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

A thesis presented in the partial fulfilment of the requirements for the degree of

Master of Science

In

Agriculture

at Massey University, Manawatū, New Zealand

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2017

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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 m² 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.

Acknowledgement

First, I would like to thank God who has guided me through this work. Second, I would like to thank my wife Ashlee Mackereth for being my number one supporter through it all. Also for providing while I completed this study and for encouraging me whenever I needed it. I would also like to thank my cousin Tommy Cushnahan for all the advice, help and time to talk about ideas and solutions. Also, thanks to Michael Dixon for the lunches over which we discussed our research and encouraged each other.

To Ian Yule, thank you for the opportunity to do this research and be a part of using innovative technology. Also, for giving me the freedom to make the research my own.

To Reddy Pullanagari, thanks for the help with analysing the data and with accuracy testing.

To Marion MacKay, thank you for all the help with your tree expertise and keeping the research in the right perspective. Also, want to thank you for the many hours of discussion on the research as it helped me critique my own work.

Thanks to the various scholarship funding bodies: William Reed Scholarship (2016), Taranaki Tree Crops (2016 & 2017) and the Gosling Ornamental Horticulture Bursary (2016 & 2017) for the funding to help me through this research.

Table of Contents

1.0 Introduction	8
2.0 Literature review	9
2.1 Benefits of the urban forest	10
2.2 Urban forest management.....	12
2.3 Use of tree inventory to manage the population.	13
2.4 Hyperspectral remote sensing	14
2.5 Classifiers and pre-processing methods	19
2.6 Summary	22
3.0 Study site	25
4.0 Stage one	26
4.1 Methodology.....	26
4.1.1 Aerial survey.....	26
4.1.2 Data analysis.....	26
4.2 Results.....	31
4.3 Discussion	34
5.0 Stage two	41
5.1 Methodology.....	42
5.1.1 Ground survey	42
5.1.2 Data analysis.....	42
5.2 Results.....	45
5.2.1 Overall accuracy	45
5.2.2 Classifier accuracy	46
5.2.3 Image accuracy.....	48
5.3 Discussion	51
6.0 Conclusion	56
7.0 References	60

Table of Figures

Figure 1: Difference between multispectral and hyperspectral data	15
Figure 2: The measured light intensity of the five objects as observed by the aisaFENIX sensor	16
Figure 3: Aerial survey by the aisaFENIX	25
Figure 4: Examples of 2x2 pixel regions of interest for the Non-Organic, Non-Tree Organic and Mixed Trees classes selected for training or accuracy testing.	30
Figure 5: Stage one ML x DR MNF 20 classification image and colour image comparison	38
Figure 6: Regions of interest selected over the image for training and accuracy testing.	43
Figure 7: Over-classification	51
Figure 8: Accuracy ROI pixels chosen for horse chestnut (Top) and upright elm species (Bottom)	53

Table of Tables

Table 1: Description of different supervised classifiers	20
Table 2: The pre-processing methods used to create the processed images.....	27
Table 3: Stage one overall accuracy	31
Table 4: Stage one class accuracy.....	33
Table 5: The Mixed Trees class accuracy results with the combinations <99% removed.	34
Table 6: DR MNF 20 x ML accuracy summary	35
Table 7: DR MNF 20 x ML class statistics.....	36
Table 8: Tree species used as separate classes	41
Table 9: Stage two classification overall accuracy results.....	45
Table 10: The best combination for each classifier.....	47
Table 11: The best combination of each transformation.....	50