Measuring Plant Area Index (PAI) from panorama photo images

Speaker: WANG Haozhou

Supervisor: John A.Kershaw

Department: For. and Env. Mgmt.

Contents

1. Introduction
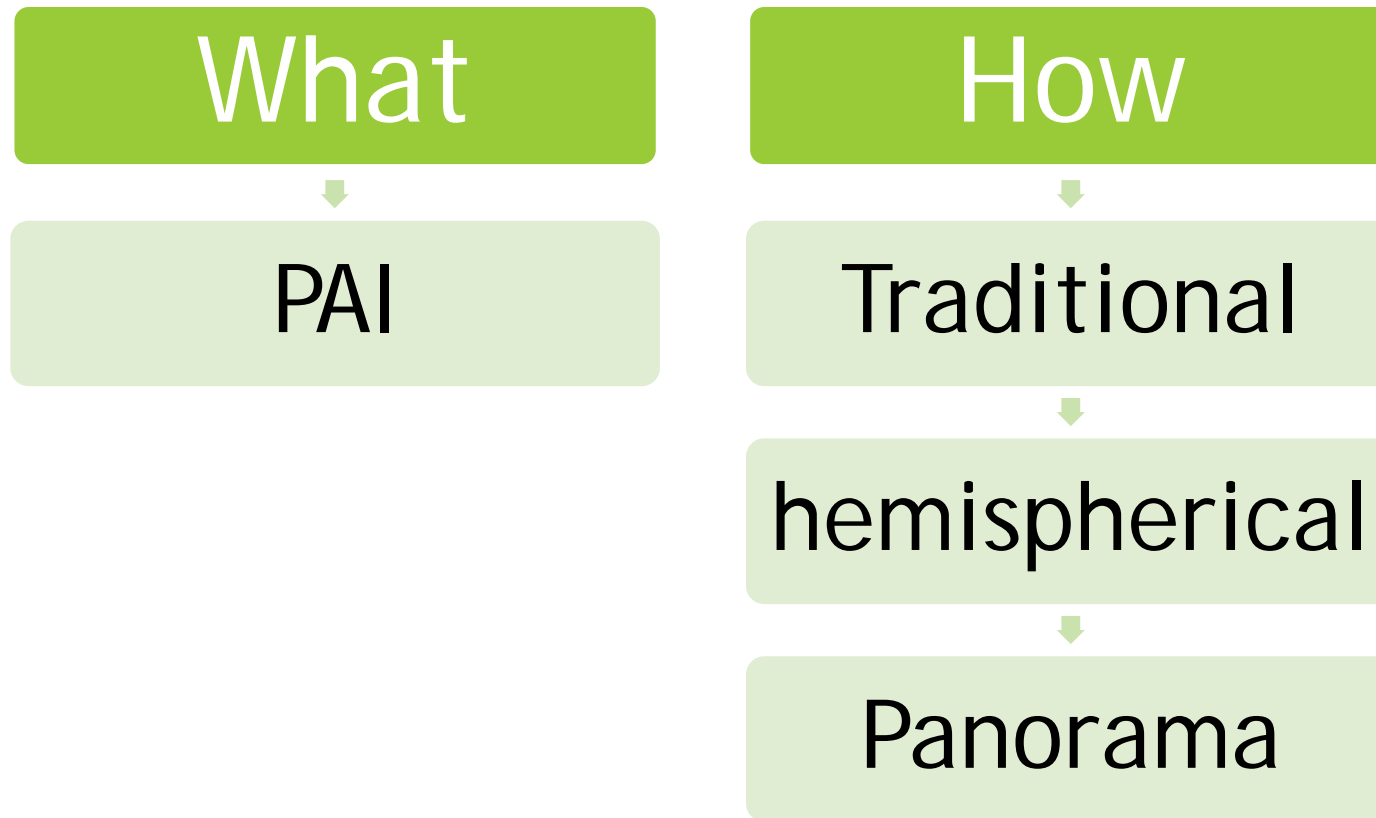
2. Methods and Current Results

3. Future Work

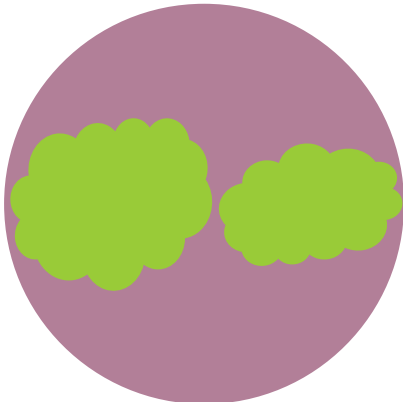# Contents

1. Introduction
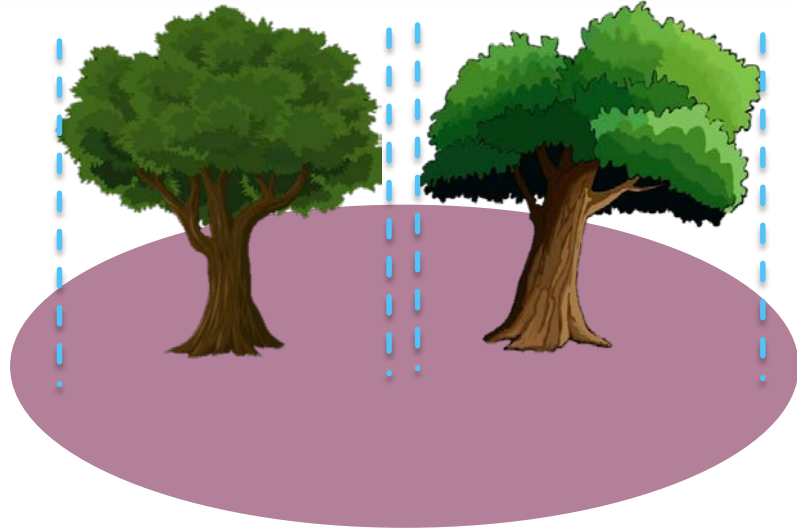
2. Methods and Current Results

3. Future Work

1. Introduction

What	How
PAI	Traditional
	hemispherical
	Panorama

1.1 What is Plant Area Index (PAI)?

tree crown coverage (Sky -> Ground)

PAI (Ground -> Sky)

Percentage of crown?

1.2 How to measure PAI?

▶ 1.2.1 Traditional method: visual estimate

I think is 60%

I think is 50%

I think is 60%

Pros

- Fast
- Easy

Cons

- Unrepeatable
- Low accuracy
- Inter-observer error

Record: 56.7% (Mean of three people)

1.2 How to measure PAI?

▶ 1.2.2 hemispherical (fisheye) method

Colored (Camera Raw)

Binary Image -> PAI
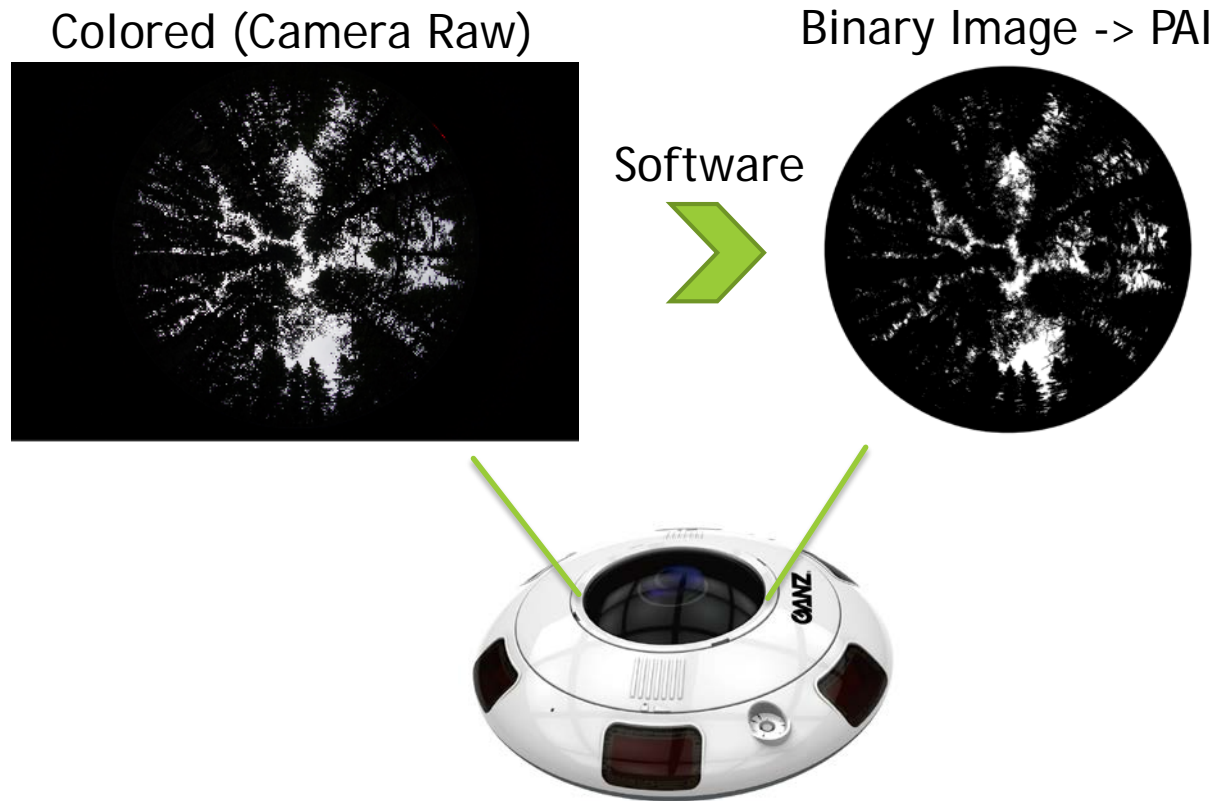
Software

Pros
- Accurate
- Repeatable

Cons
- Few open-source Software
- Cost ($15,000)

1.2 How to measure PAI?

▶ 1.2.3 Panorama method

What's new

360° Information
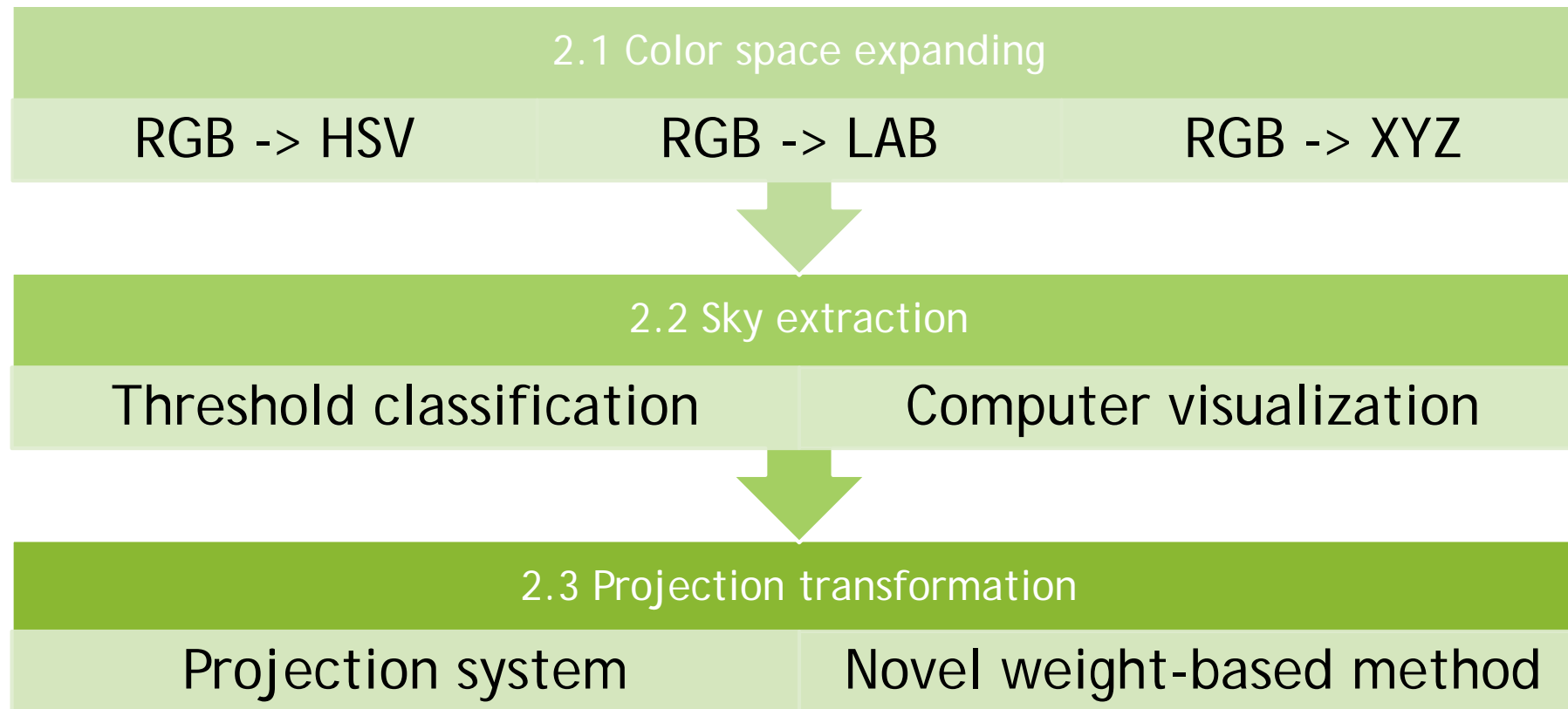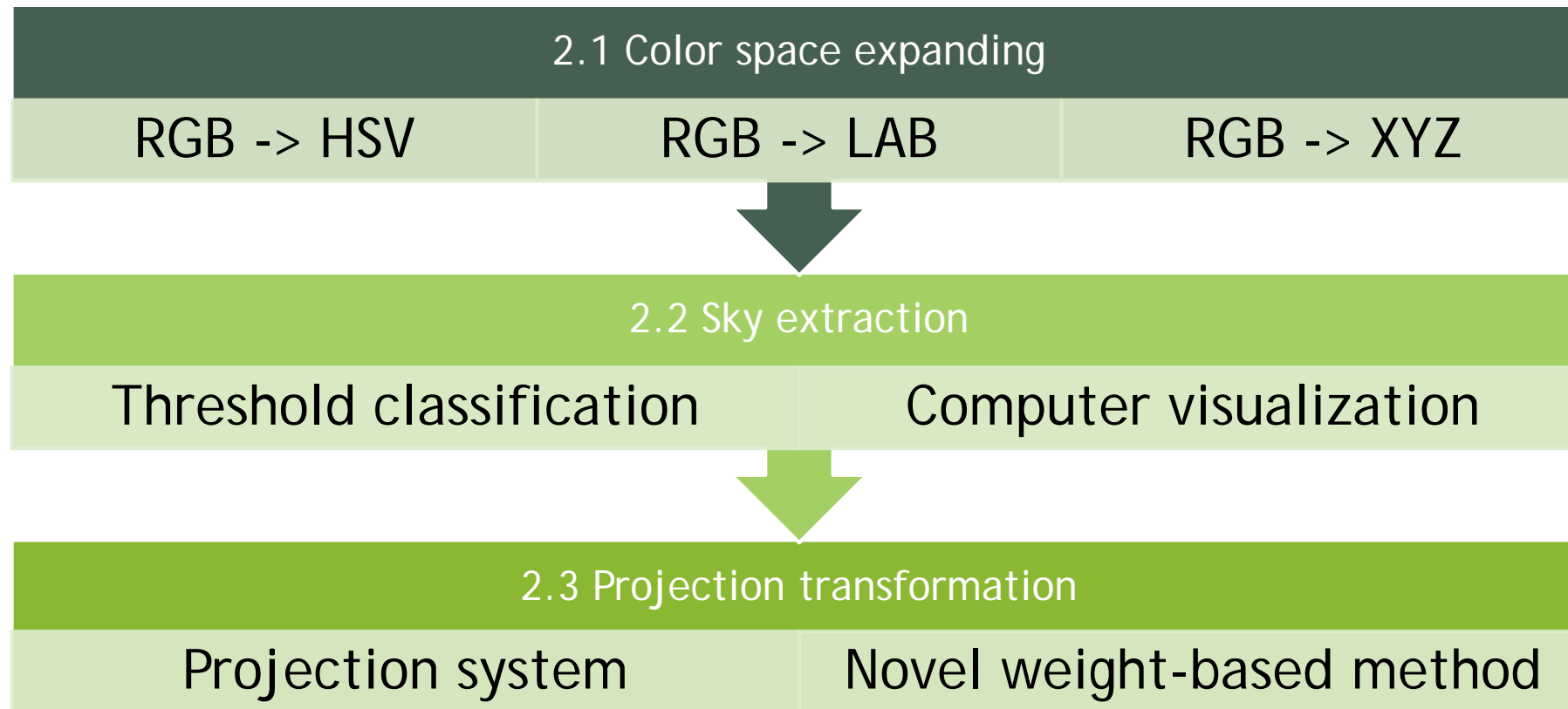
Raise through canopy easily

Phone apps

Source: https://www.skypixel.com/photos/d44cbb7e-772e-456c-b5c7-1a8f94ea10b7

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2. Methods and Current Results

2.1 Color space expanding

RGB -> HSV   RGB -> LAB   RGB -> XYZ

2.2 Sky extraction

Threshold classification   Computer visualization

2.3 Projection transformation

Projection system   Novel weight-based method

2. Methods and Current Results

2.1 Color space expanding		
RGB -> HSV	RGB -> LAB	RGB -> XYZ

2.2 Sky extraction	
Threshold classification	Computer visualization

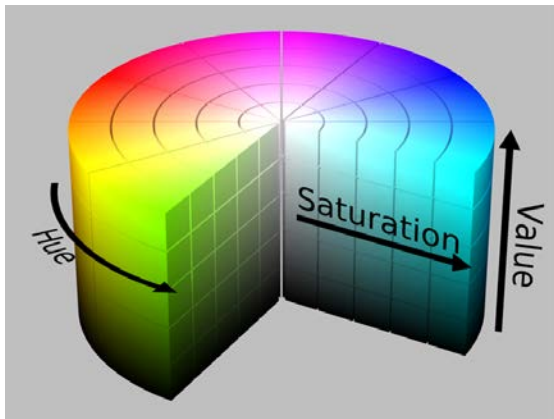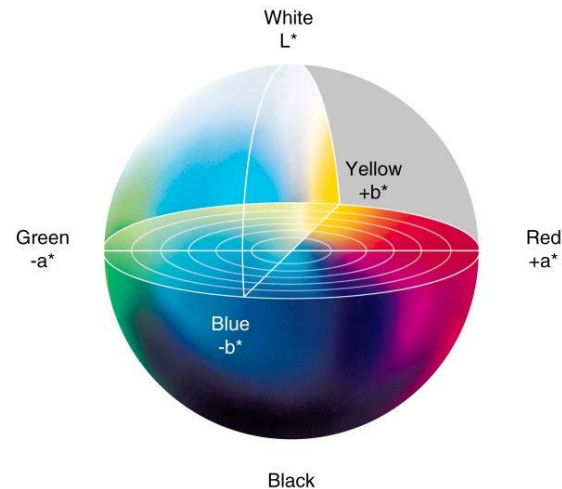| 2.3 Projection transformation	
Projection system	Novel weight-based method

2.1 Color space expanding (RGB to …)

Different Physics models to describe color in computer

HSV   La*b*   CIE 1931 XYZ
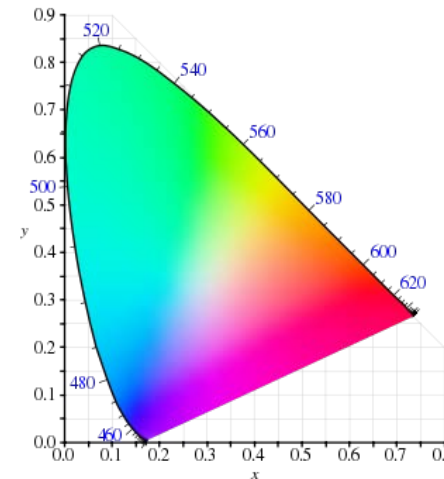
More Information, more choice for classification

2. Methods and Current Results

2.1 Color space expanding

RGB -> HSV   RGB -> LAB   RGB -> XYZ

2.2 Sky extraction

Threshold classification   Computer visualization

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Projection system   Novel weight-based method

2.2 Sky extraction
2.2.1 Threshold Classification

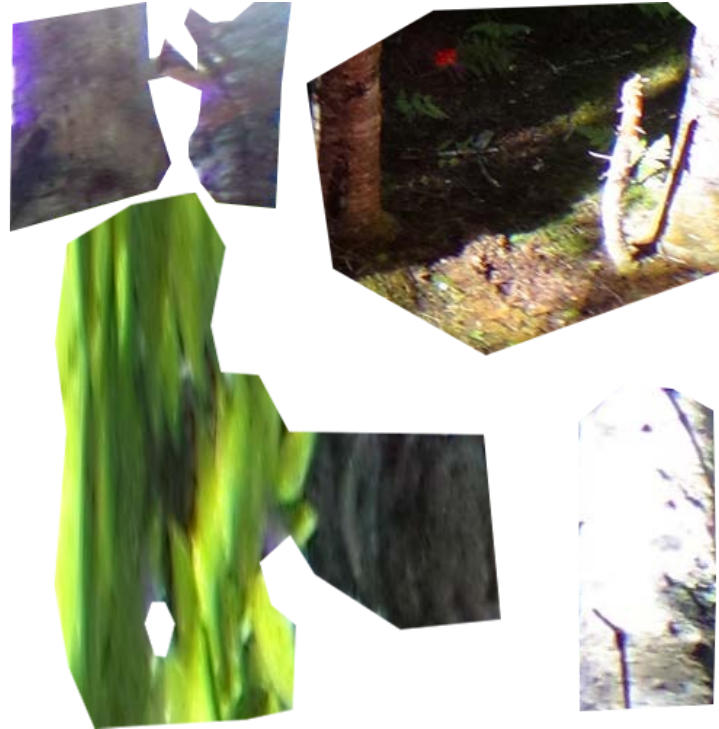Background | Plant
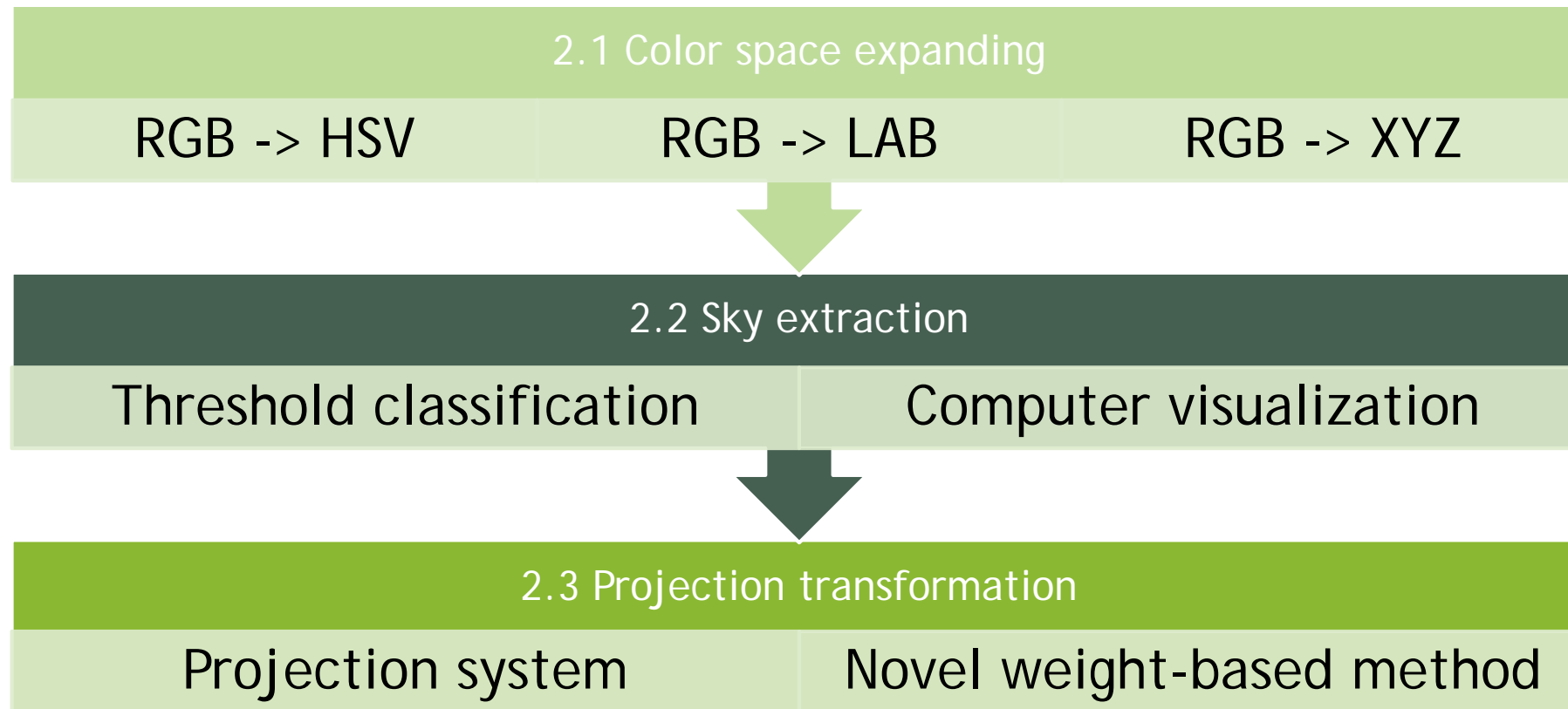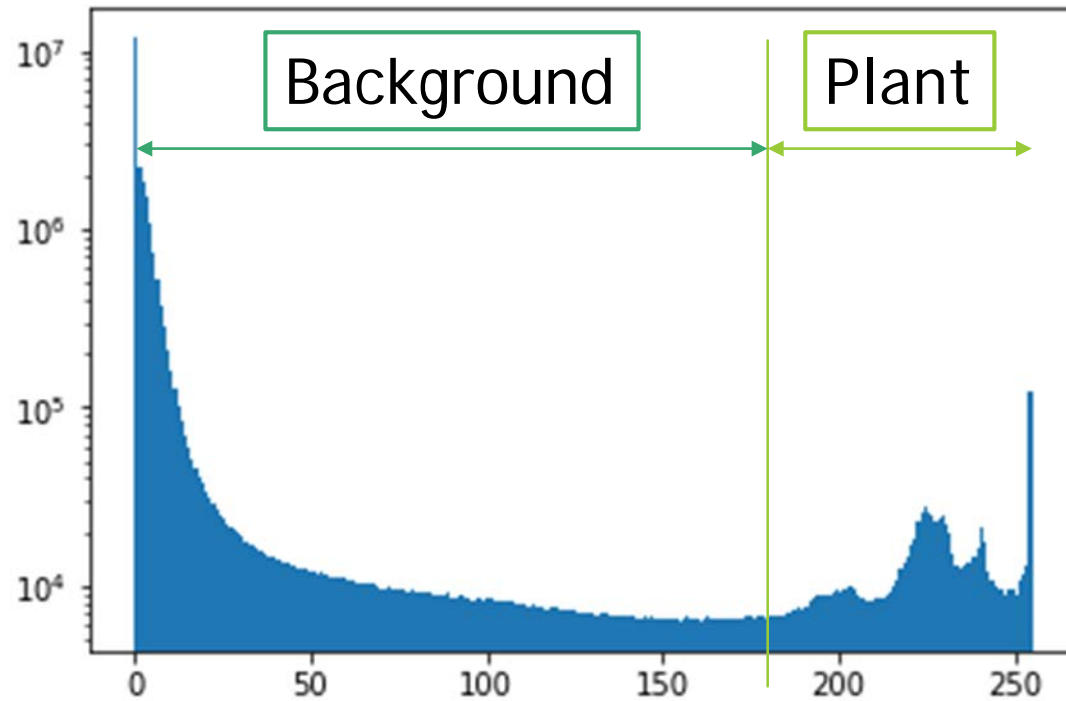
Histogram of image (Green channel)

2.2 Sky extraction
2.2.1 Threshold Classification
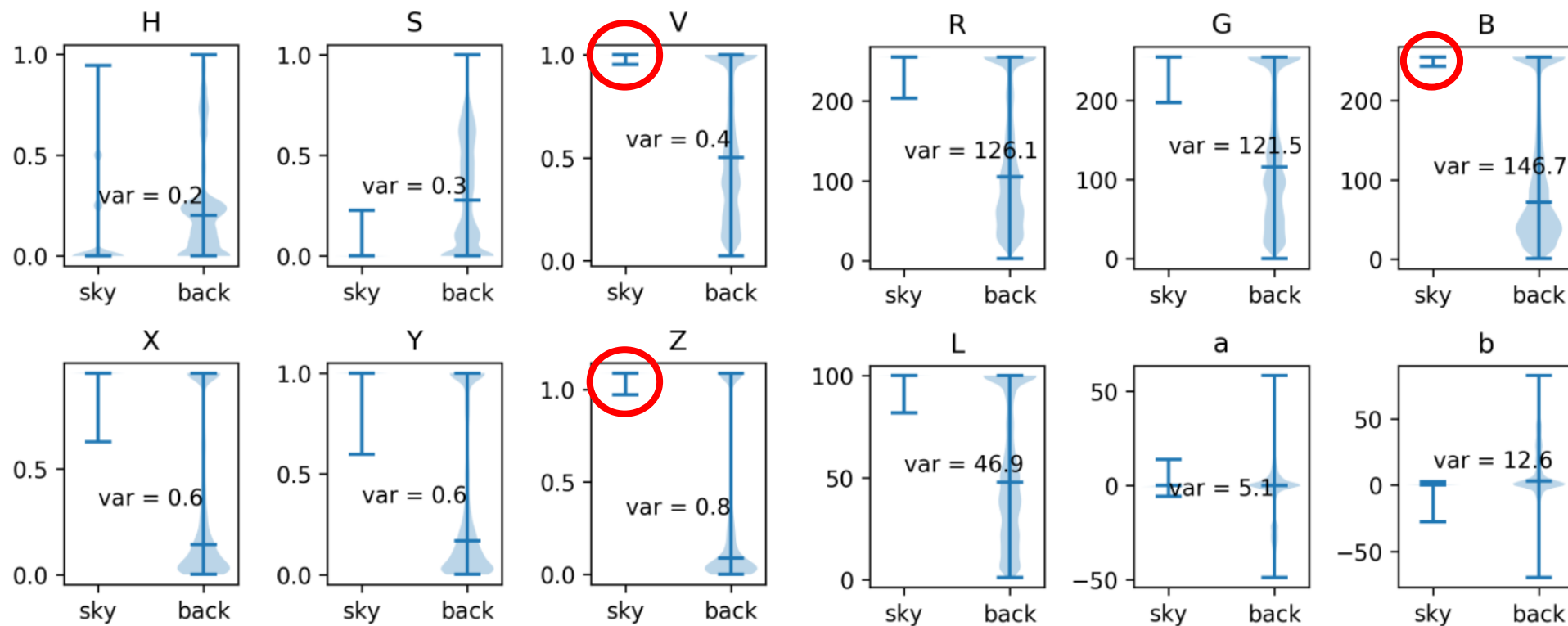
▶ Threshold estimation

Sky

Background

2.2 Sky extraction
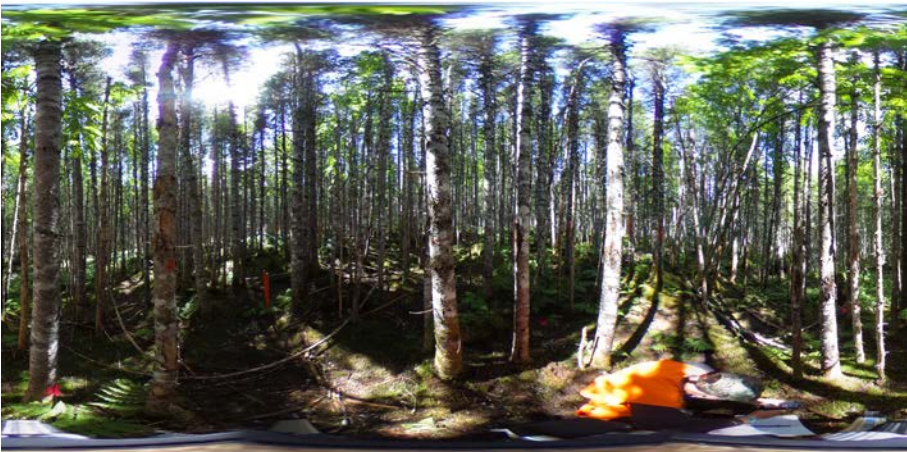## 2.2.1 Threshold Classification
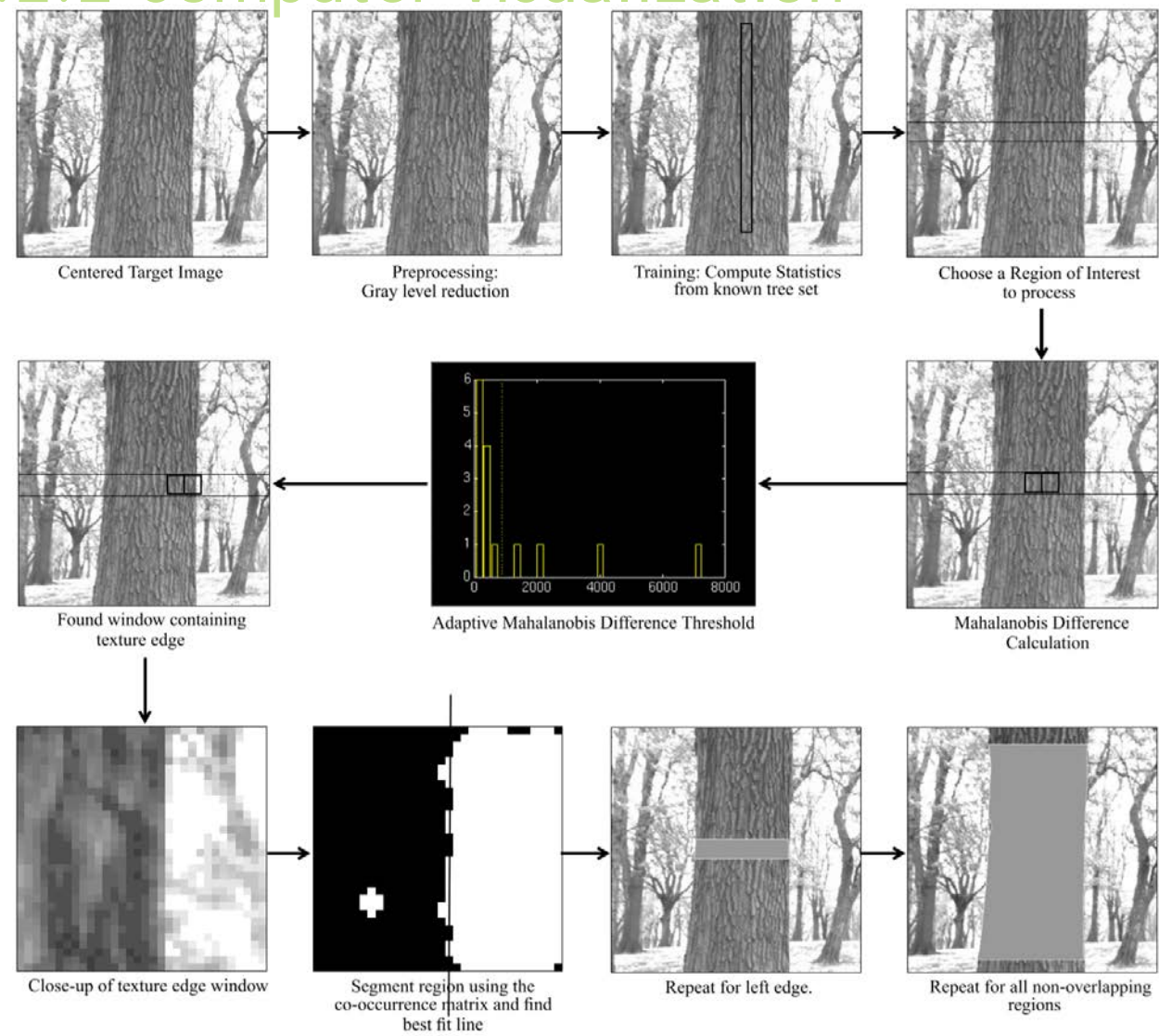
▶ Threshold estimation

2.2 Sky extraction
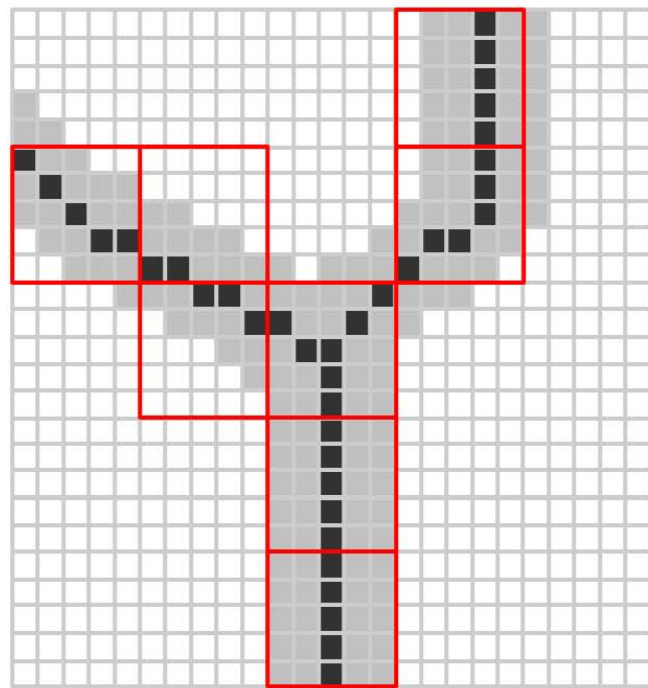## 2.2.1 Threshold Classification

▶ Application results

Cloudy days

Sunny days

Byrne, J., and S. Singh. 1998. Precise Image Segmentation for Forest Inventory. Robotics Institute Carnegie Mellon University 8921:909–927.

2.2 Sky extraction
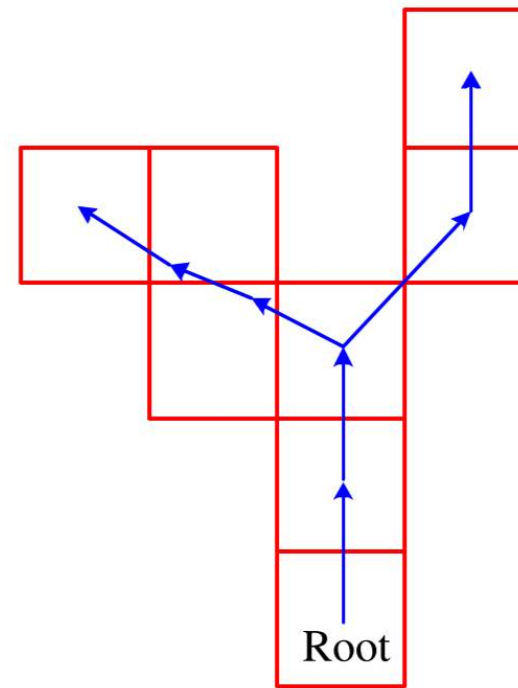### 2.2.2 Computer visualization ▶ Trunk Edge Extraction

2.2 Sky extraction

2.2.2 Computer visualization ▶ Single Tree Segmentation

Trunk Region   Trunk Skeleton   Trunk Element

Root

Trunk Flow

Teng, C. H., Y. S. Chen, and W. H. Hsu. 2005. Tree Segmentation from an Image. Pages 59-63 Iapr Conference on Machine Vision Applications.

2.2 Sky extraction
2.2.2 Computer visualization ▶ Single Tree Segmentation
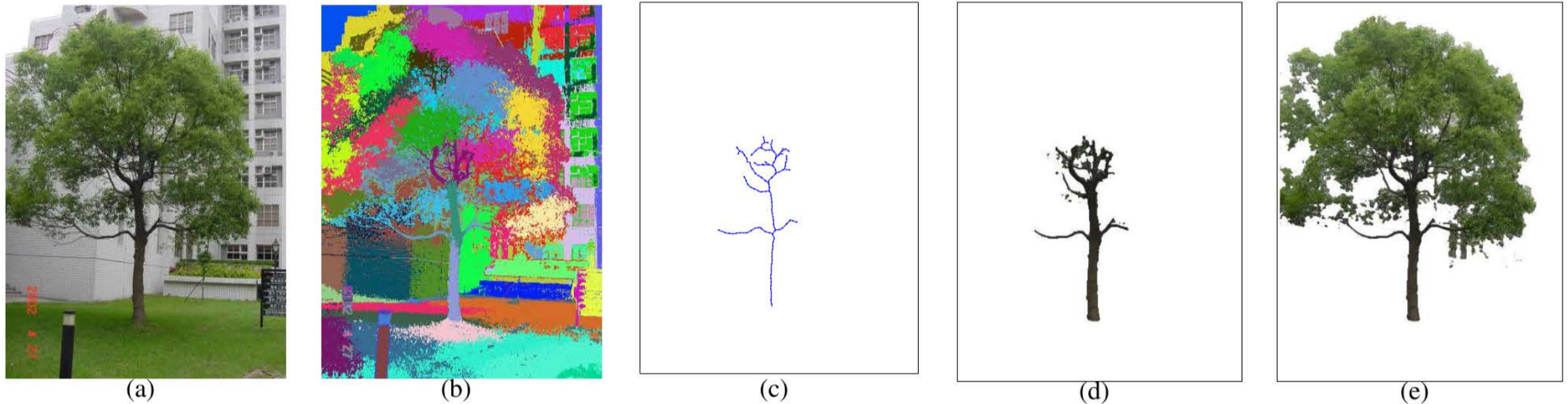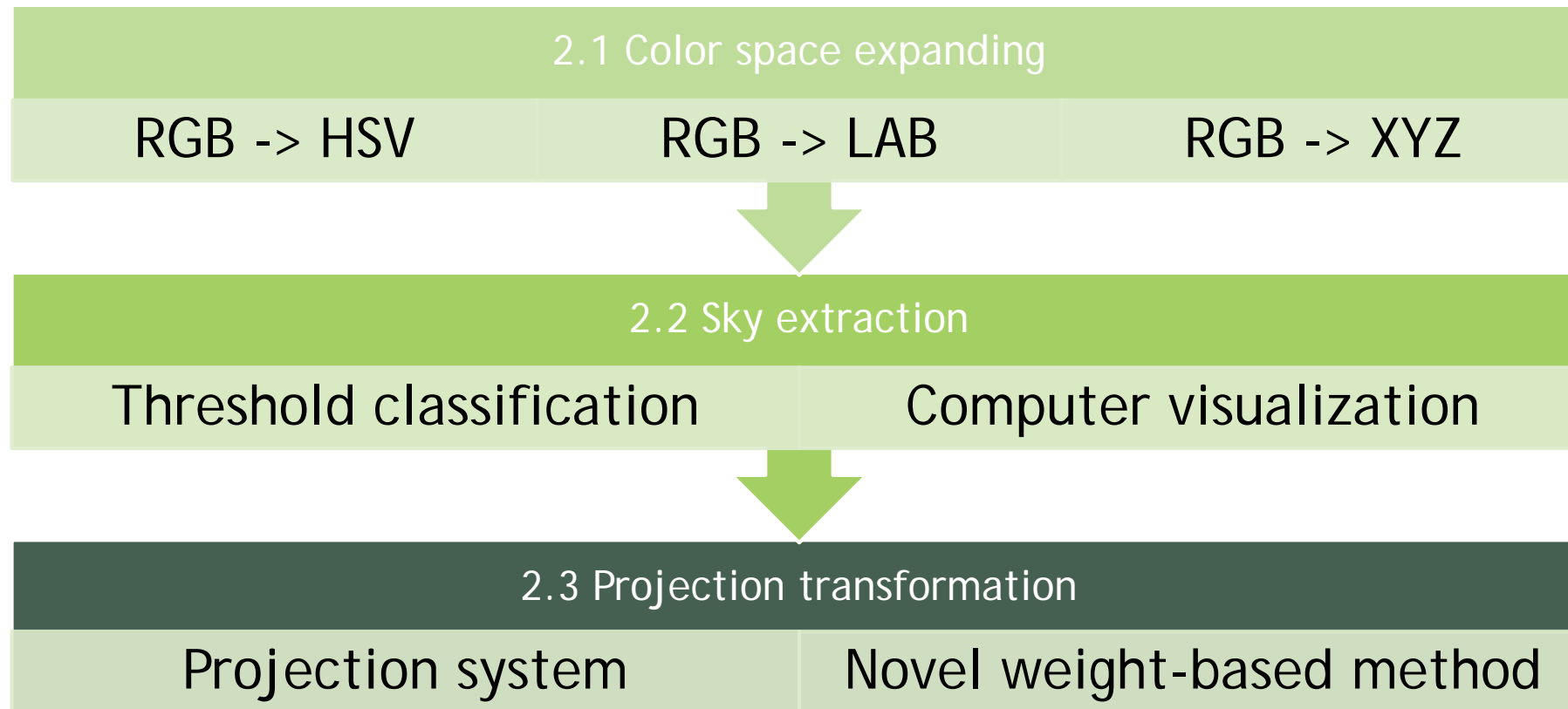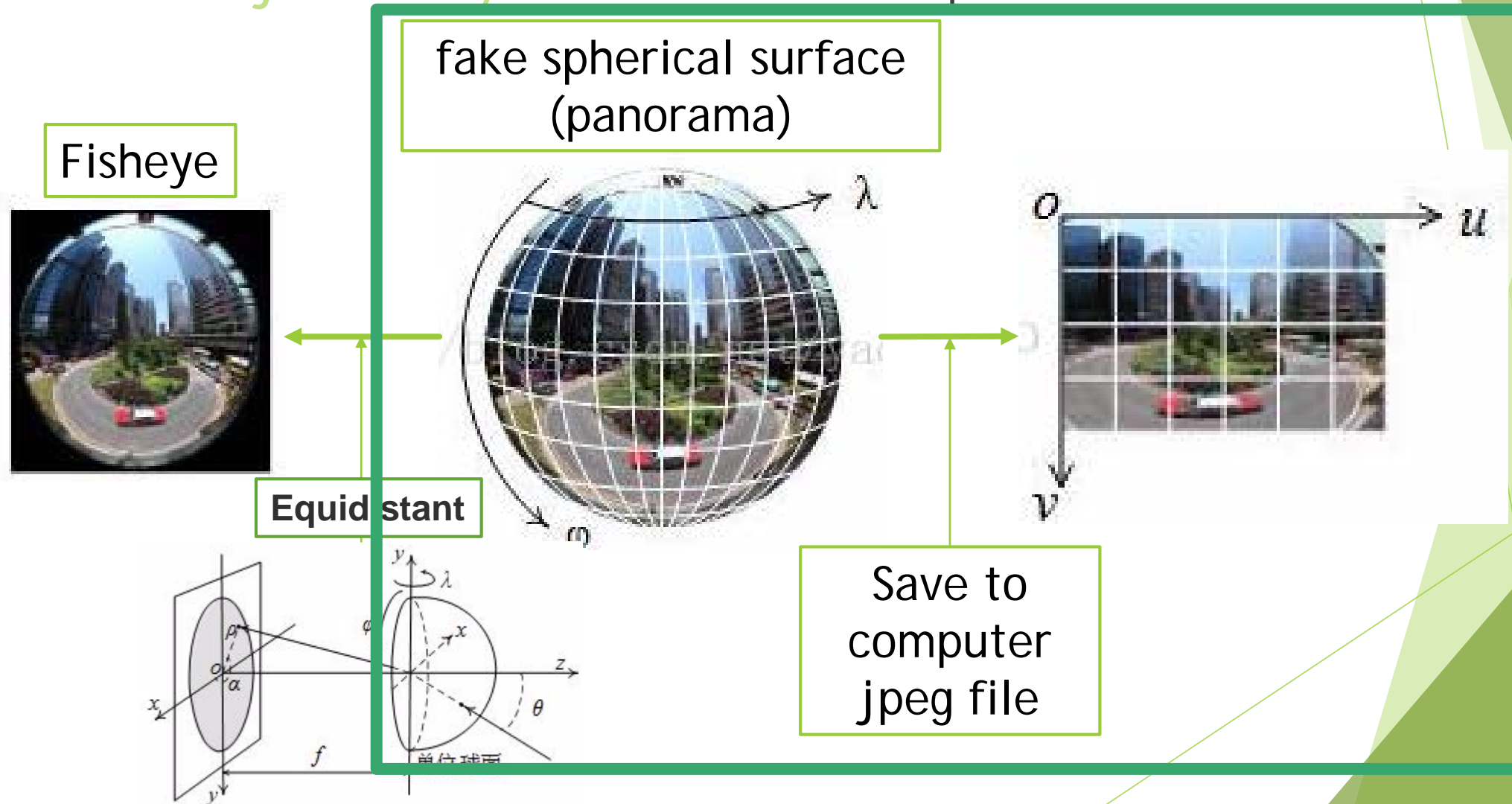

Figure 5. Illustration of tree segmentation using proposed algorithm: (a) input image, (b) preliminary segmentation, (c) extracted trunk flow, (d) extracted trunk region, and (e) final tree segmentation.

Teng, C. H., Y. S. Chen, and W. H. Hsu. 2005. Tree Segmentation from an Image. Pages 59-63 Iapr Conference on Machine Vision Applications.

2. Methods and Current Results

2.1 Color space expanding		
RGB -> HSV	RGB -> LAB	RGB -> XYZ

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fake spherical surface (panorama)

Fisheye

Equidistant

Save to computer jpeg file

Pictu

ed

quite low
o accelerate?

2.3 Projection transformation
2.3.2 Novel weight-based method

4. PAI = sum(percent x weight)

1. Percentage of each line in classified result

2. Calculate each line projected area

3. According to area, calculate weight of each line
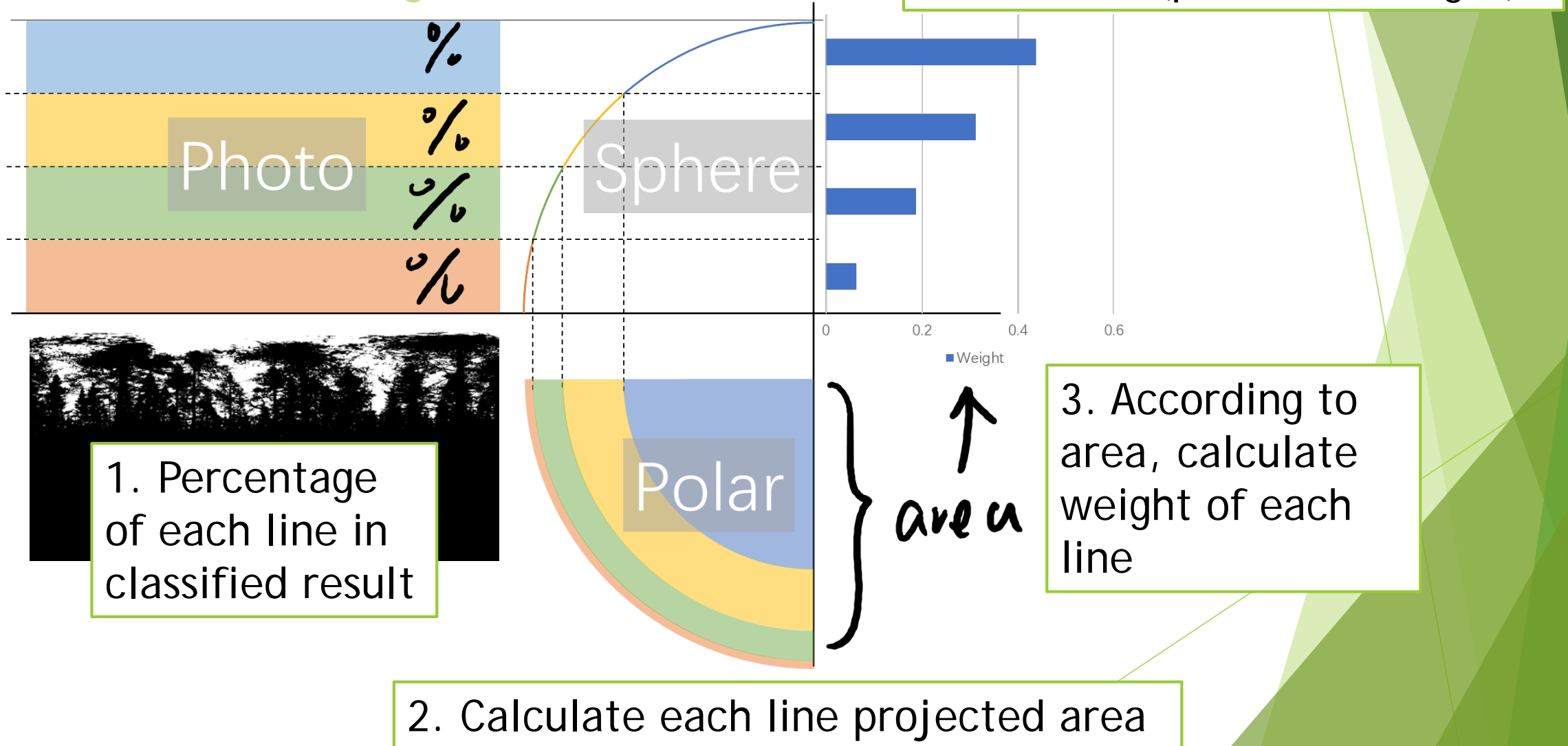
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3. Future work

1
- Reduce sun spot effect
- Tree extraction

2
- Compare fisheye with panorama

3
- Apply for more site photos
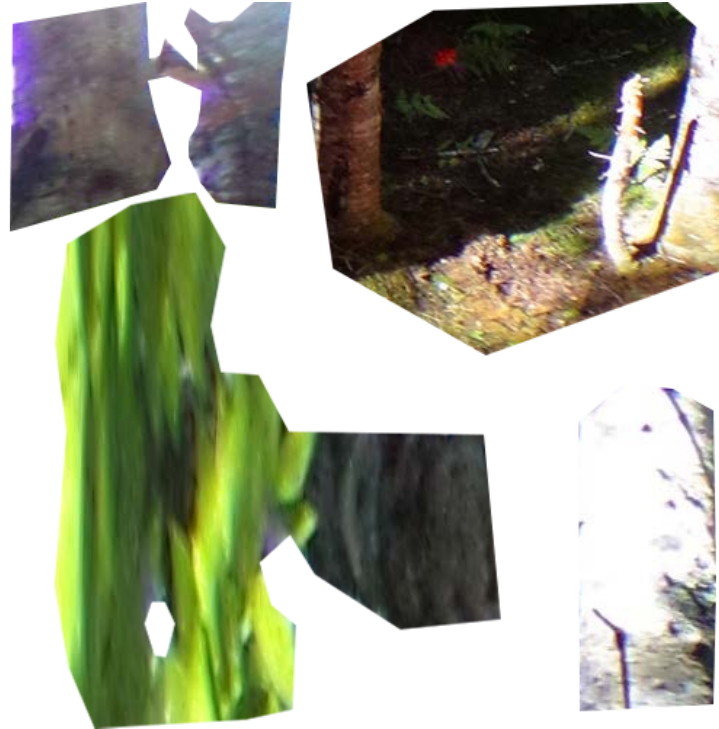
Thanks for your attention

2.2 Sky extraction
2.2.1 Threshold Classification

▶ Threshold estimation

Sky

Background

2.2 Sky extraction
2.2.1 Threshold Classification

▶ Threshold estimation