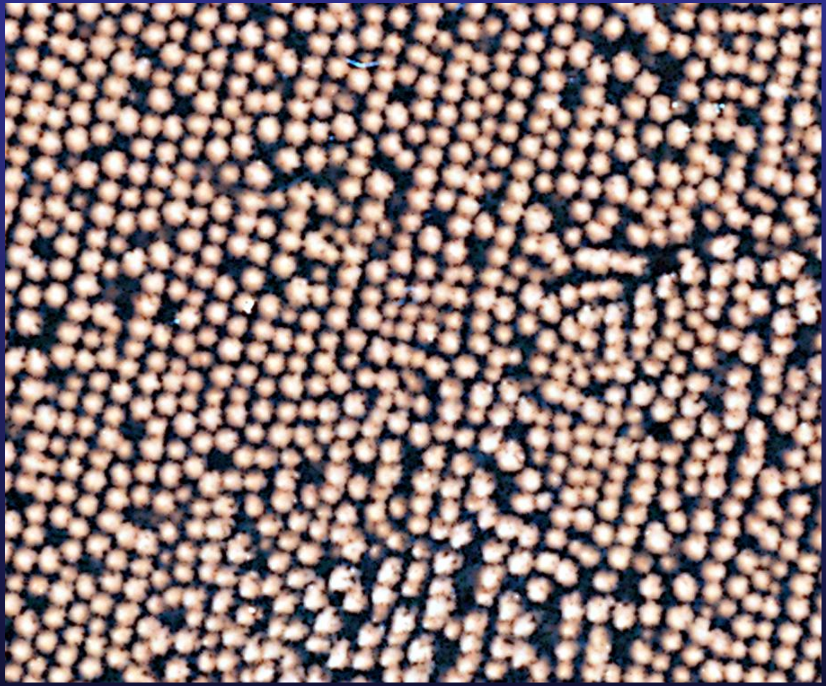
INDIVIDUAL TREE COUNTING USING HIGH RESOLUTION REMOTELY SENSED IMAGES



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PRESENTATION OVERVIEW

- Introduction and Motivation
- Objectives
- Background on Remote Sensing of Forest Plantations
- Material and Methods
- Discussion and Conclusions
- Future Research

1. INTRODUCTION

- Availability of high resolution remotely sensed images (e.g., Google).
- Faster forest planning with higher accuracy and lower costs (inventory, harvesting and logging, transportation etc).
- Individual tree counting and crow delineation (e.g., template matching, local maxima detection, region growing, edge detection etc).
- Well known and less complex approaches might be used with a good accuracy.

2. OBJECTIVES

Our main goal was to count individual crows of Eucalyptus trees using high resolution aerial images acquired over forest plantations.

Specific Objective:

Evaluate the suitability of simple approaches to image processing in order to achieve the main goal. Specifically, ***image enhancement*** using the Lee filter and ***unsupervised clustering*** using the Isodata algorithm were tested.

3.1 Forestry activities and Remote Sensing

How are forestry data obtained nowadays?

Field sampling

↑ Error, cost and time

What are the benefits of using Remote Sensing?

Complete aerial coverage

↓ Error, cost and time

Alternative and repeatable methods

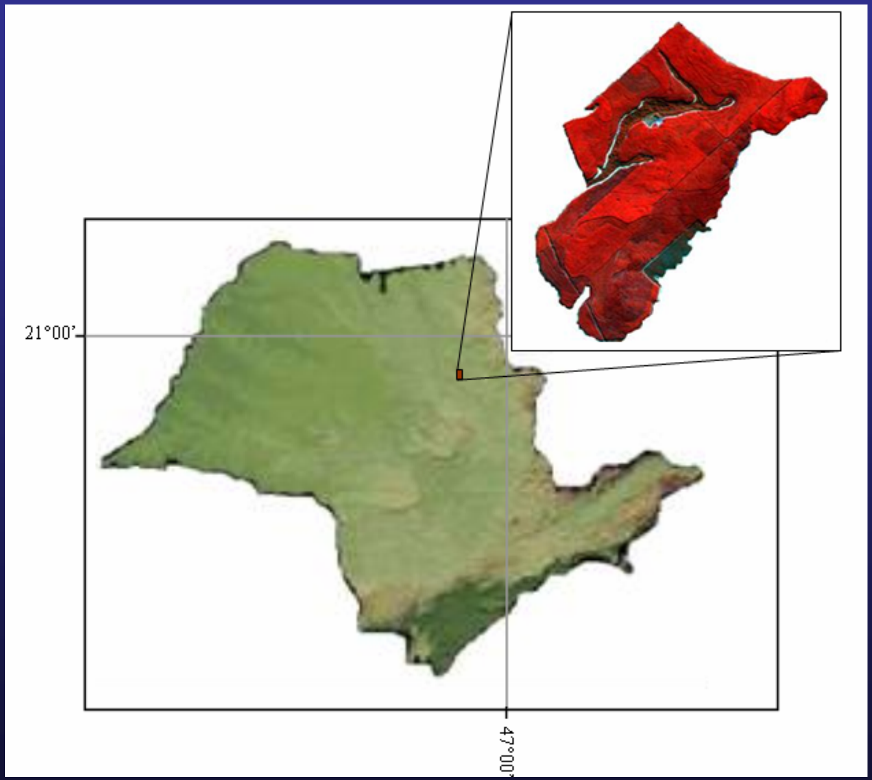
Integration with GIS

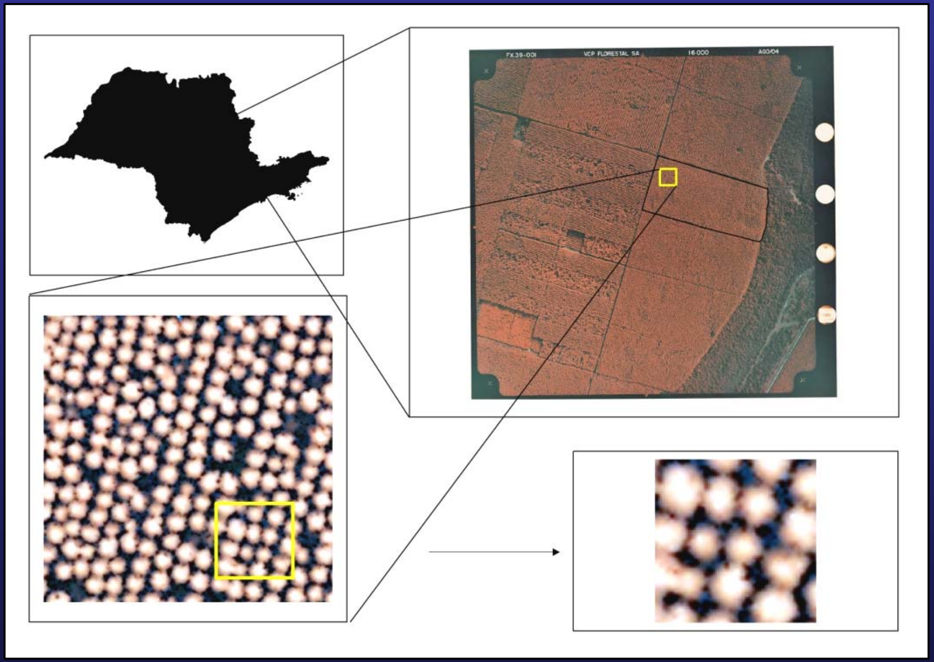
3.2 Why counting trees?

- Improved accuracy of Forest Inventories
- Better planning of harvesting activities
- Improved estimates of wood supply for the industry

4. MATERIAL AND METHODS.

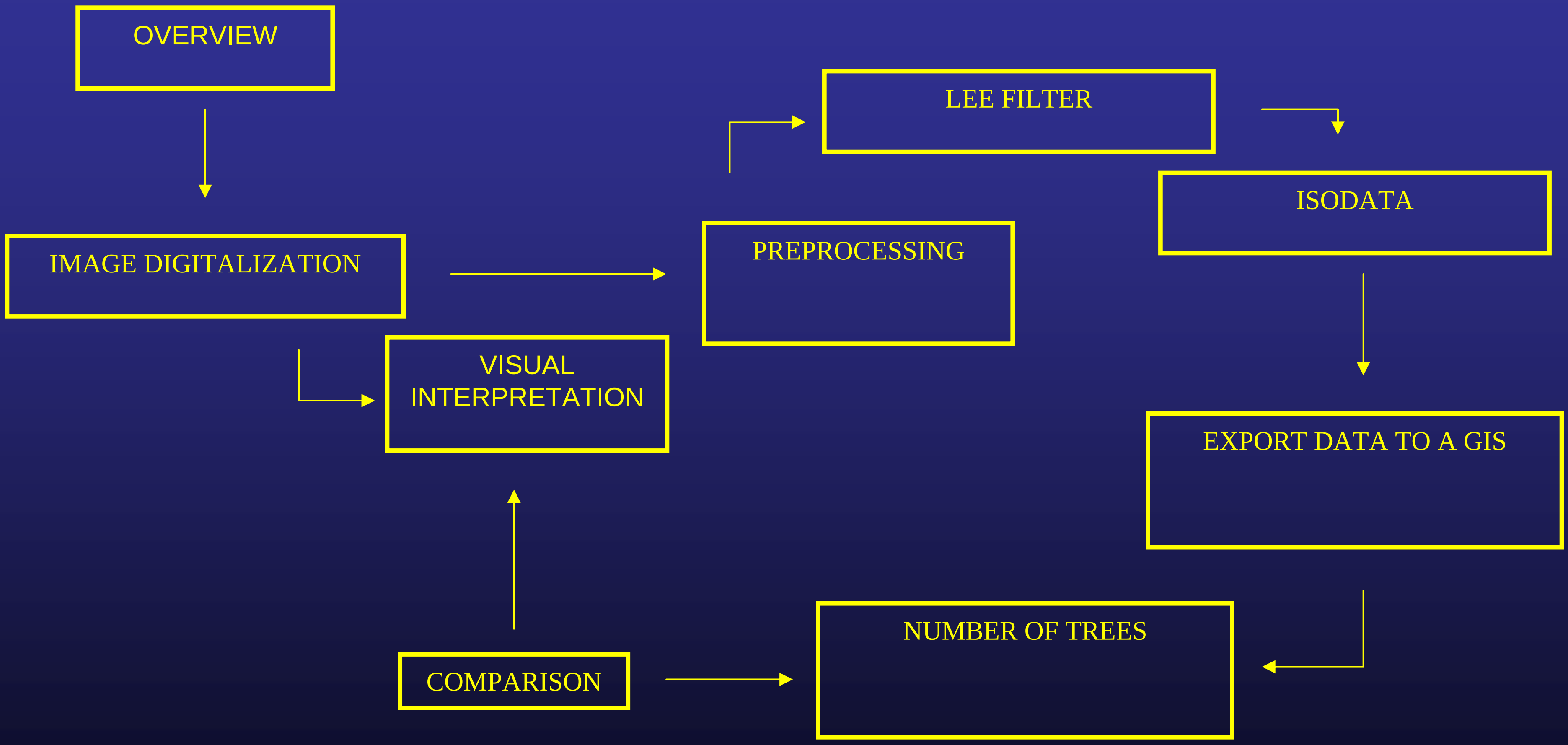
4.1 Study Area





4. MATERIAL AND METHODS

4.2 Methodology Overview

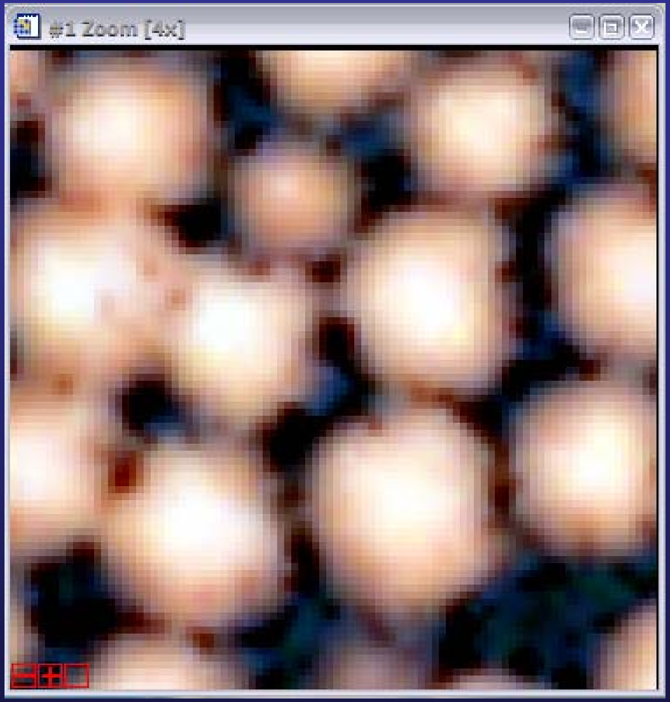


4.3 Lee Filter.

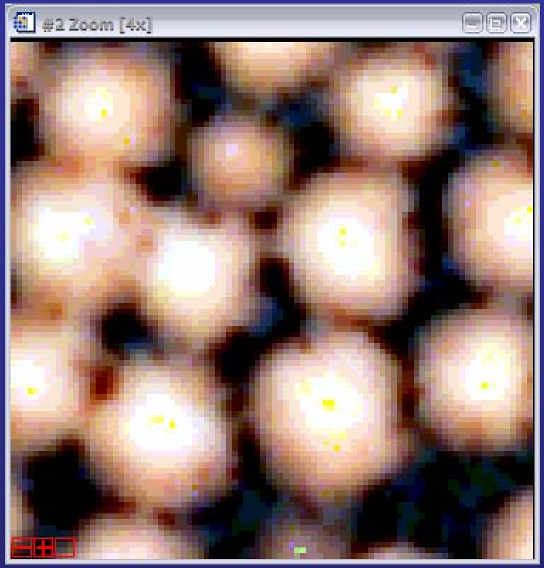
An adaptive filter that corrects for random, additive or multiplicative noise:

Noisy pixels are replaced by a weighted sum of the central pixel value within a moving window, the mean value, and the variance calculated from homogeneous areas of the image

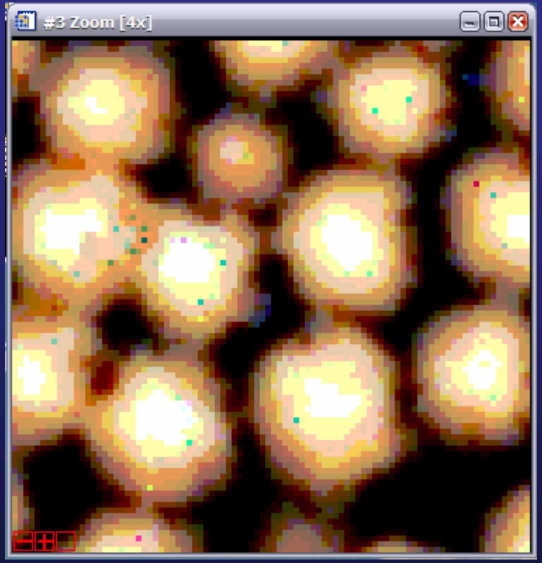
4. MATERIAL AND METHODS



ORIGINAL IMAGE

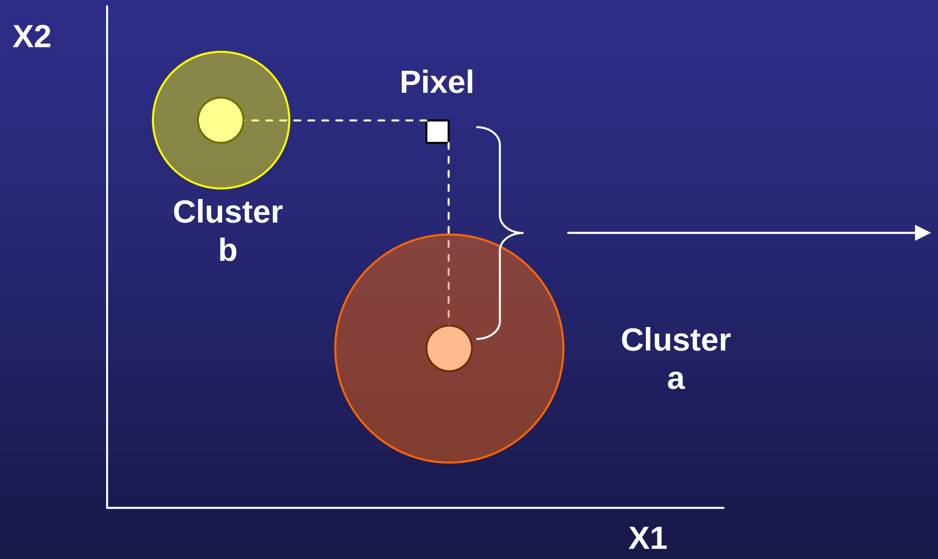


WINDOW: 5X5 PIXELS
Noise Model: Multiplicative and Additive
Additive Noise Mean: 10
Multiplicative Noise Mean: 10



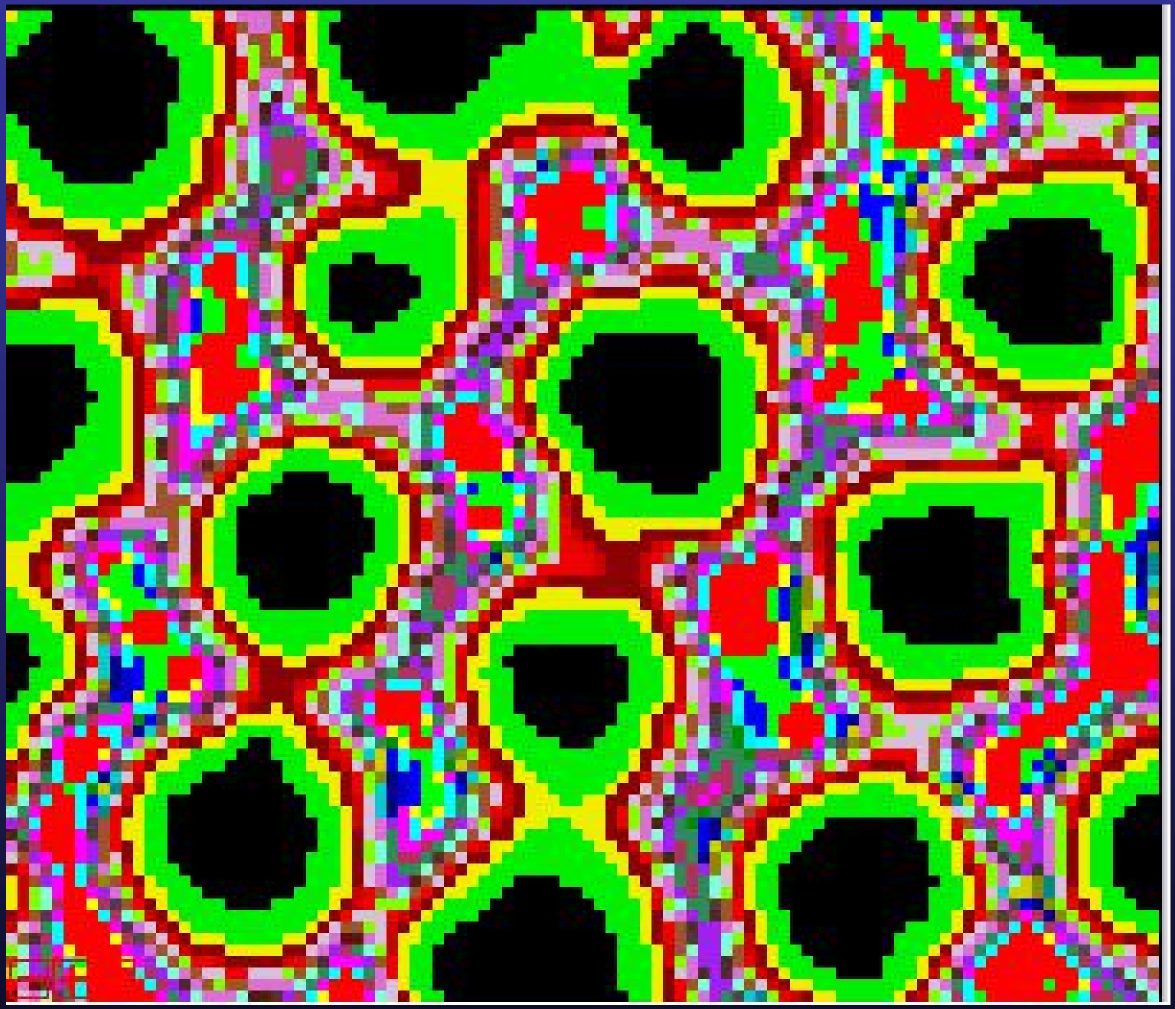
WINDOW: 5X5 PIXELS
Noise Model: Multiplicative and Additive
Additive Noise Mean: 20
Multiplicative Noise Mean: 20

4.4 ISODATA Unsupervised Classification.



$$D^2_E = (X_i - M_j)^2$$

4. MATERIAL AND METHODS

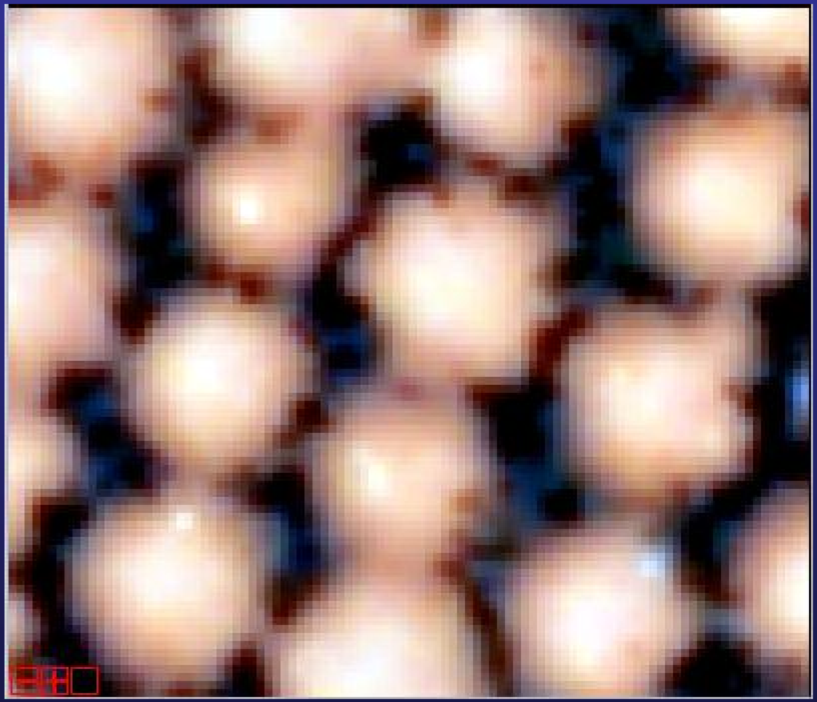


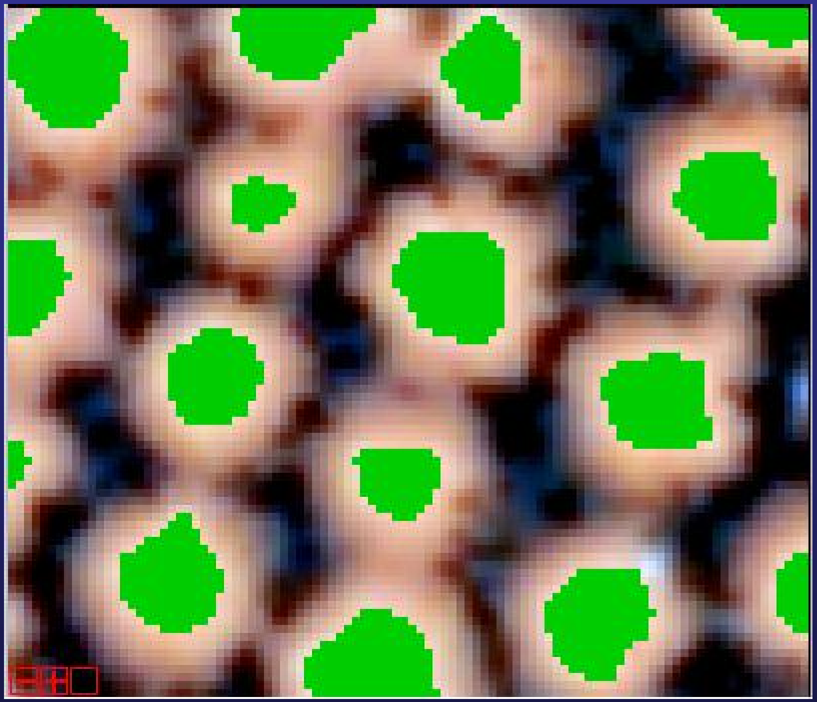
4.3 Counting Procedure.

1) Aerial Image was scanned and input to visual tree counting.
2) Preprocessing.
3) Resulting image was input to a 5 x 5 pixels Lee filter.
4) ISODATA was applied to the filtered output.
5) The class representing top crowns were input to a GIS for automatic counting.

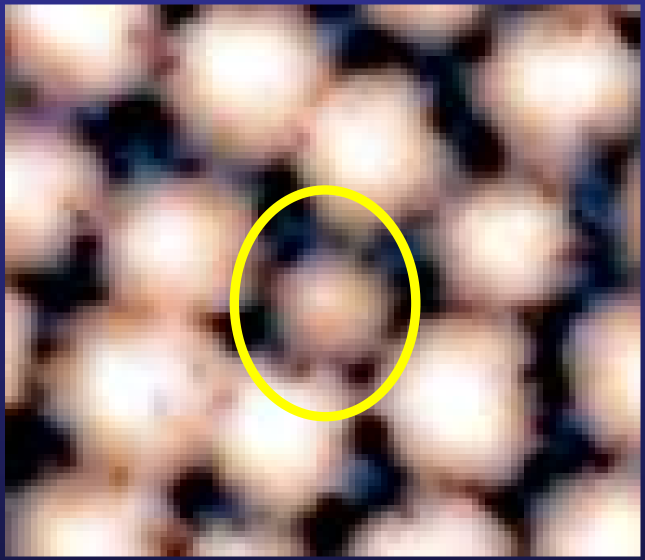
5. RESULTS

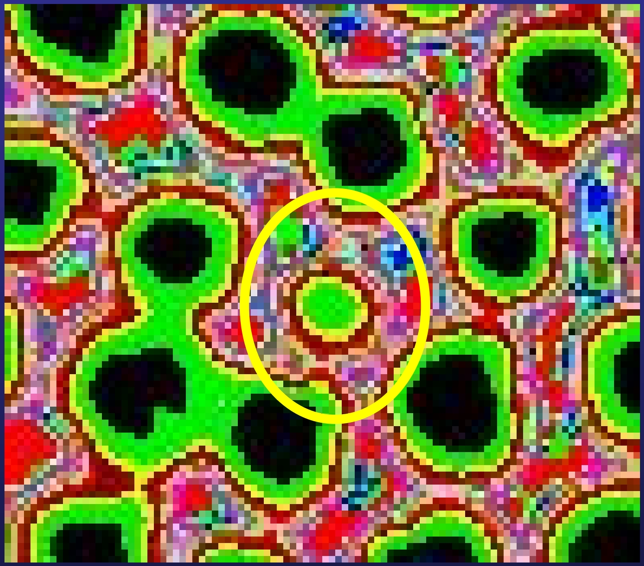
5.1 Class that represented top crowns.



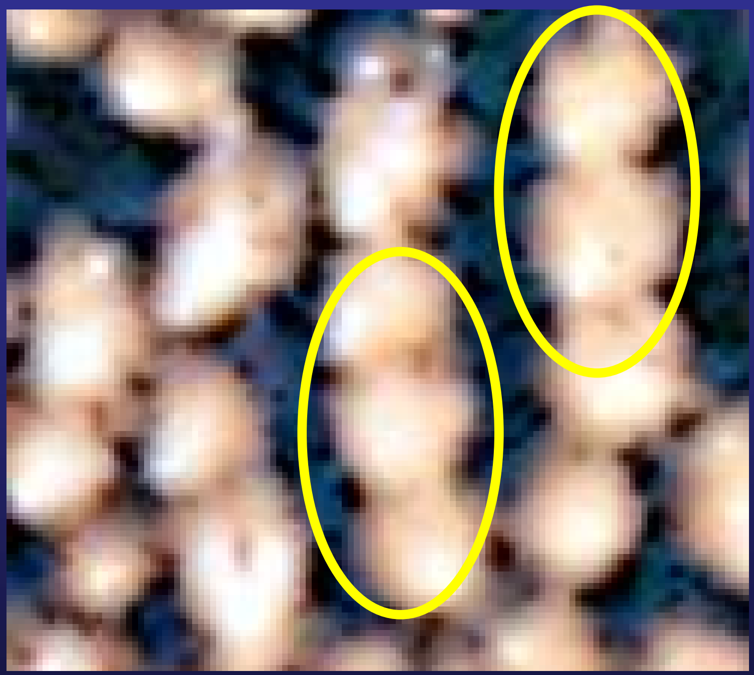


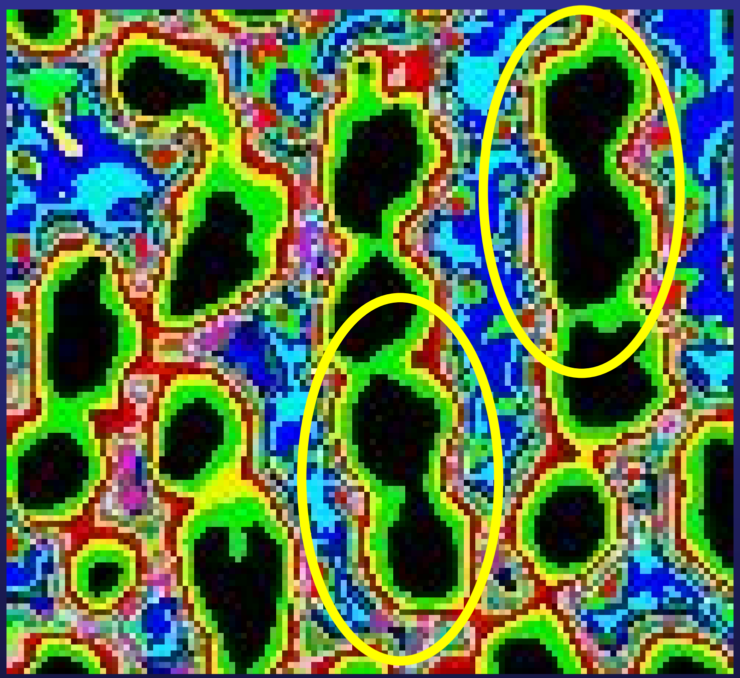
5.2 Omission Errors





5.3 Comissiom Errors





6. DISCUSSÃO

Korpela *et al*. (2006)	Acuracy	Omission Errors	Comission Errors
	92.1%	7.4%	6.4%
	77.9%	23.4%	8.9%
	81.9%	12.8%	17.2%
	70.6%	22.6%	12.2%
	67.1%	25.5%	17.7%
	71.3%	12.6%	24.6%

Wulder (2004)	Acuracy	Omission Errors	Comission Errors
	67.0%	33.0%	25.0%
	46.0%	8.0%	54.0%
	31.0%	4.0%	69.0%

Gougeon (1995)	Acuracy	Comission and Omission Errors
	92.30%	7.70%

Reis *et al*. (2007)	Acuracy	Comission and Omission Errors
	93.58%	6.42%

6. CONCLUSIONS

A methodological approach to tree counting was developed and successfully applied to a test area of planted forest.

Remote sensing and image processing techniques can aid the definition of the number of tree within Eucalyptus plantations.

Compared to other studies, our approach produced satisfactory results in terms of commission and omission errors.

Simple and well known approaches to image processing are suitable for tree counting. Image enhancement using the Lee filter improved the performance of the ISODATA algorithm facilitating the classification of top tree crowns.

7. FUTURE RESEARCH

- Different plantation spacing
- Varying topography
- Optimal image spatial resolution
- Optimal plantation age
- Combination with LIDAR data
- Alternative algorithms

THANK YOU !

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