Manaaki Whenua
Landcare Research

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Short webinars for environmental policy-makers and practitioners

Remote Sensing – more than meets the eye webinar series 2023

AI-powered tree mapping in urban, rural and forest environments

The following questions were asked during our live webinar with Jan Schindler but due to time restrictions, we were unable to answer these in the session.

Would you be able to count/find understory trees with LiDAR imagery? If so, how many point per metre in the LiDAR are required for that?

This is unfortunately not directly possible from top view aerial photography. Only overstory trees can be identified. High-resolution aerial LiDAR surveys , creating 3D point clouds, are capable of capturing understory trees, but this requires >30 or better >100 points/m2 which is not available through the standard regional surveys.

How accurate tree height and diameter is in the https://wtree.landcareresearch.co.nz/

Tree height is quite accurate (a bit smoothed to the 30cm pixel resolution) and is from the 2019 LiDAR survey. The imagery is from 2017 so there will be a slight mismatch. The crown diameter is as accurate as the polygon - we did not measure the stem diameter here.

Could it be possible to do horticultural industry inventories? i.e., identify likely orchards at a low-res scale, and segment/count/classify trees/vines at higher-res scale?

Yes, absolutely. This is a good example of applying the technique to imagery at different scales. I would suggest running an encoder-decoder CNN to segment orchards at lower resolution (50cm or 1m imagery might suffice) and then identify individual trees from 10cm (or better) imagery.

Where can we find the latest article by Spiekermann et al, which the speaker says is available pre-publication on a journal?

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4347971

Can it detect kauri dieback symptoms?

It is possible to train CNNs to identify texture and colour patterns in remote sensing imagery. Detecting unhealthy looking or dead trees is possible but requires a carefully selected training dataset. The different symptoms of Kauri dieback are not always directly visible from top view imagery and can be hard to detect because the different age classes of trees, shapes and symptoms.

Can you make assumptions of what tree species are in the understory based on the canopy species?

This is unfortunately not directly possible from top view aerial photography. Knowing the forest type and locality might help to make some assumptions but this is probably not reliable.

In the 2 cm crown mapping, do the colour represent species or just a colour to differentiate between crowns?

We do have species information for all trees in the scene, but the colours used were chosen at random. Top-view imagery is unfortunately very tricky to align with plot-based ground surveys so this ongoing work.

Are you able to get info on soils and soil water etc?

The image data I showed in the webinar cannot be used to get info on soil properties. There are different kinds of remote sensing instruments available that can measure soil properties including soil water. Hyperspectral imagers can detect soil properties over bare land. Radar systems can penetrate the soil and measure moisture-dependant reflectance's. AI techniques, as presented in the webinar, can be used to infer soil properties from these instruments.

Are you able to get info on tree health?

Yes, this is possible either by monitoring individual trees over multiple images and detecting changes or, by carefully selecting training dataset that trains CNN to identify texture and colour patterns in remote sensing imagery (e.g. unhealthy looking or dead trees).

Does the presence of vines affect tree crown mapping and has any work been done to identify the vines in the tree canopy?

Yes, this will create problems identifying the actual tree species underneath and crown dimensions. I don't think it is feasible for a human interpreter looking at the top view image and separate out what is what in most cases.

What information do you need to do the species mapping in urban areas?

A spatial tree inventory is needed. We are currently working with Councils to align their point-based tree species inventories with our tree crown dataset to create a training dataset used for species mapping. This is ongoing work and happy to talk about it in more detail.

Any relationship between this technology and remote sensing tree carbon stocks? Thinking about how this could reduce the compliance/monitoring cost for tree carbon accounting on farms and increase the flexibility of the ETS criteria.

This technology can help with identifying overstory trees, but more in-depth knowledge of the actual woody material and density of the forest is needed. To create accurate estimates of carbon stocks several methods and datasets must be combined which, to my knowledge, is still ongoing research in NZ.

What software have you been using for tree crown delineation and detection from lidar?

We use self-written Python code to process the LiDAR point clouds and delineate crown polygons using PyCrown, which we published on Github: https://github.com/manaakiwhenua/pycrown. The version on Github is outdated but still can be used as reference.

How often trees Height data is updated at the wtree website? Trees are growing.

The tree height on the wtree website is calculated as the highest canopy height value within a given tree crown polygon from the 2019 LiDAR survey over Wellington city. At this stage there is no plan to update the data on the wtree website. We did create, however, updated crown polygons maps for the recent imagery from 2021 for Wellington. The tree height values can only be updated when a new LiDAR survey comes in - which might be several years away unfortunately.

Do you think the model could be trained to discern between different types of conifers? (Thinking issues with wilding conifers here)

It is possible to train CNNs to identify texture and colour patterns in remote sensing imagery. If the conifers look differently in the imagery and a human interpreter can create a labelled training dataset the AI method should be able to pick this up as well.

On the farm landslide project in Wairarapa with assessing the effect of planted trees to mitigate landslide, can you use this data to predict how many trees (tree density and maybe species composition) is needed to reduce landslide risk? E.g., could you develop a model to show different scenarios of different tree density ranging from 0 to 100% cover, and the likely landslide scenarios over the next 100 years at each site? (That way a farm manager could work out the optimal solution of land stability and farm profitability (possibly including net carbon emissions also)).

This is a very interesting research questions and I will forward it to my colleagues in the erosion team to get a better answer for you. My understanding is that the developed models can also ingest synthetic data (thinking of different models runs with an increasing number of trees planted in different scenarios). So, yes, I think this is possible and a very practical application of this work. I will talk to my colleagues and get back to you. Thank you very much

Do you know what is the crown count accuracy for native forests for Mask R-CNN vs Yolo? Or do you use both models together to increase overall accuracy?

In my experience Mask R-CNN is much better at accurately delineating tree crown outlines whereas the recent YOLO types still struggle with instance segmentation. The detection rate is similar overall, however YOLO sometimes struggles to detect smaller trees. Depending on your training dataset (lots of small or tall trees) and the image size, there is hardly a difference in terms of object detection rate. Choosing the right training parameters, augmentation types and prediction settings (IoU and score thresholds) does have a big impact on your overall accuracy - in my experiments this was more important that difference between Mask R-CNN and YOLO.