

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

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## 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

## Automated measurement of timber: Commercial apps

The collage displays three mobile applications for timber measurement, each developed by the Centre for Research in Wood Technology (CRWT) at the University of the Sunshine Coast. The applications are:

- AForS:** An Android application for measuring timber piles. It shows a user taking a photo of a log pile, which is then processed to provide volume and count data.
- FOVER:** An iOS application for measuring timber piles. It shows a user taking a photo of a log pile, which is then processed to provide volume and count data.
- TIMBETER:** A stereoscopic measurement system for vehicles. It shows a user taking a stereoscopic photo of a log pile from a vehicle, which is then processed to provide volume and count data.

The TIMBETER app interface on the right shows a 3D model of a log pile and a data table:

	Vol. (m <sup>3</sup> )	%	Count
Total	28.12m <sup>3</sup>		209
Scale	26.11m <sup>3</sup>	92.82%	202
Cull	0.20m <sup>3</sup>	2.52%	7

	Volume	Count
Pile	0.38m <sup>3</sup>	3
Checked log	0.12m <sup>3</sup>	2
Average diameter	0.12m	1

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”

## 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



1301117												
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												
<b>TOTAL LOGS</b>	<b>29</b>	<b>13</b>						<b>16</b>				

20 truckloads

- 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

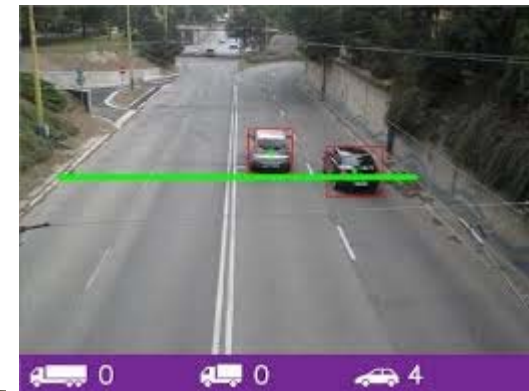
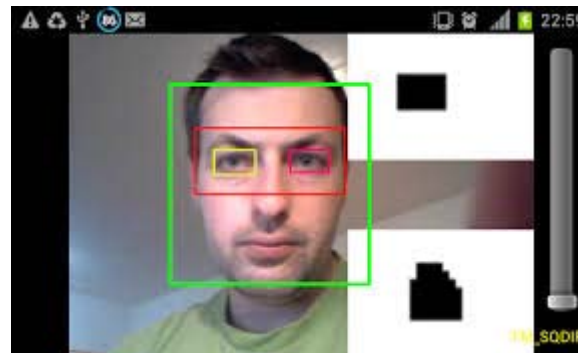
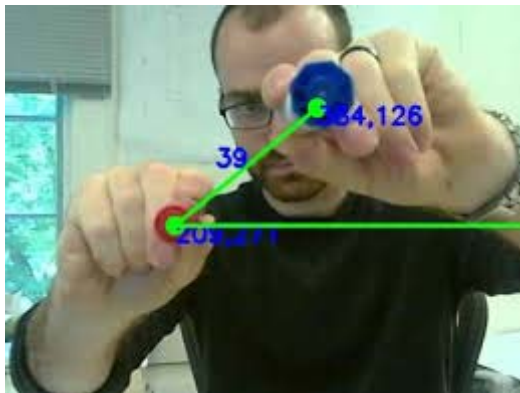


# Methodology

## OpenCV: Open Source Computer Vision

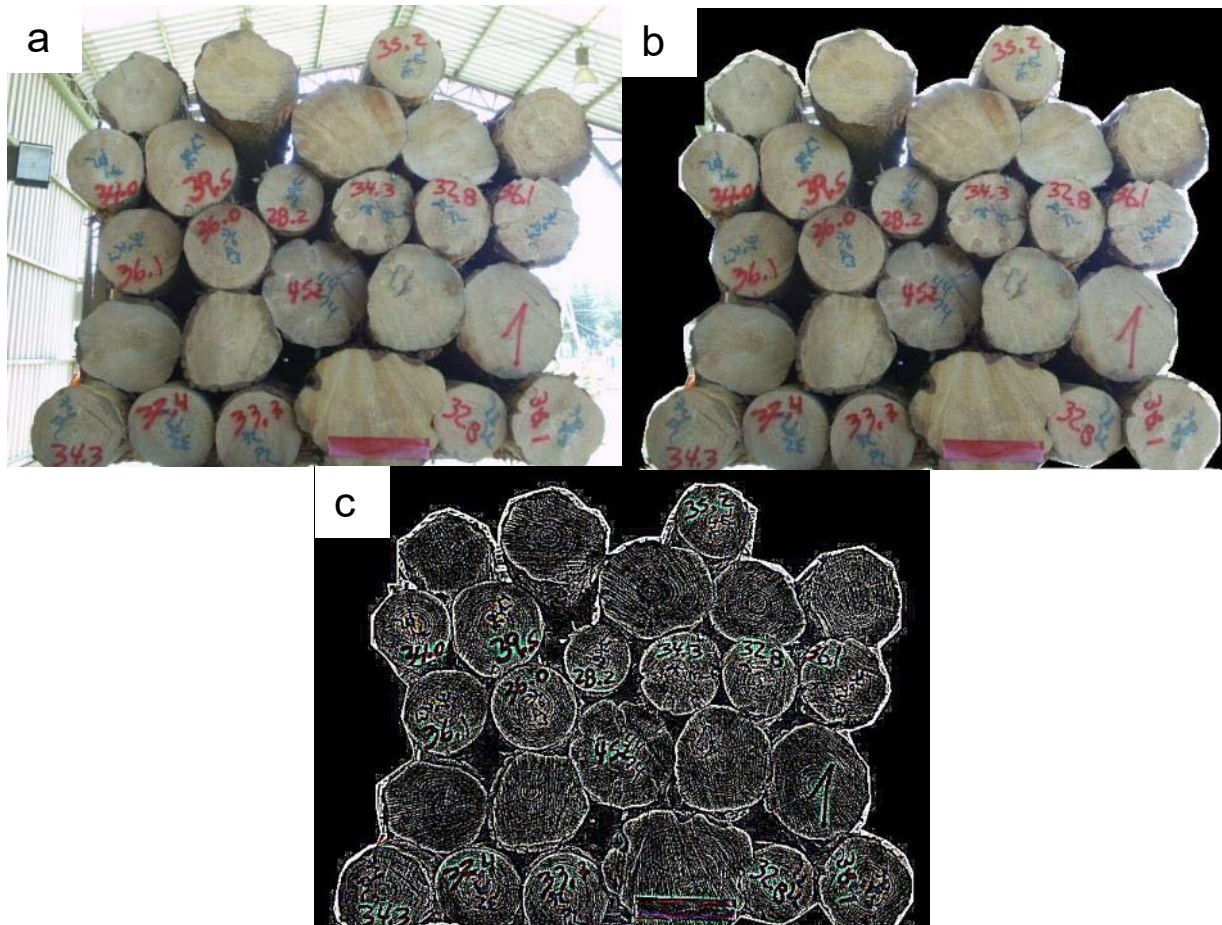


[Opencv.org](http://opencv.org)



# Methodology

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



# Methodology

Log diameter measurement tool called LogVision developed by Acuna.

Open Image

Measure to scale up

Length object in pixels

105.5

Length object in cm

40

Factor

2.6375

Process image

Parameter 1 1.980

Parameter 2 30.0

Parameter 3 100.0

Parameter 4 100.0

Parameter 5 5.0

Parameter 6 61.0

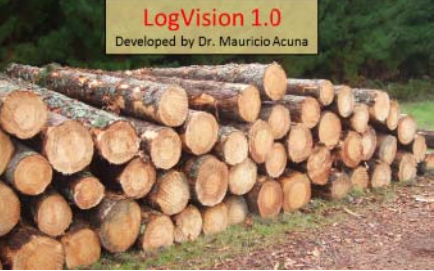
Save processed image

Export to Excel

Center 1: [227, 250]	Diameter : 34.13
Center 2: [92, 167]	Diameter : 26.65
Center 3: [549, 231]	Diameter : 35.47
Center 4: [189, 167]	Diameter : 37.00
Center 5: [292, 201]	Diameter : 28.45
Center 6: [383, 211]	Diameter : 32.68
Center 7: [328, 312]	Diameter : 38.18
Center 8: [415, 58]	Diameter : 31.40
Center 9: [448, 146]	Diameter : 41.34
Center 10: [134, 256]	Diameter : 33.88
Center 11: [466, 225]	Diameter : 26.99
Center 12: [425, 304]	Diameter : 40.21
Center 13: [569, 138]	Diameter : 37.81
Center 14: [144, 88]	Diameter : 33.85
Center 15: [571, 435]	Diameter : 40.14
Center 16: [80, 441]	Diameter : 36.63
Center 17: [138, 349]	Diameter : 41.14
Center 18: [488, 423]	Diameter : 21.98
Center 19: [165, 446]	Diameter : 35.98
Center 20: [245, 347]	Diameter : 44.64
Center 21: [346, 128]	Diameter : 38.31
Center 22: [266, 454]	Diameter : 34.48
Center 23: [243, 76]	Diameter : 37.65

Number of logs: 23

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.






# LogVision – Log detection & diameter estimates

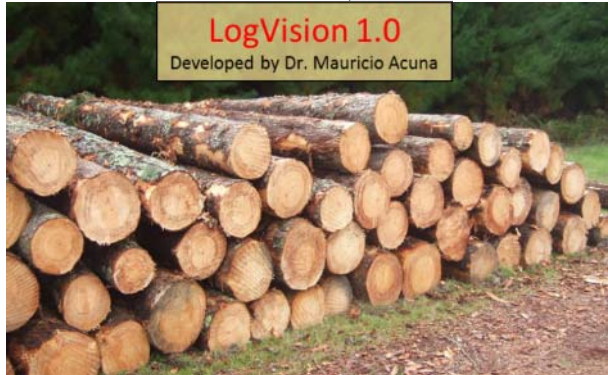
LogVision 1.0

File Processing Help



Center	Diameter
Center 1: [82, 96]	Diameter : 34.1
Center 2: [163, 126]	Diameter : 34.2
Center 3: [69, 294]	Diameter : 40.7
Center 4: [167, 316]	Diameter : 32.4
Center 5: [322, 114]	Diameter : 32.9
Center 6: [380, 83]	Diameter : 26.7
Center 7: [462, 64]	Diameter : 30.5
Center 8: [262, 392]	Diameter : 40.8
Center 9: [480, 312]	Diameter : 30.2
Center 10: [576, 284]	Diameter : 33.4

LogVision 1.0  
Developed by Dr. Mauricio Acuna



# Results

## Statistics - Manual and automated measurements

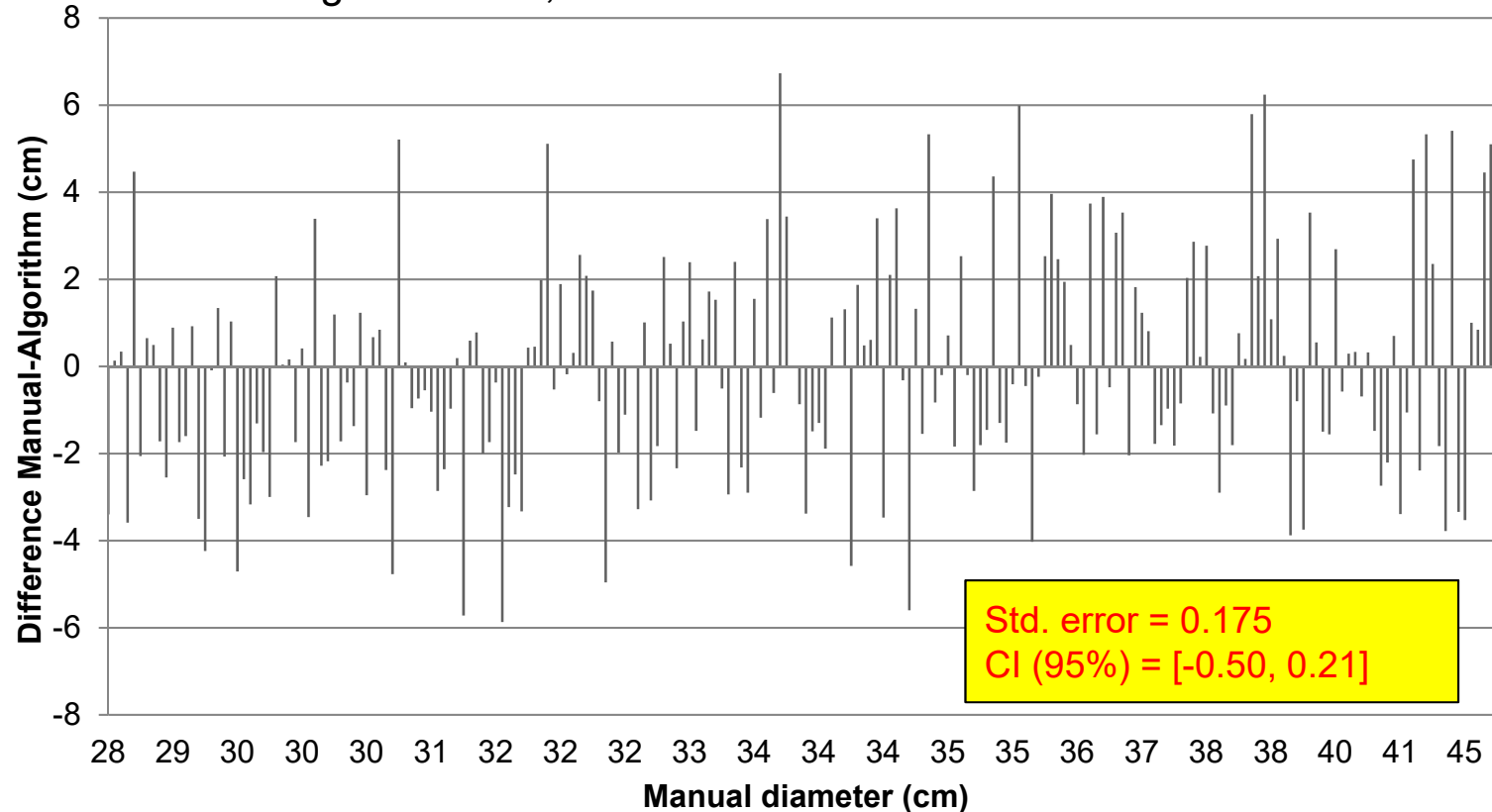


Description	Manual	Algorithm
Count	220	220
Mean	34.4	34.6
Std. error	0.28	0.30
Median	34.1	34.0
Std. deviation	4.15	4.44
Range	21.3	27.8
Min	27.5	23.7
Max	48.8	51.5
CI (95%)	0.56	0.60

# Results

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

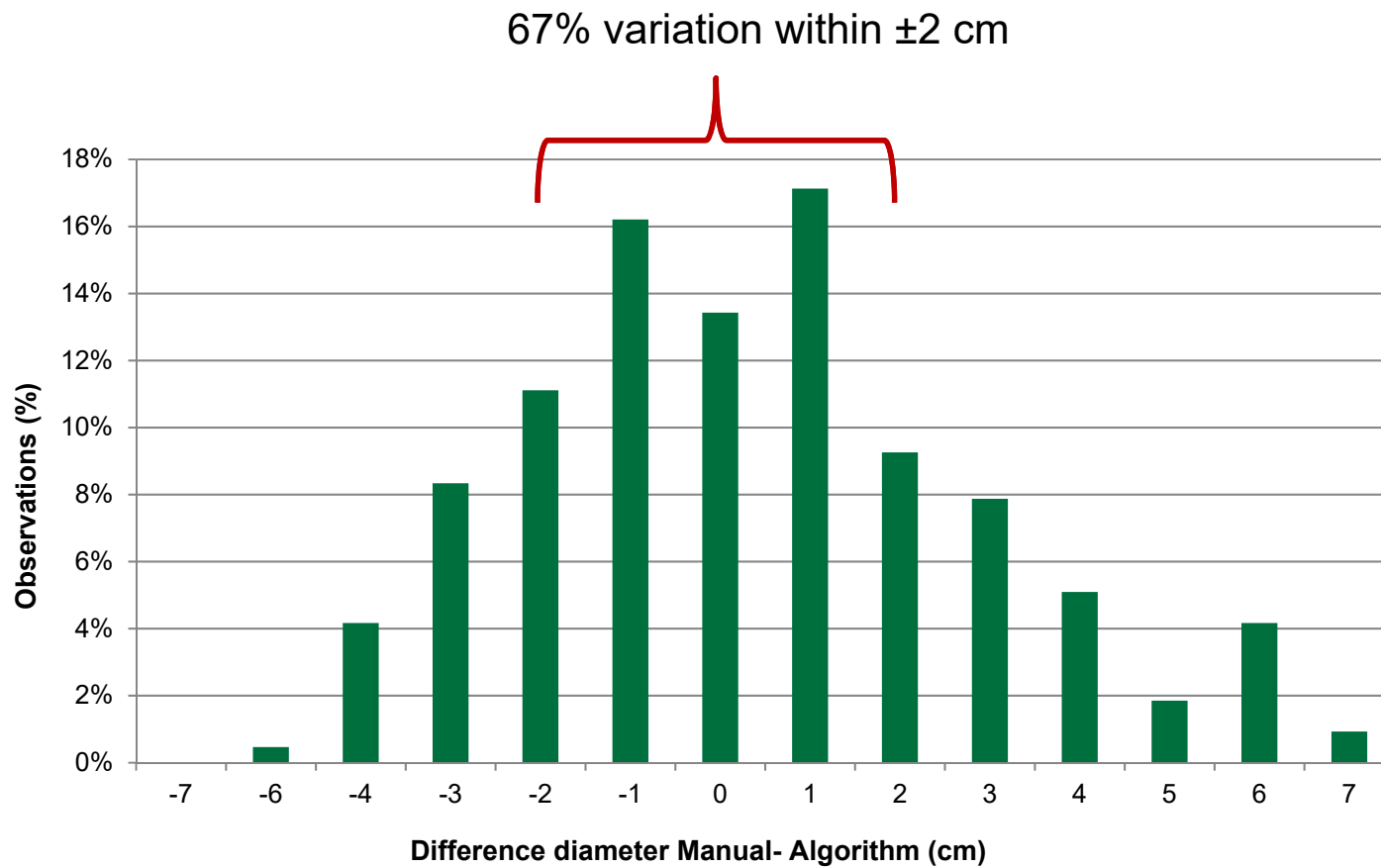
Difference avg. - 0.13 cm, with a maximum of 6.73 cm and minimum of - 5.87 cm



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

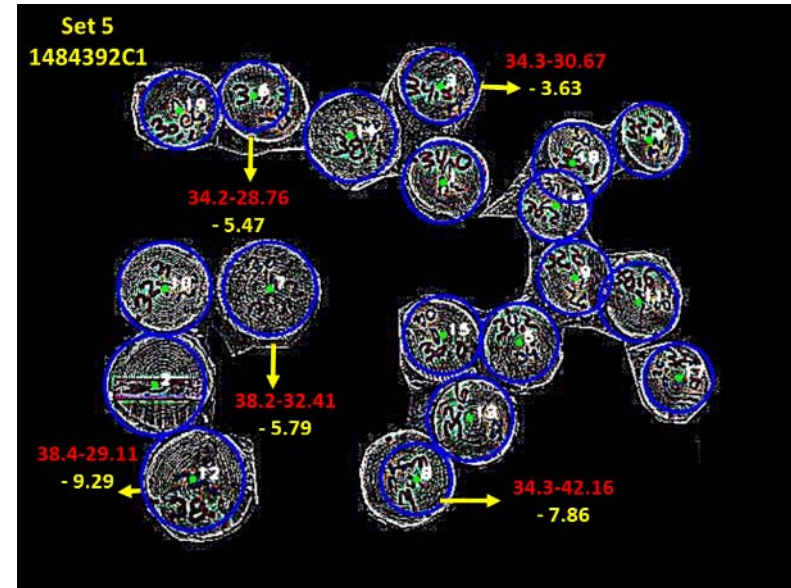
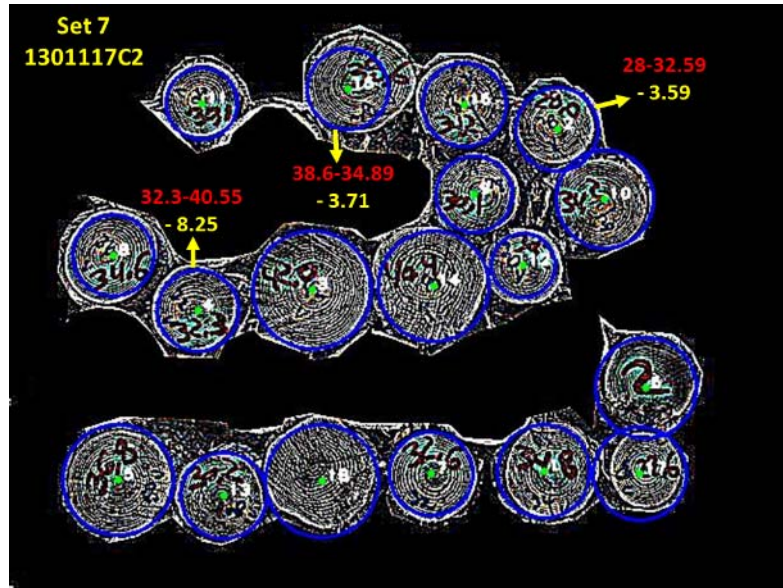
# Results

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

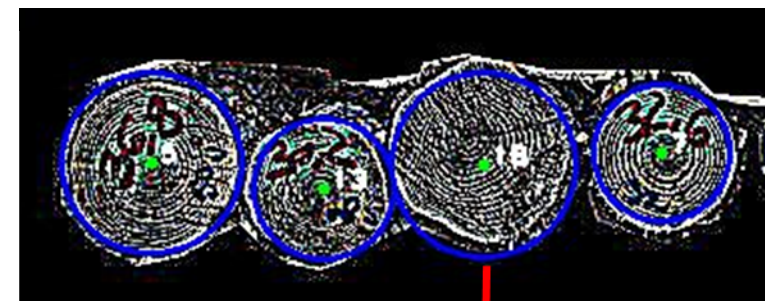




# Results

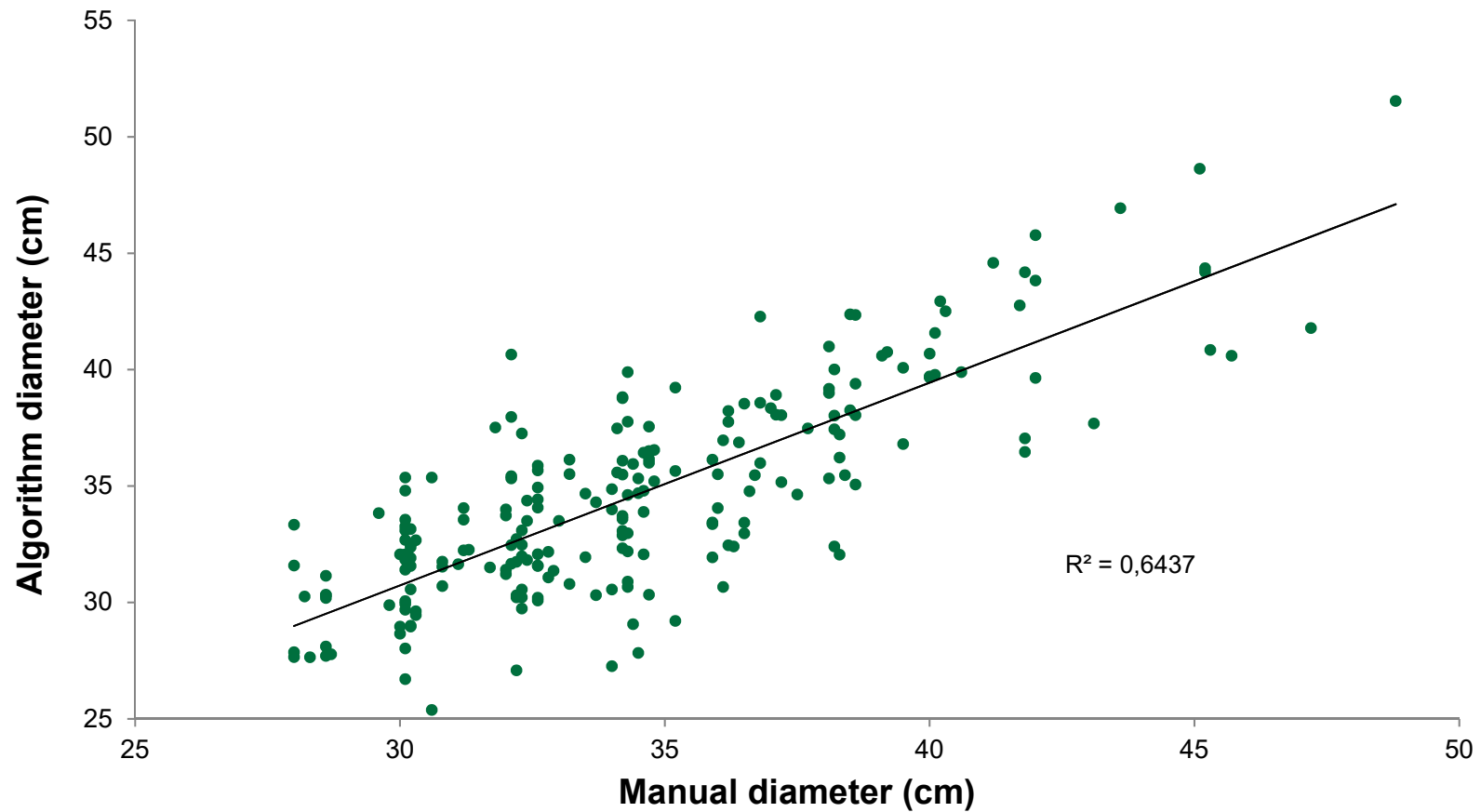


**Manual – Software**  
**34.2 cm - 28.76 cm = 5.47 cm**



**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

## Measuring stacked piles and logs on forwarders

```
C:\QT5.4-2\Tools\QtCreator\bin\qtcrea... - □ ×  
***** VIDEOINPUT LIBRARY - 0.1995 - TFW07 *****  
center : [66, 118]  
radius : 14  
center : [306, 190]  
radius : 17  
center : [477, 154]  
radius : 15  
center : [238, 210]  
radius : 20  
center : [98, 138]  
radius : 21  
center : [533, 110]  
radius : 17  
center : [461, 122]  
radius : 21  
center : [553, 74]  
radius : 21  
center : [557, 186]  
radius : 22  
center : [425, 94]  
radius : 18
```



# Summary

- 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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