Implementation of a computer vision algorithm for automated detection and diameter estimation of logs on trucks

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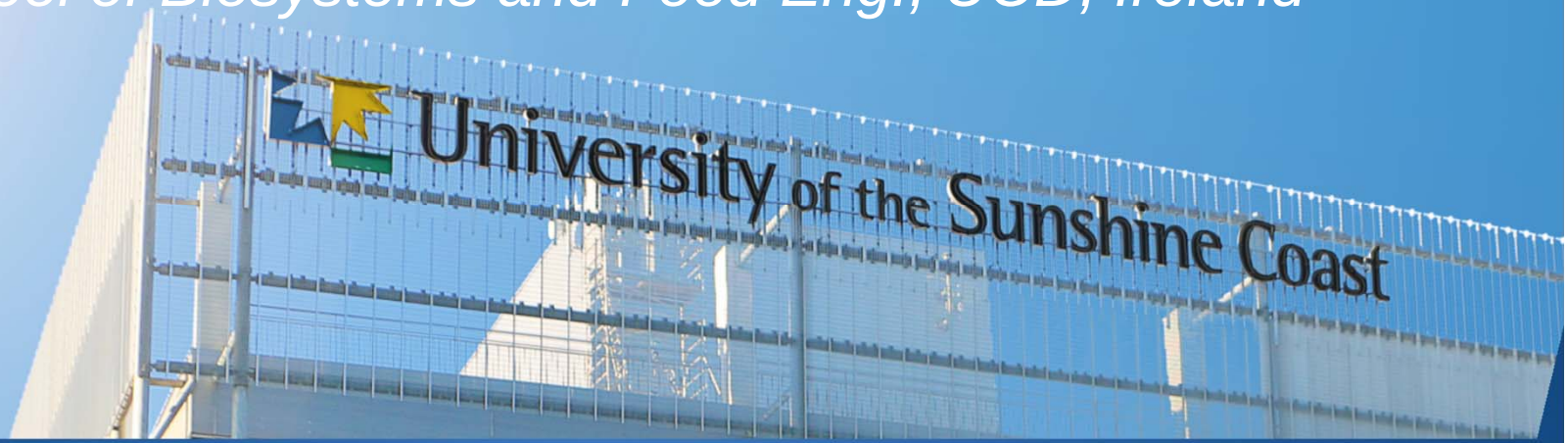

Outline

1. Problem – Manual and automated measurement of logs
2. Objectives of the study
3. Methodology – samples, computer vision algorithm, and tool (LogVision)
4. Results from research trial (Forestal Mininco, Chile)
5. Future research
6. Summary

Problem

Manual measurement of timber

- It is time consuming and labour expensive
- Manually measuring logs is inaccurate and prone to high errors
- Not consistent among people (scalers)
- Often not transparent to buyers

Problem

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Automated measurement of timber: Commercial apps

Source: Sarzynski et al. 2016

"Using the app is easy: a person takes a photo of the pile and instantly obtains the number of logs, their volumes and the exact diameters of each log"

Problem

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Automated measurement of timber

- Few scientific references presenting errors and limitations of commercial vision systems in different conditions (e.g. species, log size, luminosity, pulp vs sawlogs, etc.)
- Volume calculations based on log diameter, but which diameter (SED or LED)?
- Logs of variable length
- Volume of sawlogs are measured using the SED (e.g. JAS rule)

Objectives

- Apply and implement a computer vision algorithm to detect logs and estimate their diameters
- Quantify errors between actual and estimated diameters
- Investigate patterns in the errors
- Develop regression model between actual and estimated diameters
- Test the algorithm/tool in operational conditions

Methodology

Radiata pine sawlogs in Chile

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Diam. range	Frequency	1						2							
28	5	28.6	28.6	28				28.6	28.0						
30	6	30.3	30.8	30.1				30.2	30.1	30.1					
32	3	32.1						32.6	32.3						
34	11	34.7	34.7	34.5	34.2	34	34.2	34.8	34.6	34.2	34.2	34.2			
36	1							36.8							
38	1							38.6							
40	1							40.4							
42	1							42							
44															
TOTAL LOGS	29	13						16							

20 truckloads

Methodology

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- End faces from 220 logs carried on trucks.
- Each diameter was measured manually with a measuring tape.
- The background of the images was cropped to remove noise from the end face of the logs.
- A convolved algorithm was used for contrast enhancement of the image.
- Automated detection and diameter estimation.
- Algorithm implemented with OpenCV, and programmed with C++ and Qt

Methodology

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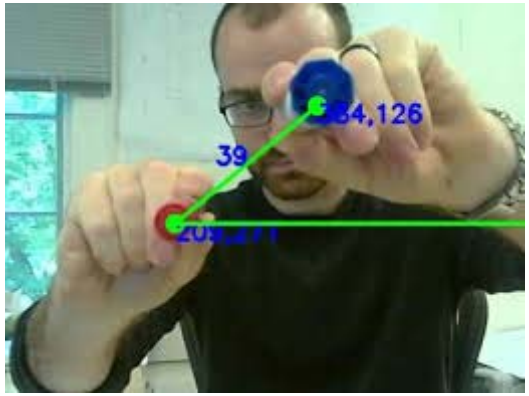
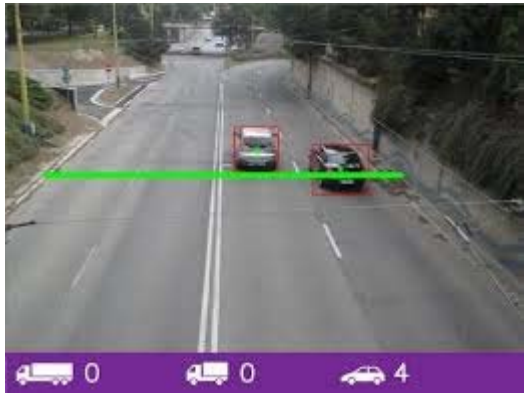
OpenCV: Open Source Computer Vision

OpenCV

Opencv.org





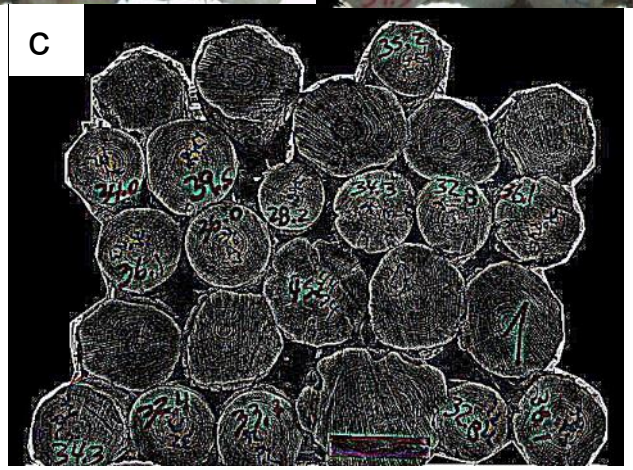
Methodology

Images from the back of trucks carrying logs a) original
b) with cropped background and c) convolved

a

b

c



Methodology

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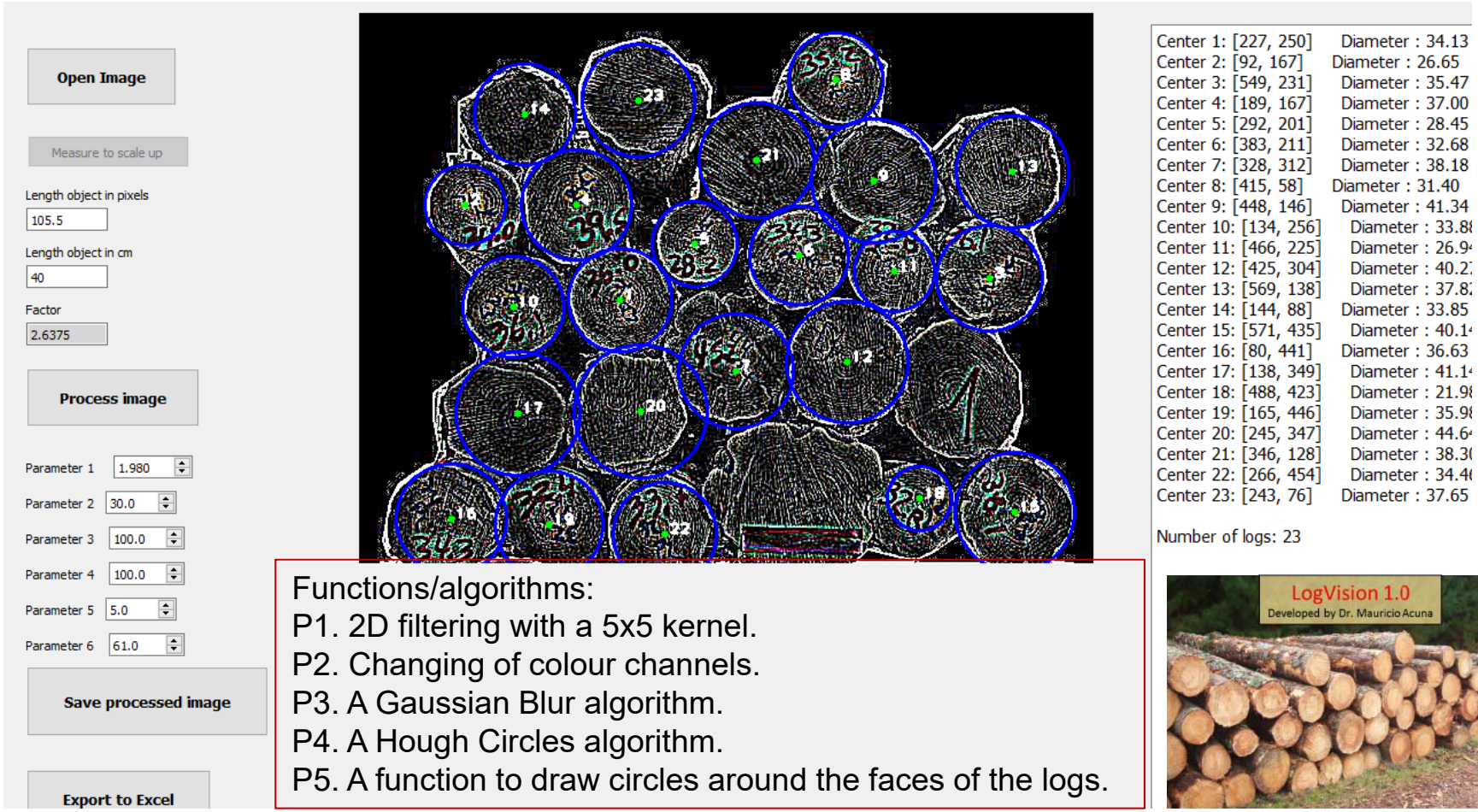
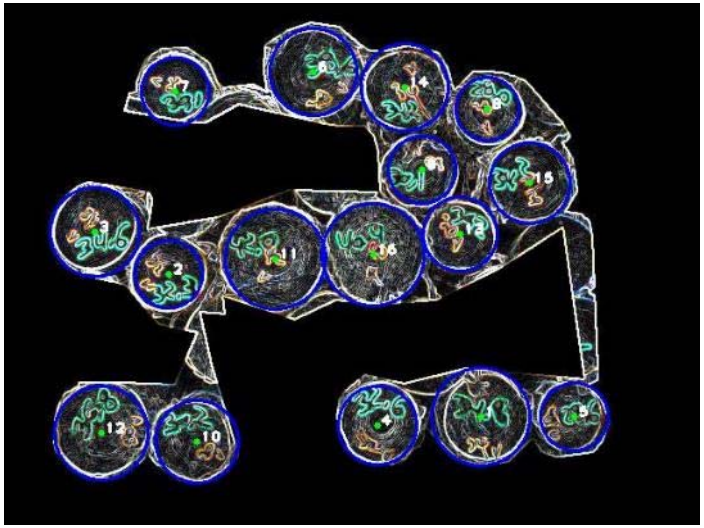
Log diameter measurement tool called LogVision developed by Acuna.



Functions/algorithms:
P1. 2D filtering with a 5x5 kernel.
P2. Changing of colour channels.
P3. A Gaussian Blur algorithm.
P4. A Hough Circles algorithm.
P5. A function to draw circles around the faces of the logs.

Methodology



LogVision – Log detection & diameter estimates

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Results

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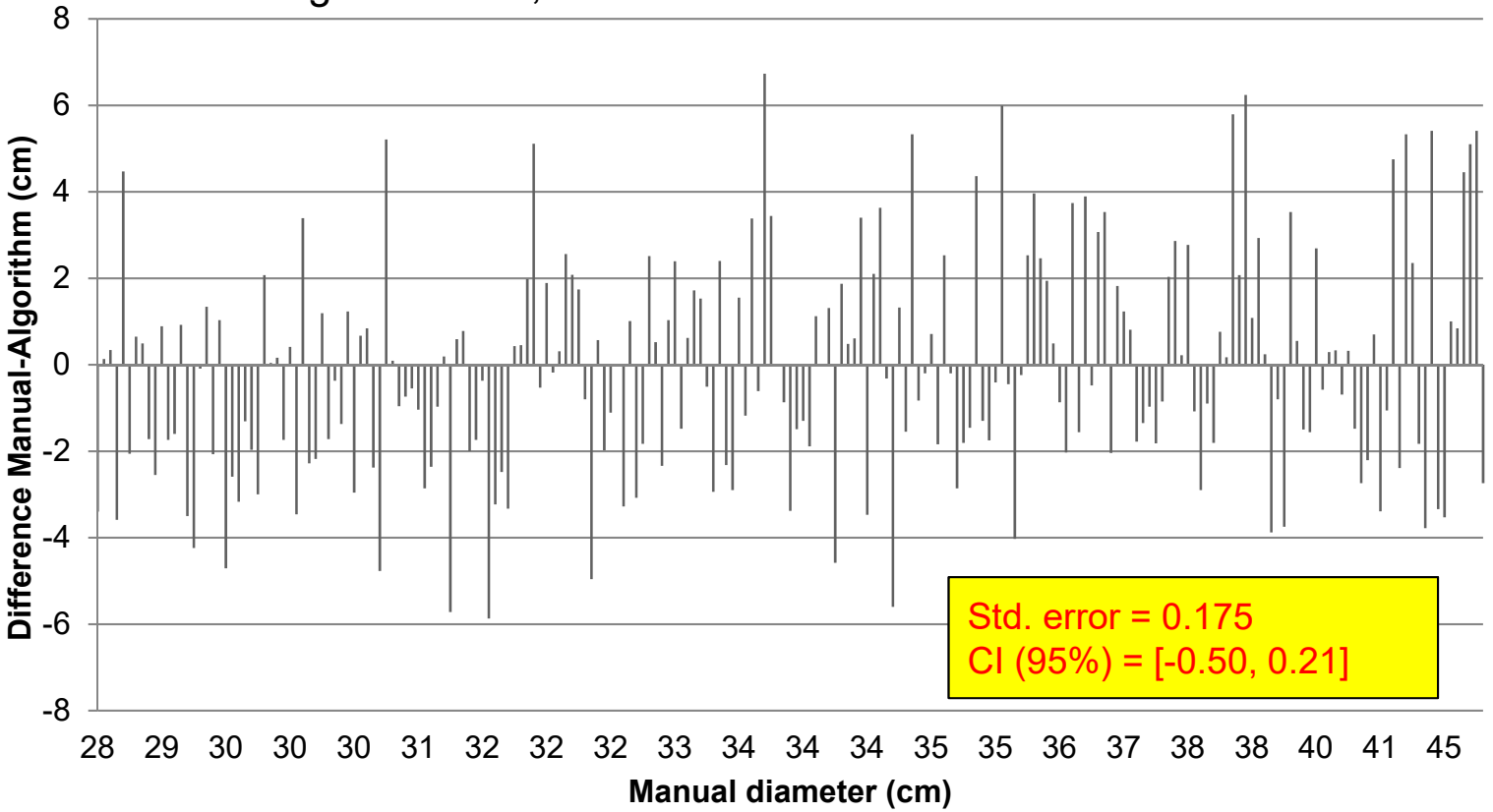
Statistics - Manual and automated measurements

Description	Manual	Algorithm
Count	220	220
Mean	34.4	34.6
Std. error	0.28	0.30
Median	34.1	34.0
Std. deviation	4.15	4.44
Range	21.3	27.8
Min	27.5	23.7
Max	48.8	51.5
CI (95%)	0.56	0.60

Results

Variation (cm) between the manual and digital measurements of the diameters

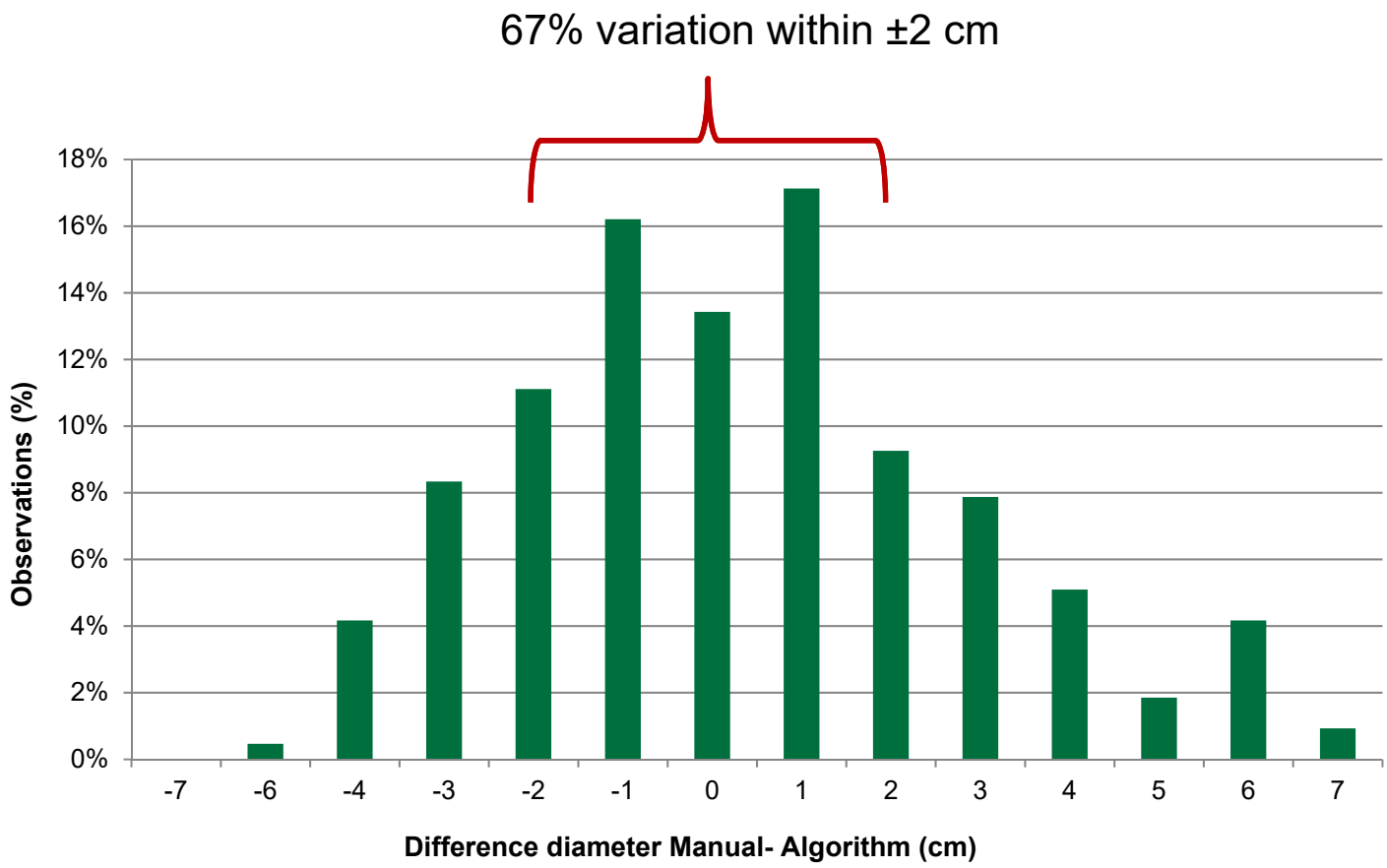
Difference avg. - 0.13 cm, with a maximum of 6.73 cm and minimum of – 5.87 cm



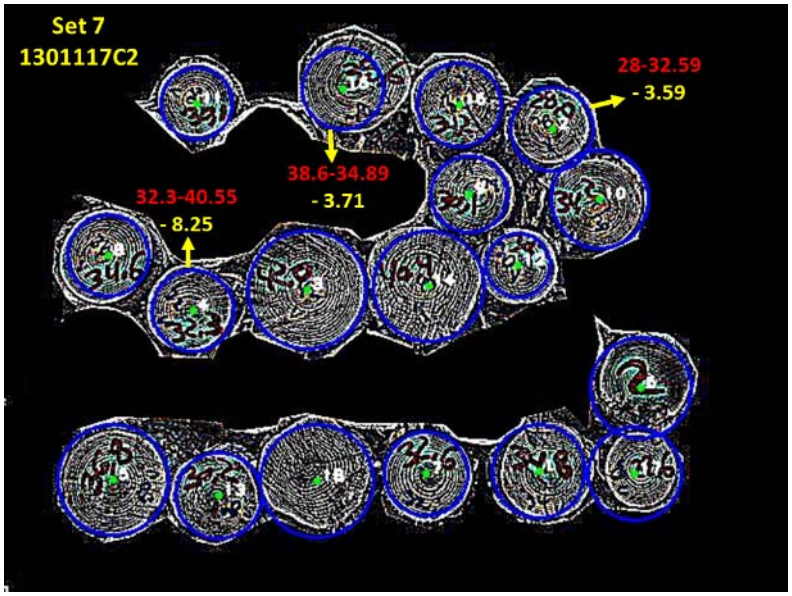
Class	Difference
38-30	-0.68
30-32	-1.10
32-34	-0.05
34-36	0.12
36-38	0.47
38-40	0.40
>40	0.32

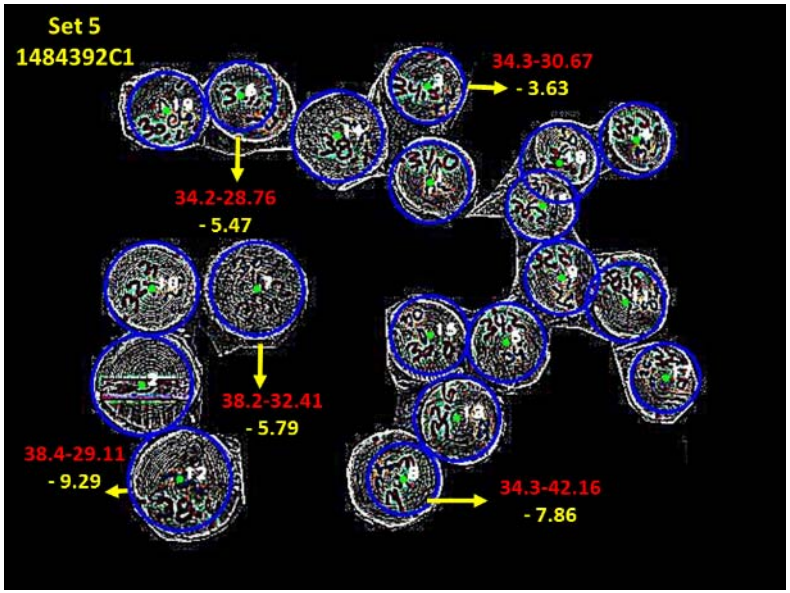
Results

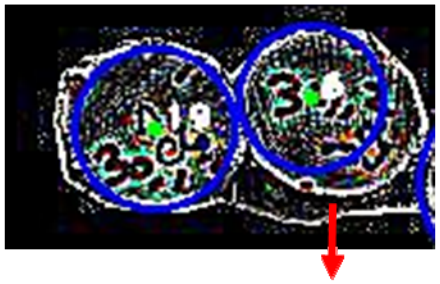
Variation (cm) between the manual and digital measurements of the diameters



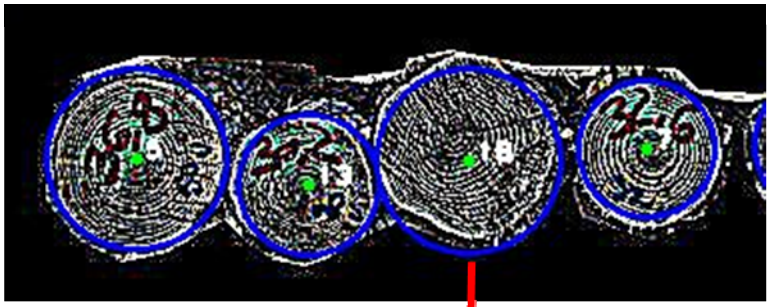
Results





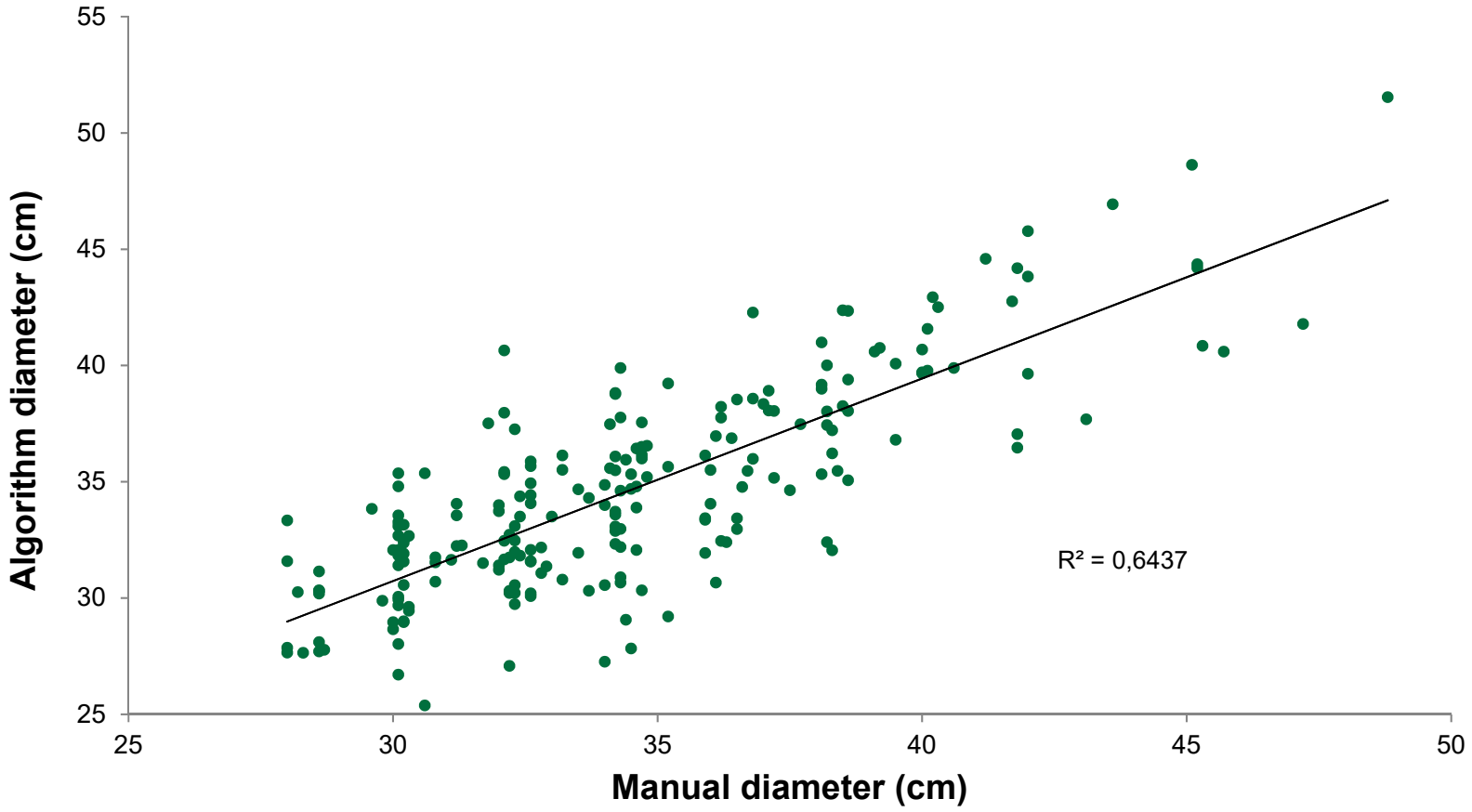


Manual – Software
34.2 cm - 28.76 cm = 5.47 cm



Irregularities in shape

Regression model between manual and automated measurements of the diameters



Future research

- Use the algorithms/app to measure stacked piles
- Apply and test improved algorithms in different conditions (species, log size, luminosity, etc.)
- Test the accuracy of commercial applications
- Quantify the errors and their economic impact
- Provide volumetric estimates based on a combination of photogrammetric (3D reconstruction) and computing vision algorithms

Future research

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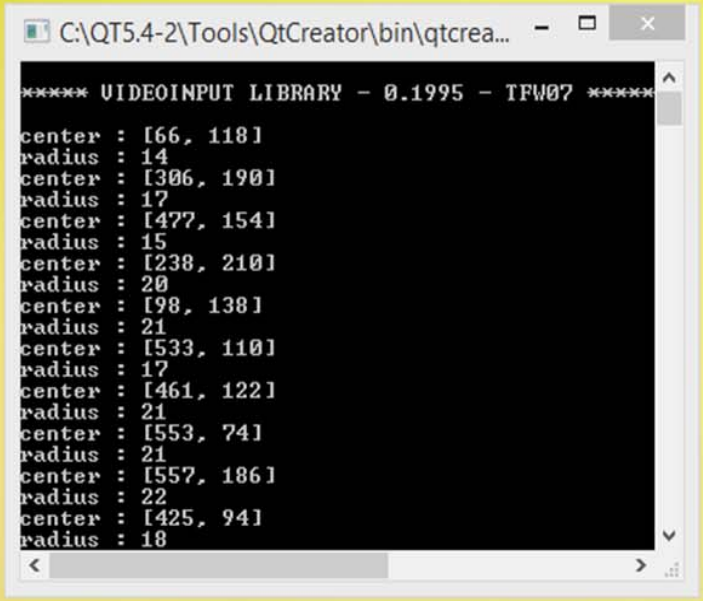
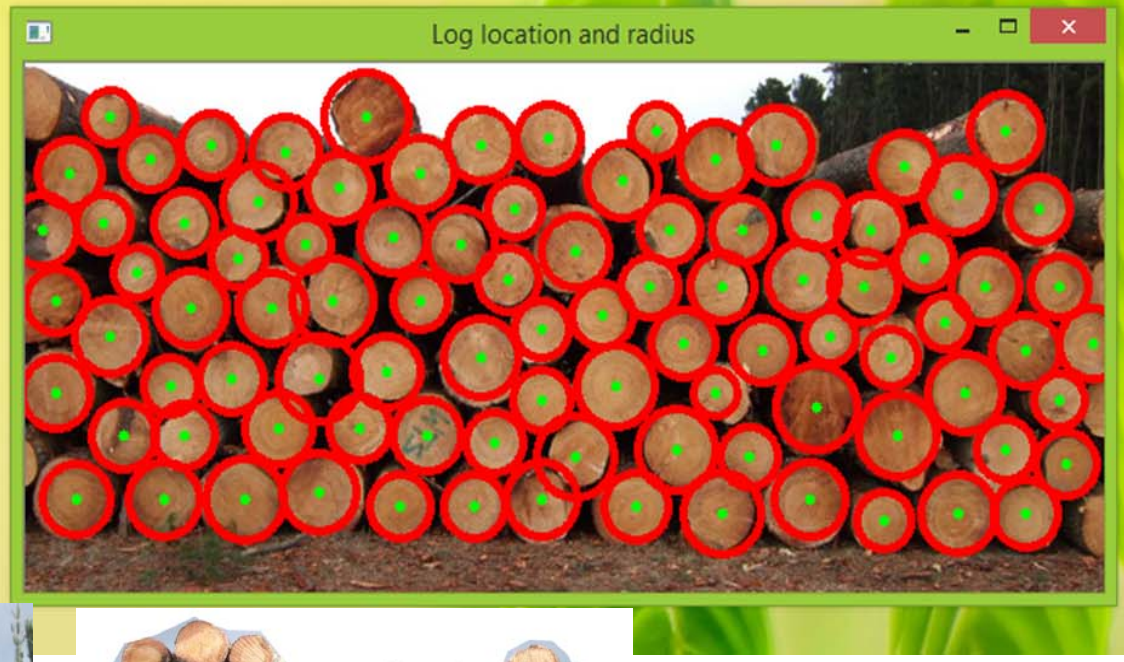
Measuring stacked piles and logs on forwarders





Summary

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- A computer vision approach for detection and estimation of diameters of logs on trucks (LogVision) has been presented.
- Based on OpenCV algorithms and developed with the Qt/C++ framework.
- Preliminary results show the potential in real life operations. Mean differences were -0.13 cm.
- Further studies will compare different image capturing and pre-processing techniques, and also different measurement algorithms.

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