Estimating Forest Attributes from Spherical Images

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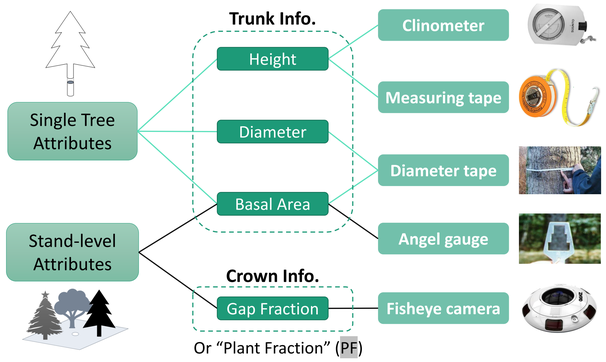
Introduction



Traditional Tools Drawbacks

Time consuming

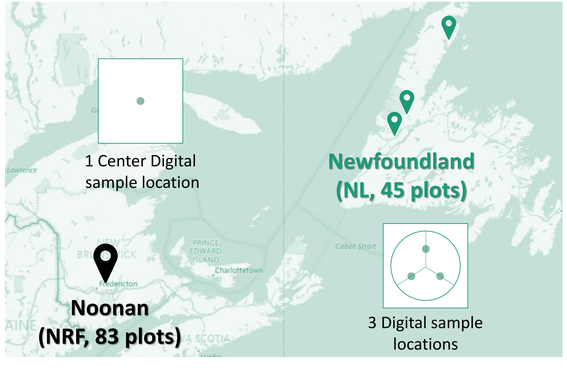
Labor intensive

Revisit required for checking

Objectives

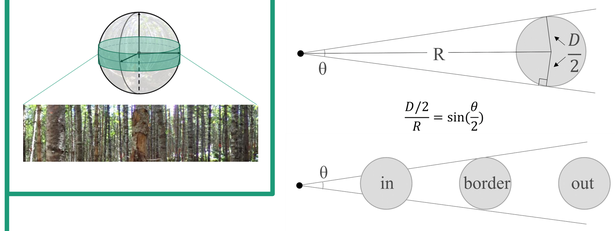
Integrate attributes measured with traditional tools into one consumer-grade spherical camera, validate the feasibility and repeatability compared with traditional field inventory tools

Study Area



Instrument

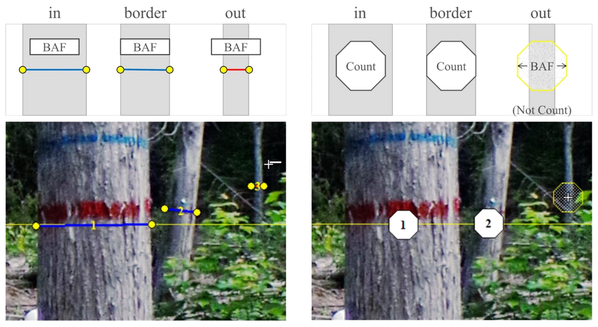
Stand Basal Area



Angle count sampling is a sampling method that uses a horizontally projected angle (basal area expansion factor, BAF) to select trees for inclusion in the sample. Basal area per ha is obtained by counting selected trees and multiplying by the BAF.

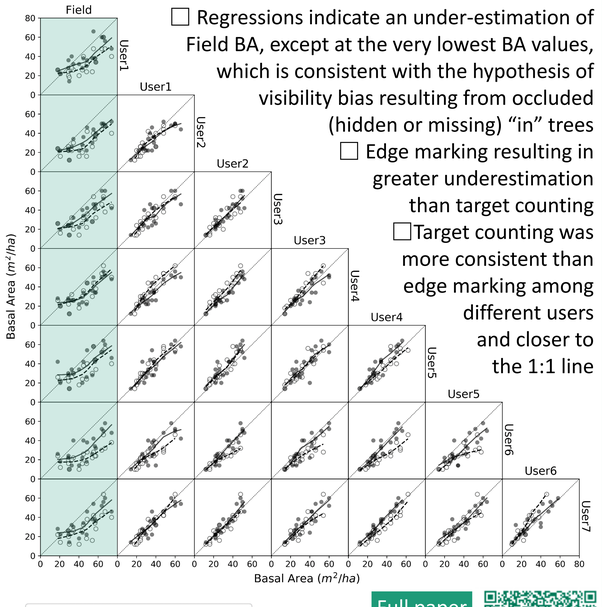
Software Implementation

The key point to apply this on a spherical image is determining which trees in an image should be counted or not



(a) Edge Marking (b) Target Count

Repeatability and Reproducibility Analysis

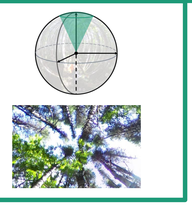


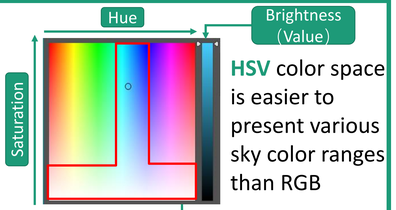
- ☐ Regressions indicate an under-estimation of Field BA, except at the very lowest BA values, which is consistent with the hypothesis of visibility bias resulting from occluded (hidden or missing) "in" trees
- ☐ Edge marking resulting in greater underestimation than target counting
- ☐ Target counting was more consistent than edge marking among different users and closer to the 1:1 line

Full paper

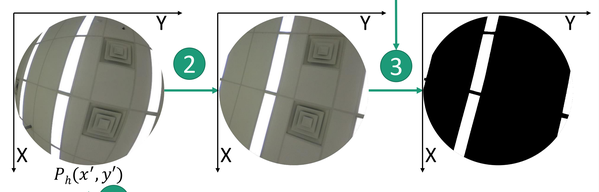
Effects of digital locations, understory density, hidden tree

Plant (Gap) Fraction





HSV color space is easier to present various sky color ranges than RGB



1.Spherical to fisheye

$$\theta = \frac{y_0}{width} \times 360°$$

$$d = \sqrt{r^2 - (r - x_0)^2}$$

$$\begin{cases} x' = r + sin\theta \cdot d \\ y' = r + cos\theta \cdot d \end{cases}$$

2.Distortion Correction

$$f = \frac{R_{img}}{\sqrt{2}}$$

$$r_{new} = f \cdot tan(2 \cdot arctan(\frac{r_{old}}{2 \cdot f}))$$

3. HSV Classification

H=hue; S=saturation; V=brightness

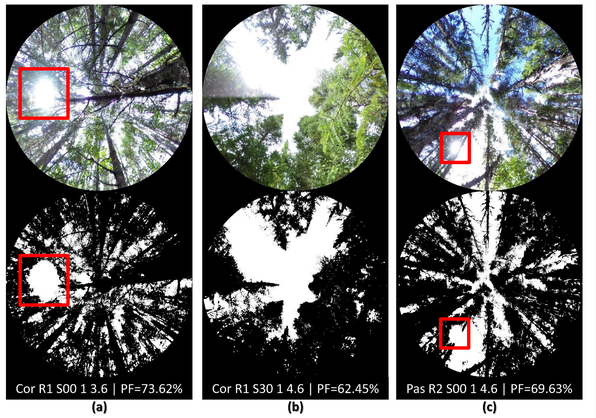
range: [0,1]=[min, max]

	h	s	v
Lower limit:	(0.5,	0.3,	0.75)
Upper limit:	(0.68,	1,	1)

	h	s	v
Lower limit:	(0,	0,	0.88)
Upper limit:	(1,	0.3,	1)

Though it is called spherical camera, the spherical images are flattened into a common 2D images stored on the disk.

Algorithm Implementation

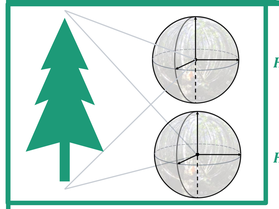


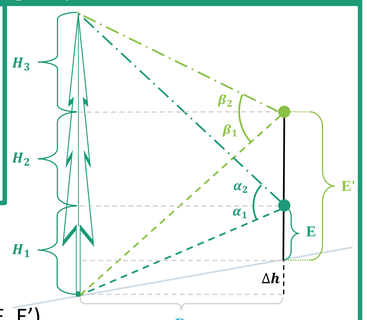
- ✓ HSV classification threshold works in different sky conditions
- ☐ Sunspots are a problem resulting in misclassification

Future Work

- ☐ The effects of zenith angle selection;
- ☐ Compare with other fisheye analyzing software;
- ☐ Compare with the fisheye camera images;
- ☐ Deal with sunspot problems

Tree Height | Diameter





Height Steps

1. Take images at 2 different elevations (E, E')
2. Pair two spherical images by 3 control points
3. Mark the base and top of the same tree in both images (α1, α2, β1, β2)

$$\Delta h = \frac{tan(\beta_1) \cdot E - tan(\alpha_1) \cdot E'}{tan(\alpha_1) - tan(\beta_1)}$$

$$R = \frac{E + \Delta h}{tan(\alpha 1)}$$

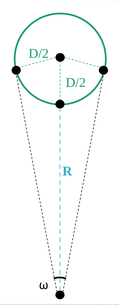
$$H = mean \begin{cases} R \cdot \tan(\beta 2) + R \cdot \tan(\beta 1) \\ R \cdot \tan(\alpha 2) + R \cdot \tan(\alpha 1) \end{cases}$$

Diameter Steps

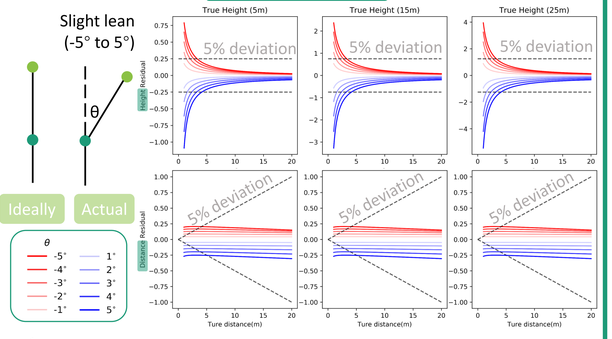
1. Calculate distance(R) from Height part
2. Mark the left and right edge of a tree at breast height, to calculate Projected Angle ω

$$R = \frac{E + \Delta h}{tan(\alpha 1)}$$

$$D/2 = \frac{sin(\frac{\omega}{2}) \cdot R}{1 - sin(\frac{\omega}{2})}$$



Rod Lean Effects



- ✓ Measuring Trees 5m away, 5° lean doesn't have substantial effects on **Height** and **Distance** estimates

Future Work

- ☐ Develop software to implement this algorithm
- ☐ Compare image measured with field measured.

Conclusion

- ❖ Using spherical camera to integrate stand basal area, plant fraction, trunk diameter, and tree height is feasible.
- ❖ These methods may have obstacle effects limited by 2d image and cause slight under-estimation.
- ❖ The image method proved repeatable and reproduceable among different users.