WANG Haozhou

Extracting DBH measurements from RGB photo images

University of New Brunswick
Faculty of Forestry and Environmental Management

UNB FREDERICTON

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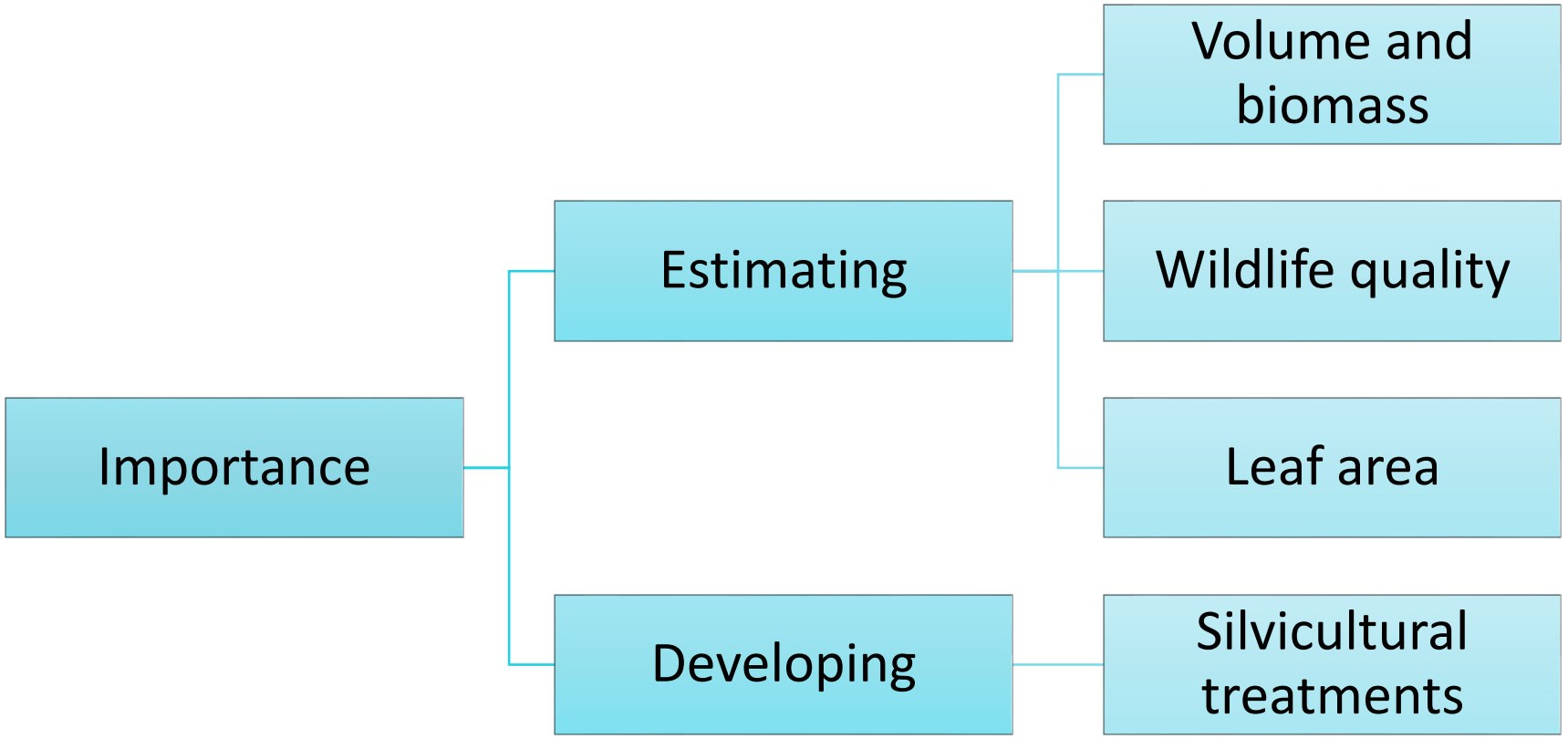
1 Introduction

Why



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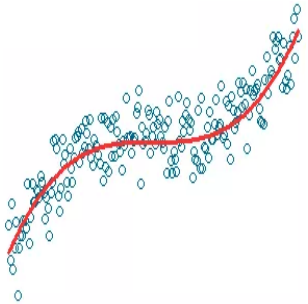
1 Introduction

How

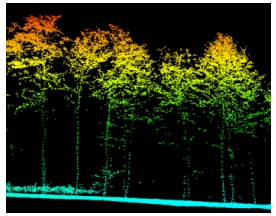
- Measurements
  - Direct measurements
    - Diameter tapes
    - Calipers
    - Biltmore stick
  - Indirect measurements
    - Regression model
    - Laser technology
    - Photos with computer vision

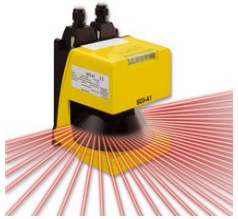
1 Introduction

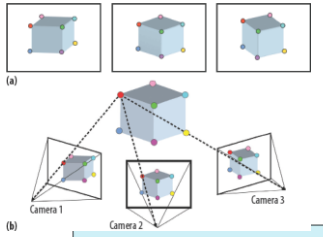
Indirect measurements

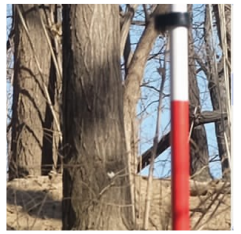


- Indirect Measurements
  - Regression model
  - Laser technology
    - Direct measuring
      - Laser dendrometers
      - Hand-held laser survey instrument
    - LiDAR (3D)
      - Ground-based
      - Airborne laser scanner
    - 2D laser scanner
  - Photos with computer vision
    - Structure from motion (SfM)
    - Vanishing point horizon
      - Benchmark assist
      - Laser point assist









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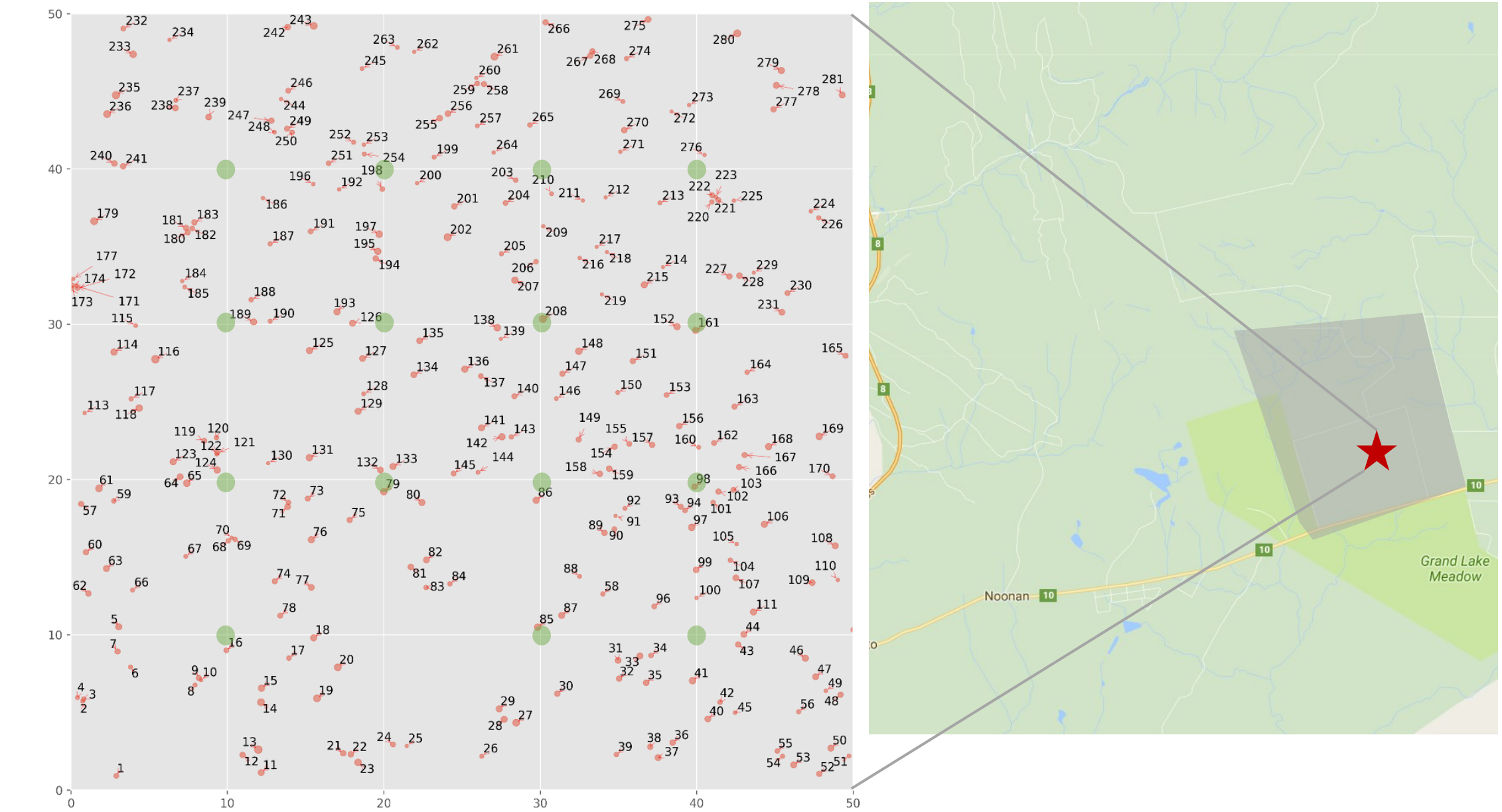
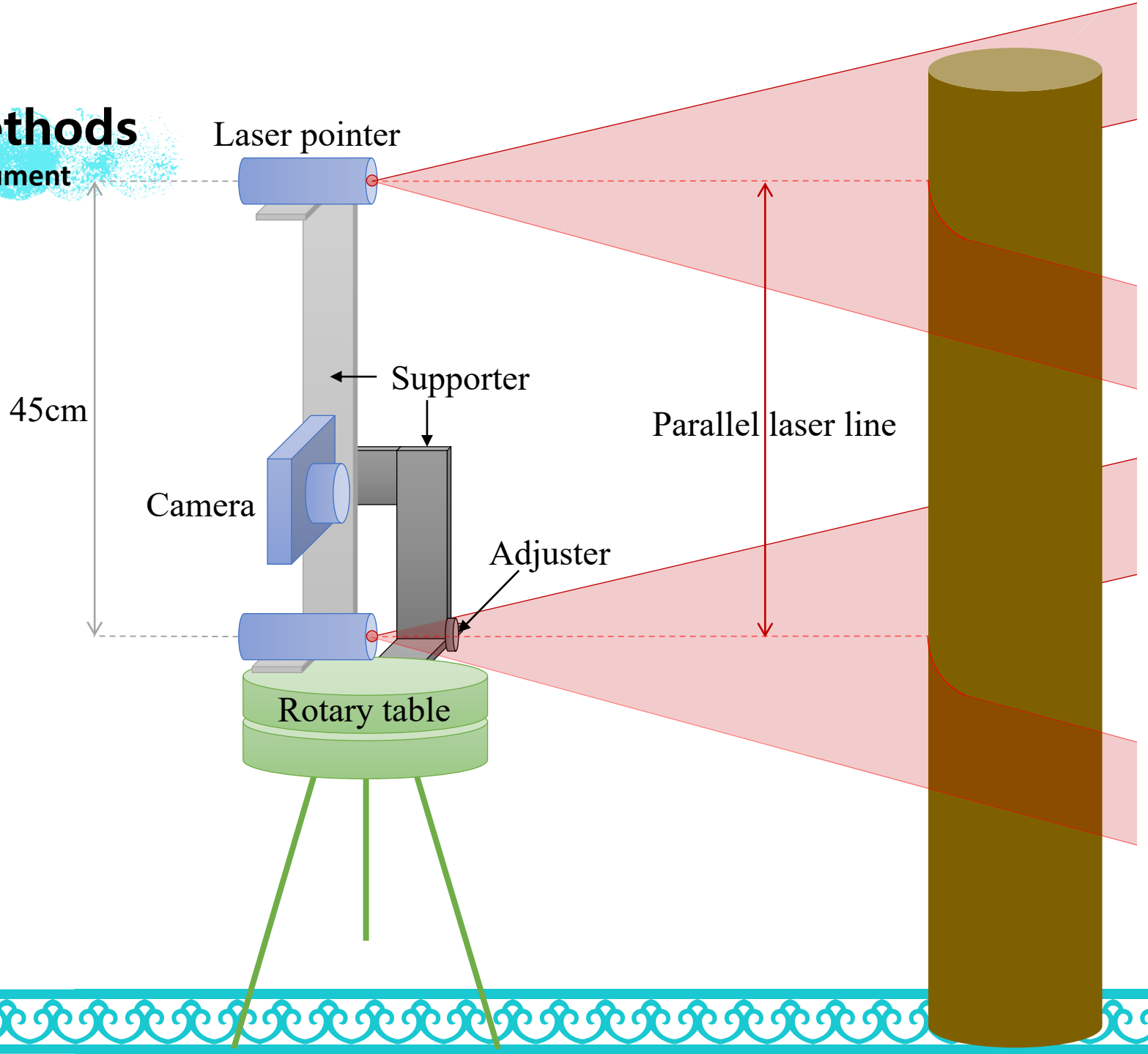

Noonan
Grand Lake
Meadow

Instrument

2

2 Methods

Instrument



Algorithm

2

2 Methods

Algorithms

$$D_L \times r = LX \times OO'$$

$$r = \frac{LX \times OO'}{D_L} = \frac{\frac{1}{2}LR \times (r + D_C)}{D_L}$$

$$r = \frac{\frac{1}{2}LR \cdot D_C}{D_L - \frac{1}{2}LR}$$

D_L & D_C $\triangle ODcUc \backsim \triangle O'Dc'Uc'$

$$\begin{cases} \frac{O'C}{f} = \frac{DcUc}{Dc'Uc'} \\ \frac{Dc'Uc'}{D'U'(Fy)} = \frac{n}{N} \end{cases} \gg \begin{cases} O'C = \frac{45cm}{Dc'Uc'} f \\ Dc'Uc' = \frac{n}{N} Fy \end{cases}$$

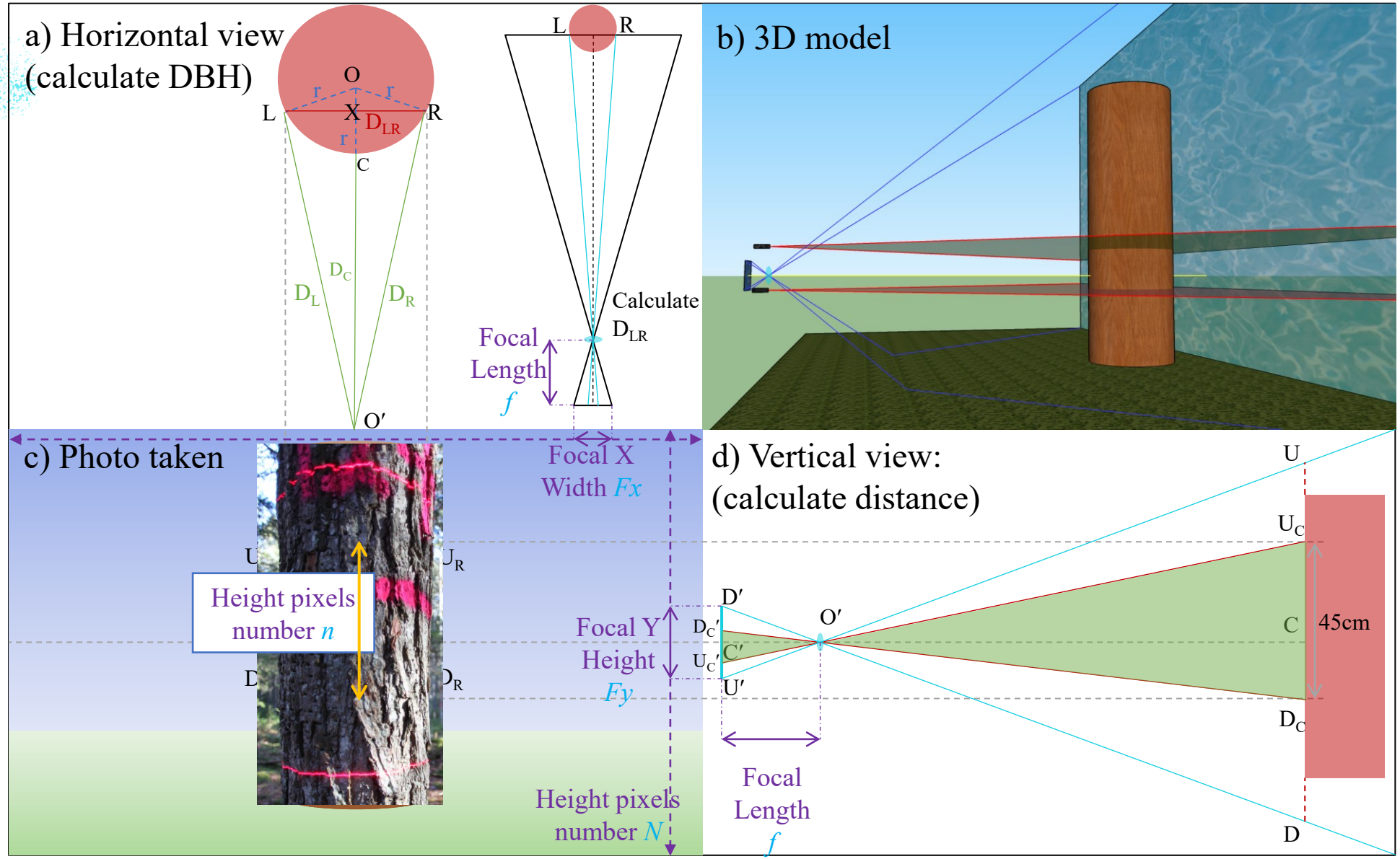
$$O'C\ (D_C) = \frac{45 \cdot f \cdot N}{Fy \cdot n}$$

LR:

$$LR = \frac{Dc \cdot m \cdot Fx}{f \cdot M}$$

DBH:

$$DBH = 2 * r = \frac{LR \cdot D_C}{D_L - \frac{1}{2}LR}$$

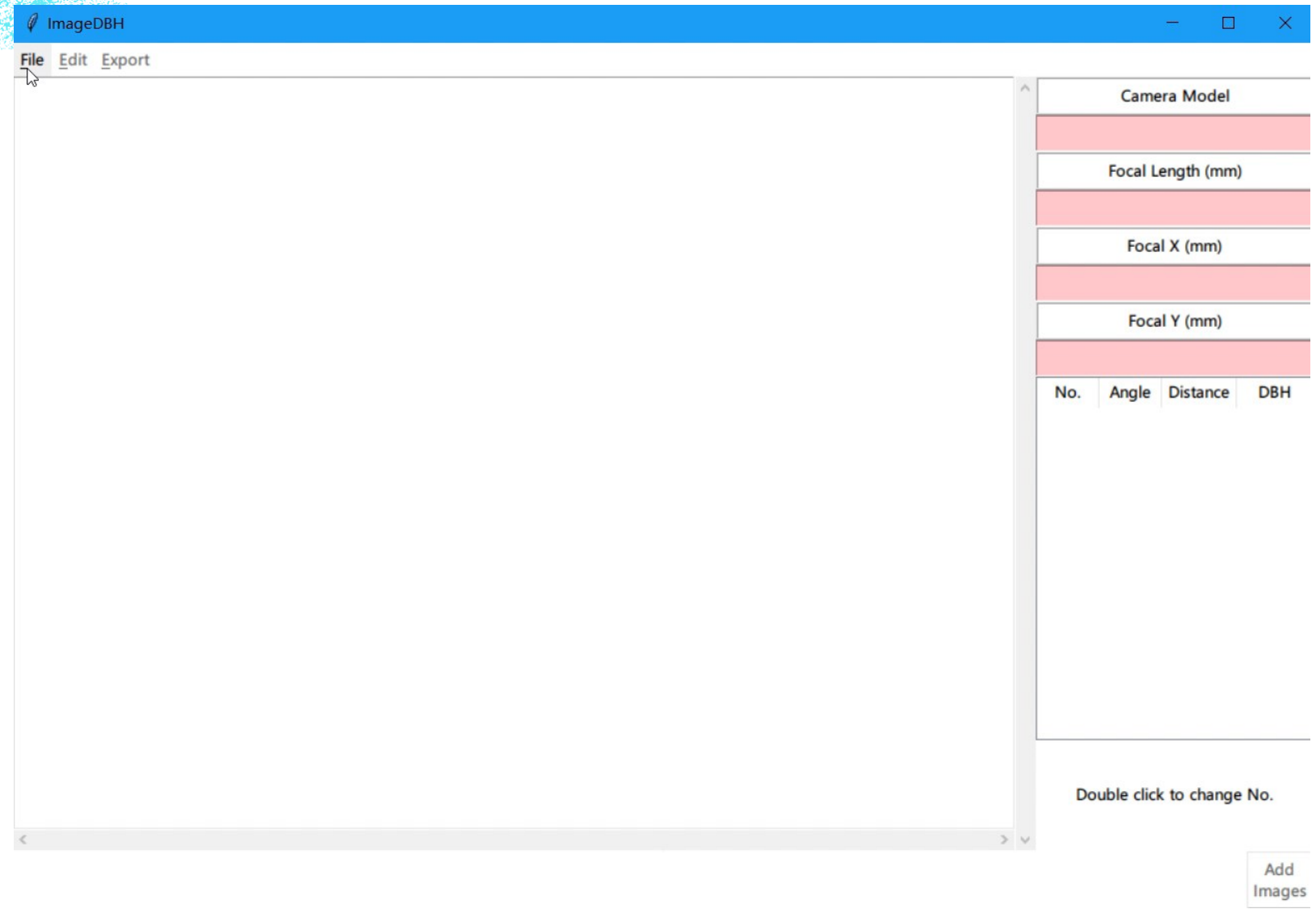


Software

2

2 Methods

Software



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Comparison

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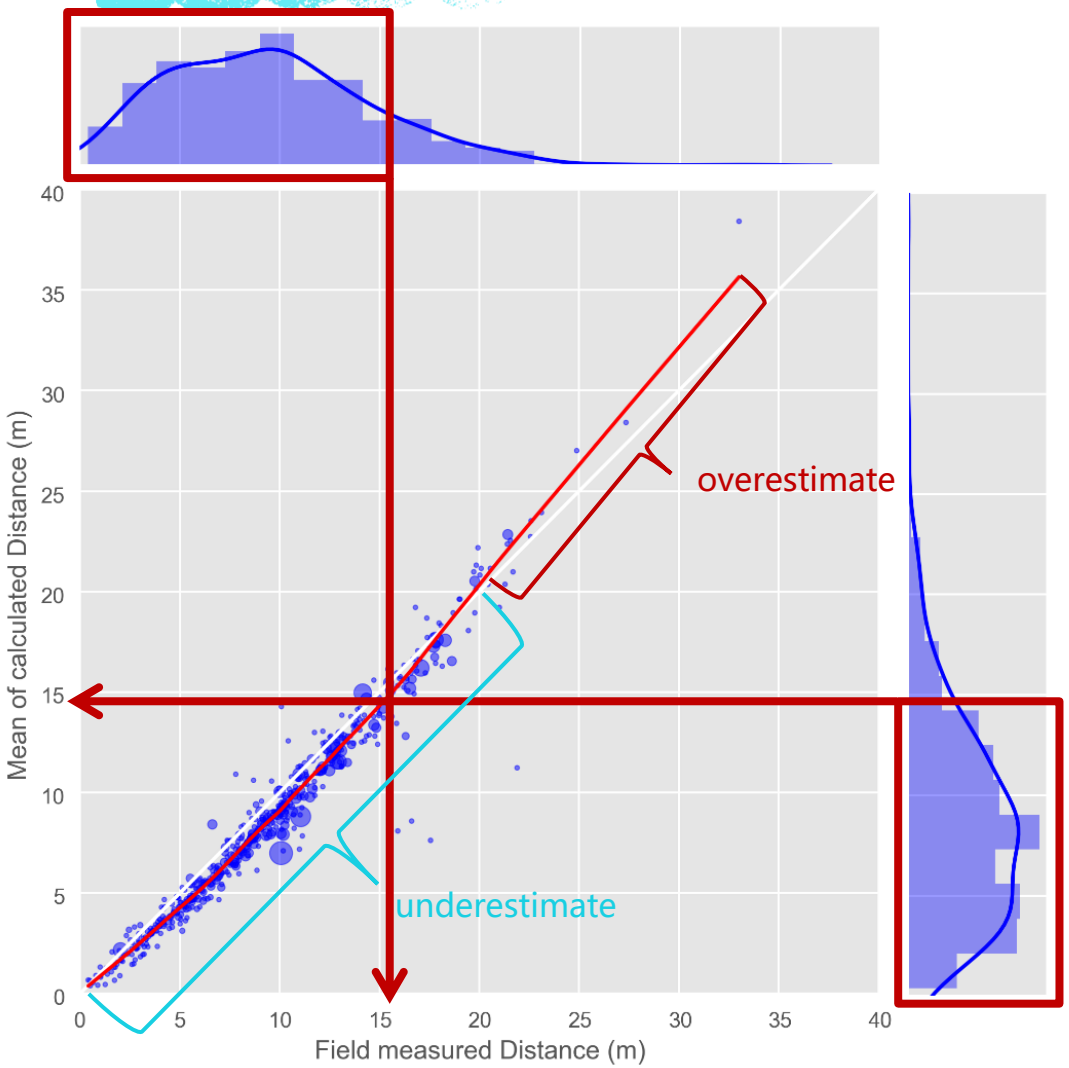
3 Results and Discussion

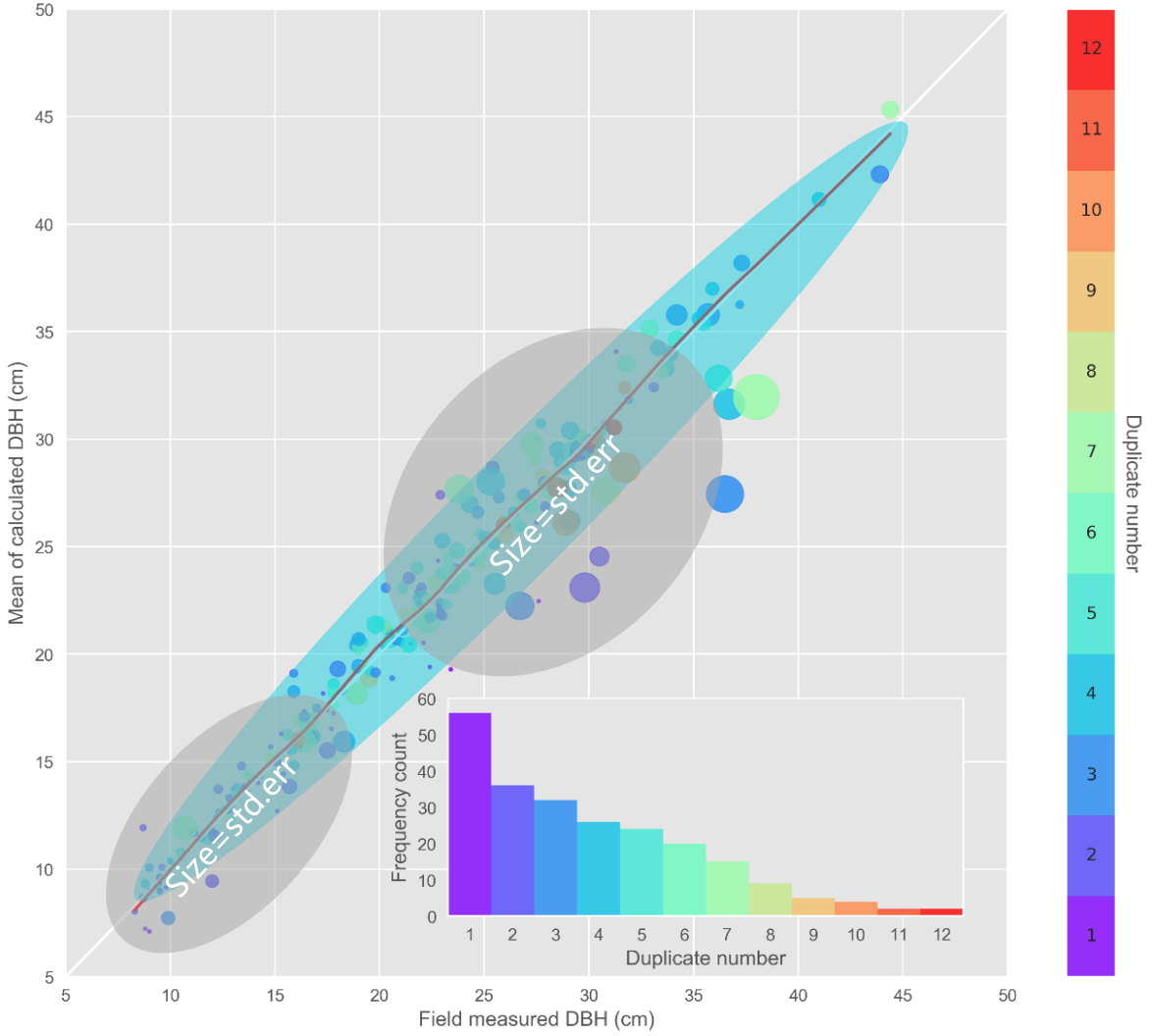
Distance results comparison



1. Most of calculated distance distributed below 15m
2. Underestimate：hard to guarantee the tape no curving
3. Overestimate：distance too far, the trunks in photo are too small (only a few pixels), causes variance

3 Results and Discussion

DBH results comparison



1. Equivalence test: region of similarity = 32% at α = 0.05
2. Standard errors associated with multiple DBH measurements increased with increasing distance from the camera

3

3 Results and Discussion

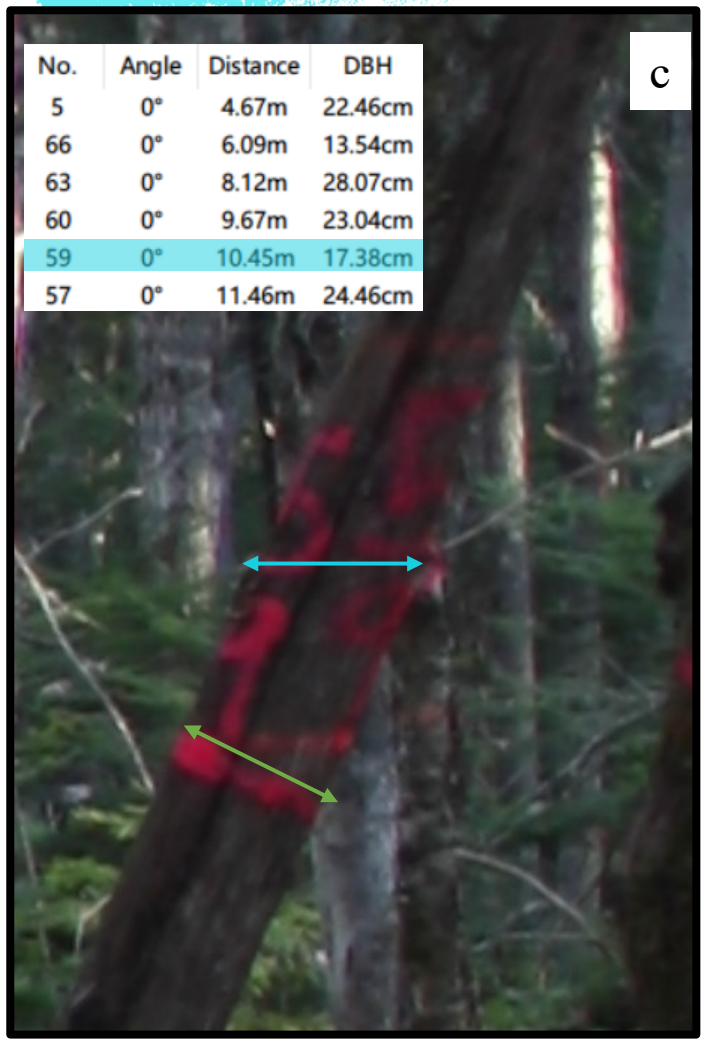
Reasons that cause error

Field measured: No.203 = 17.5cm

1. Different photo angles may capture shorter or longer axes of the stem cross-section

3 Results and Discussion

Reasons that cause error



Field measured: No.59 = 16.4cm

2. Tree lean is another factor that contributes to large deviations in DBH measurement

3 Results and Discussion

Reasons that cause error

3. the photo measured diameter position was consistently higher than that of field survey

4. Key points are marked manually which may cause error

Improvements

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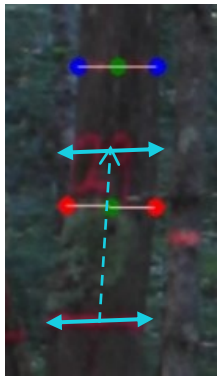
3 Results and Discussion

Improvements

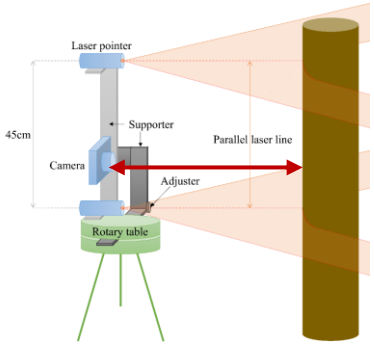
1



Make the photo calculated and field measured places on trunk closed to each other

2

The best distance between trees and camera is around 10-20m



3

Just take photos for single trees rather than multiple trees

4

Automate laser line detection through **artificial intelligence** (AI) to **minimize** human-induced errors associated with **manual selection**

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4 Conclusion

1

The **procedure and algorithms** to **extract the DBH** of trees from digital images with laser line have been illustrated.
The calculated results have also been **validated** by the field survey data. It is **applicable** to obtain DBH from photos

2

Under the circumstance of **tree shield**, the survey ratio is up to **82.2%** which has high correlation with field survey data
Due to the **limitation of picture resolution** which could make trees not recognizable, **the best distance** is **<15 m**.

3

An **open source software** developed in **Python 3.5** also makes great contribution for **simplify** the **calculation procedure** and making it convenience for other researchers' usage

4

In the future, this new technology could

1. be applied for estimating the **upper-stem diameter**
2. optimize **image identification algorithm** and reduce people participation

Acknowledgement

1. Funding for this project

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Questions?