transformers were also compared. This work identifies the most promising models in terms of usability, acknowledging their advantages and limitations, and a user-friendly tool was developed to facilitate the application of these models in practice.

Keywords: Artificial intelligence, computer vision, deep learning, remote sensing, silvopastoral systems

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