NATIONAL CONSORTIUM FOR REMOTE SENSING EDUCATION, RESEARCH, AND APPLICATIONS

IndianaView
PROJECT FACT SHEET
http://www.indianaview.org

Tree Species Identification from UAV Canopy Images Using Deep Learning Techniques

Yunmei Huang, Purdue University (huan1643@purdue.edu); Botong Ou, Kexin Meng, Baijian Yang, Joshua Carpenter, Jinha Jung, Songlin Fei, Purdue University

Introduction: In recent years, unmanned aerial vehicles (UAV) equipped with various sensors have emerged as a promising technology for tree species classification due to their relatively low cost and high spatial and temporal resolutions. Lack of studies extensively comparing various AI models using low-cost UAV images for tree ID and studies on transferability. To address this gap, we focus on training five deep-learning models on eight species of RGB images captured during the summer, fall, and early spring seasons. We then evaluate their transferability across seasons.

Methodology:

- The first step of this project was to build a dataset. We collected high resolution UAV RGB images of eight species at Martell Forest in three seasons and labeled individual canopy with species information. Eight tree species include Black cherry (*Prunus serotina*), Northern red oak (*Quercus rubra*), Red pine (*Pinus resinosa*), Black walnut (*Juglans nigra*), White oak (*Quercus alba*), Butternut (*Juglans cinerea*), American chestnut (*Castanea dentata*), and White pine (*Pinus strobus*) (See Figure 1 and 2).
- With images from multiple seasons, we trained species classification models utilizing five state-of-the-art deep learning models, including ResNet18, DenseNet, VisionTransformer, EfficientNet-B0, and YOLOv5.
- Then, we evaluated five models' performance and their transferability across seasons.

Preliminary results:

- Our results show that all models achieved great performance on datasets from all seasons, with the best performance observed on summer images.
- The number of images for each class may affect the accuracy, but the unique features of different species also influence classification accuracy. Black walnut and Red pine also keep relatively stable and high F1-scores across seasons. American chestnut shows the lowest performance, which correlates with the number of images (see Figure 3).
- Models trained on specific seasons are sensitive to

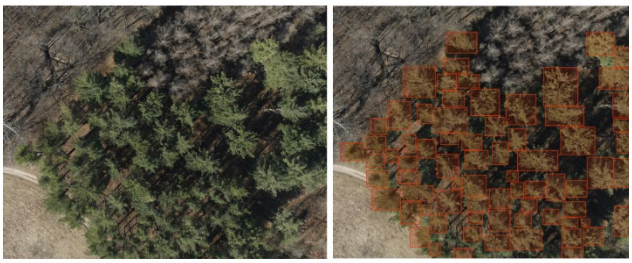

Figure 1. Examples of RGB images and labels. The left side image is the original image of White pine trees and the image on the right side shows bounding boxes.

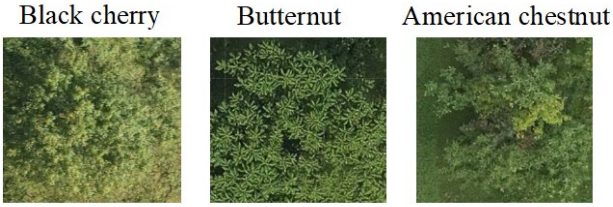

Figure 2. Examples of Black cherry (*Prunus serotina*), Butternut (*Juglans cinerea*) and American chestnut (*Castanea dentata*) in summer. These images are cropped from orthophotos of our study area.

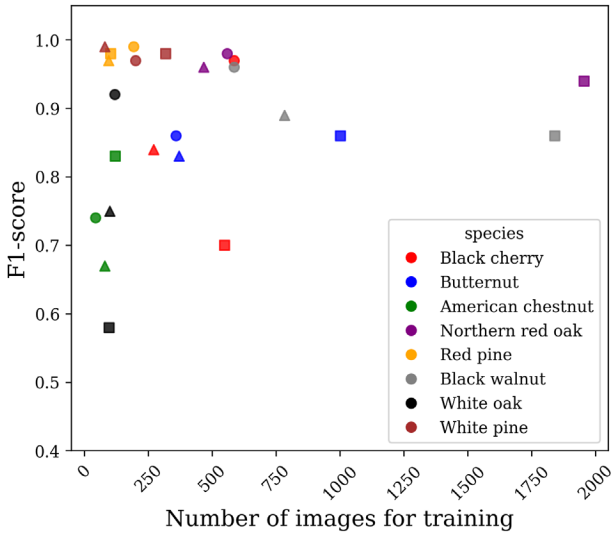

Figure 3. Average F1-scores of five models across three seasons VS number of images for eight species. Different shapes of points stand for different seasons. The round shape points, squares, and triangles stand for the summer, fall, and winter dataset respectively.