Evaluating various classification strategies for identifying tree species for tree inventory creation from a hyperspectral image

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Summary

An inventory showing tree species locations is a valuable tool for urban forest managers to support a healthy ecosystem. Urban areas offer harsh environmental conditions for these trees. This intensifies the value of a tree inventory to make sure the urban forest provides environmental, social and economic benefits. But the frequency and coverage of an inventory can be limited due to cost, time, level of expertise and poor access to private property. This study aims to overcome this limitation by using hyperspectral remote sensing and analysis to create cost effective and relatively fast tree inventories that cover both private and public land. This research tests if this technology accumulates enough information to separate and classify twenty tree species within a diverse canopy.

To classify this image, this study used two stages. The first stage removed areas of the map that did not represent trees while the second stage separated twenty tree species from each other. This study used the aisaFENIX airborne imaging spectrometer to gather reflected light in the visible-shortwave infra-red (SWIR) range (400-2500 nm) over Palmerston North, New Zealand. The image has a 1 m^2 spatial resolution, 3.5-11 nm spectral resolution of 448 spectral bands. Then ground sampling of tree species locations collected correct training and accuracy testing data for the classifiers.

The classification compared 45 different strategies (9 pre-processing methods and five supervised classifiers). These combinations identified the best method to pre-process and classify the image at each stage. The pre-processing methods included band selection, and the noise reducing techniques of minimum noise fraction (MNF) and derivative reflectance (DR). While the classifiers used included the support vector

machine (SVM), binary encoding (BE), Mahalanobis distance (MHD), maximum likelihood (ML), and minimum distance (MD) classifiers.

The strategies produced vastly different results. In the first stage the MD classifier together with DR, MNF, and band selection pre-processing produced the best results when removing the non-tree surfaces from the image. In the second stage the SVM classifier together with MNF and band selection pre-processing achieved the best overall accuracy of 94.85% to separate twenty specific tree species. (Other tree species are misclassified as one of the twenty tree species). Therefore, this accuracy means that pixels representing each of the twenty tree species will be correctly classified within their own class 94.85% of the time.

Evaluating multiple strategies led to combination producing a high overall accuracy in being able to separate twenty tree species from each other. This shows that hyperspectral remote sensing could be an effective tool to create tree inventories in urban environments.

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Table of Contents

Table of Figures

Table of Tables