UNIVERSITY OF BORDEAUX

Automatic morphology: landmarks estimation in biological images

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Contents

LaBRI

LaBRI

LaBRI[a] is a research unit associated with the CNRS, the University of Bordeaux and the Bordeaux INP.

Missions: research, technology application and transfer and training.

[a] **http://www.labri.fr/**

Staffs

- 150 teaching/research staff
- 22 administrative and technical
- More than 140 doctoral student and post-docs.

Introduction

- A collaborative project between LaBRI and INRA Rennes
- Objectives: tracking, collecting and classifying the insects based on morphometry.
- Programming of automatic identification of landmarks in biological images:
  - Cross-correlation
  - Implementation based on article *"Automatic identification of landmarks in digital images"* [1]

[1] **Palaniswamy, Sasirekha, Neil A. Thacker, and Christian Peter Klingenberg. "Automatic identification of landmarks in digital images." IET Computer Vision 4.4 (2010): 247-260.**

Cross-Correlation method

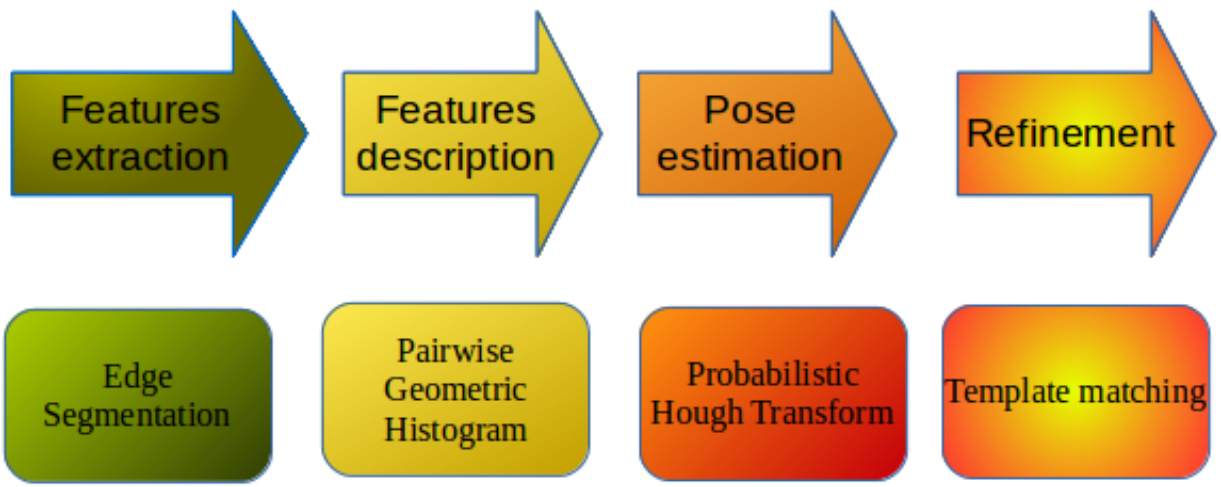
- Estimate the presentation of a template in an image.
- Formula:

$$R_{ccorr}(x, y) = \sum_{x', y'} [T(x'.y').I(x + x', y + y')] \quad (1)$$

  - **T**: template, (x', y') is coordinate in template
  - **I**: image, $(x + x', y + y')$ is coordinate on image, where we get the value to compute while template T sliding.

Edge extraction method

- The implementation based on ”**Automatic identification of landmarks in digital images**”, *Palaniswamy, Sasirekha, Neil A. Thacker, and Christian Peter Klingenberg*
- It includes four steps:



Method - Edge segmentation

Purpose:

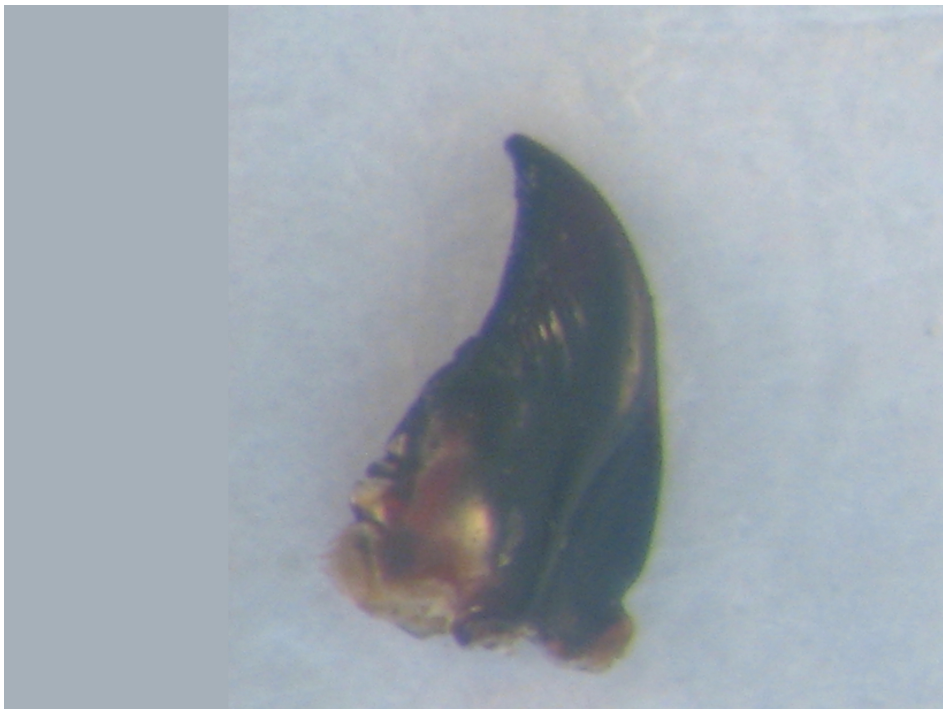
- Extract the features (edge) from images
- Get the approximate segment lines

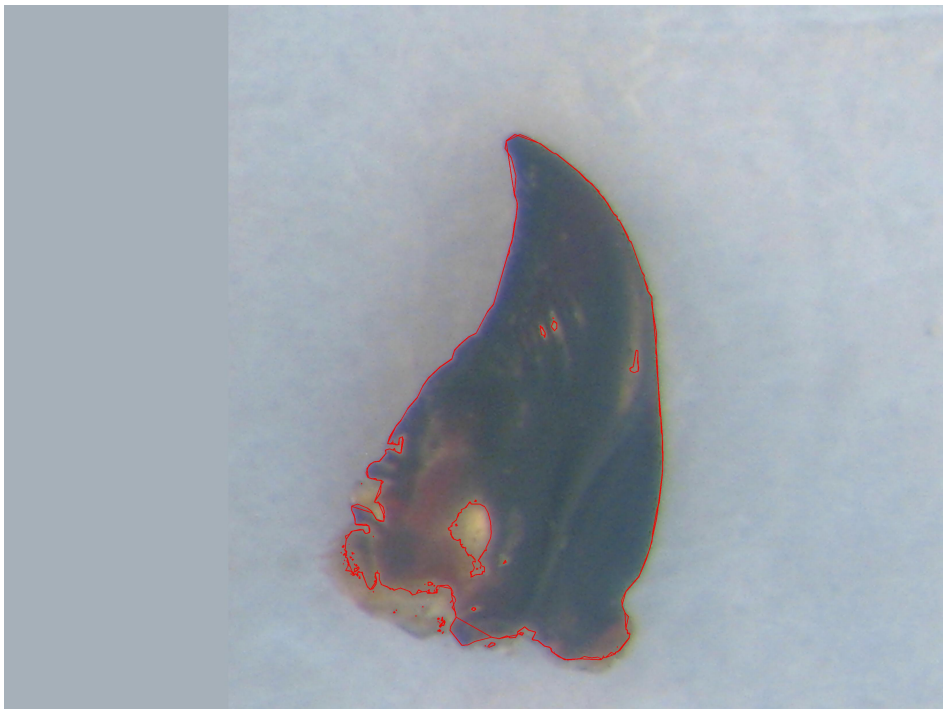
Method:

- Indicate the threshold value by analysis histogram of image
- Canny algorithm
- Break edge algorithm[2]

[2] **Thacker, Neil A., P. A. Riocreux, and R. B. Yates.** ***"Assessing the completeness properties of pairwise geometric histograms."*** **Image and Vision Computing 13.5 (1995): 423-429.**

Method - Edge segmentation





Method - Pairwise geometric histogram

Purpose: detecting the present of scene image in model image

Method[3]:
- Construct the **local PGH** for each line
- Construct the **shape PGH**, it is a set of local PGH
- Matching shape's PGH by Bhattacharyya metric

PGH information: angle between two lines and perpendicular distance from two endpoints of scene line to reference line.

[3] **Thacker, Neil A., P. A. Riocreux, and R. B. Yates.** ***"Assessing the completeness properties of pairwise geometric histograms."*** **Image and Vision Computing 13.5 (1995): 423-429.**

Method - Probabilistic Hough Transform

Purpose:

- Determine the presence and location of model image in scene image
- Estimate the landmarks in the scene image

Method:

- Build the reference table
- Find the pair of scene lines have the best “vote” with pair of model lines
- Estimate the “reference point” in scene image
- Estimate the landmarks

Method - PHT parameters (Building the reference table)

1. Choose an arbitrary **reference point**
2. Compute the **perpendicular distance and angle** from each closet pair of model lines to *reference point*.

Example:

Pair lines	space 1	space 2
(l1,l2)	(30;110.33)	(23.5; 855)
(l1,l3)	(15; 121.5)	(5.5; 200)

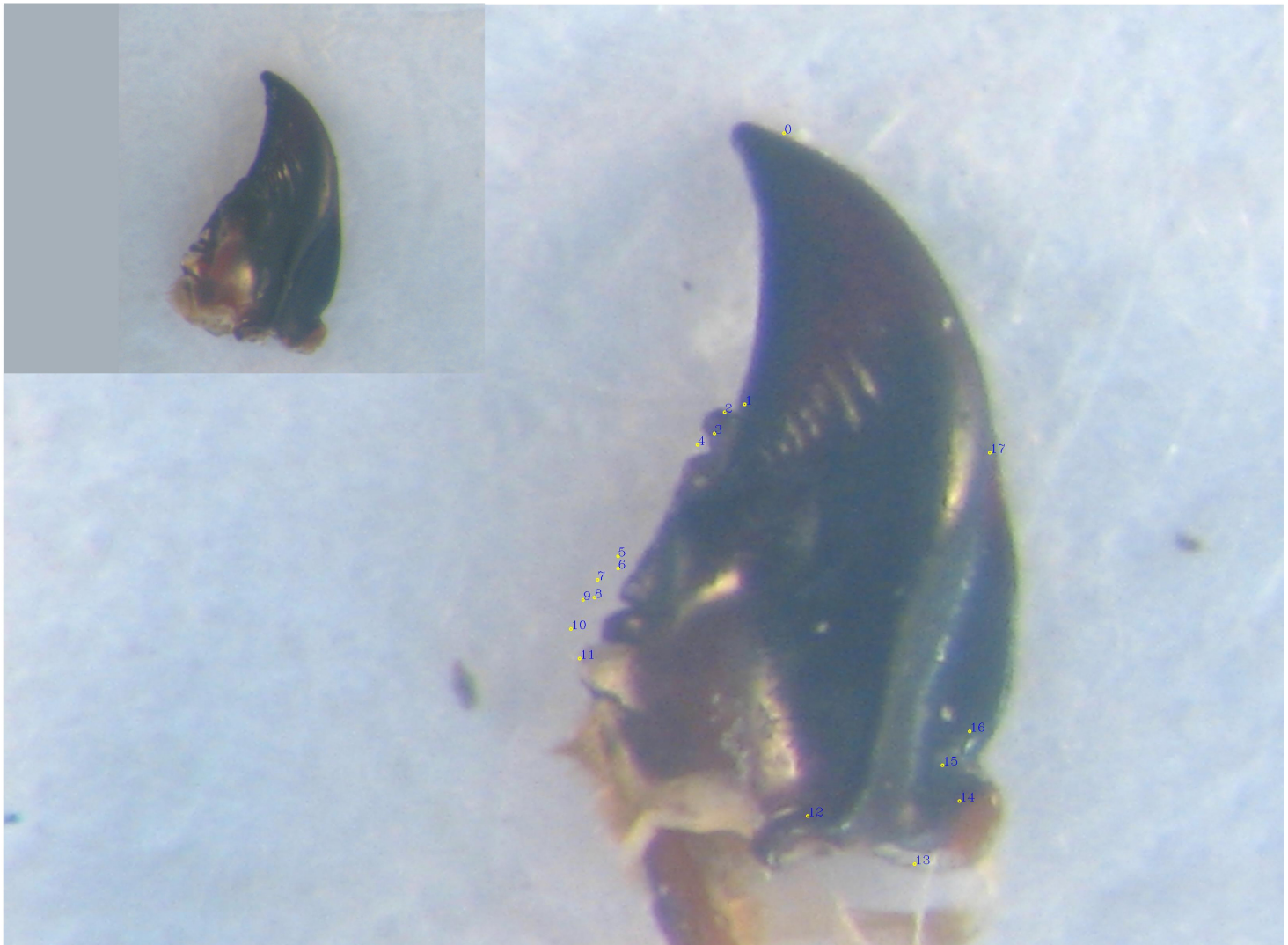
Method - PHT Parameters (Estimate the reference point in scene image)

The process to find the best vote are followed:

- Create an accumulator
- Find the pair of model line reasonable agreement about the **position, orientation and scale** and have the best “vote”
- Estimate the reference point in scene image[4]

[4] **Ashbrook, Anthony, et al. “Robust Recognition of Scaled Shapes Using Pairwise Geometric Histograms.” BMVC. Vol. 95. 1995.**

Method - Probabilistic Hough Transform



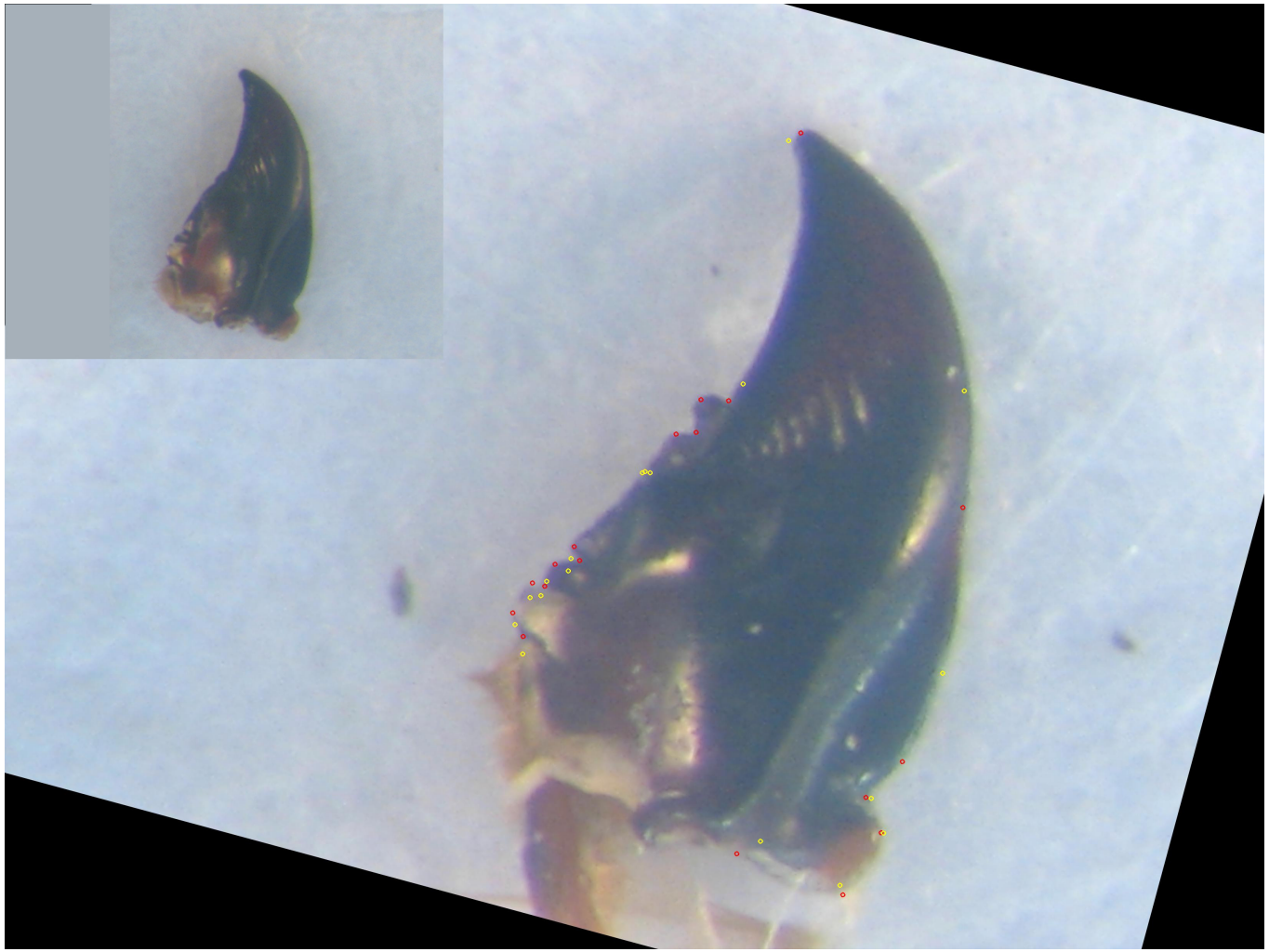
Method - Template matching

Purpose: Refine the estimated landmarks on the scene image

Method:

- Create a box around each model landmarks on model image
- Rotate scene image to match with model
- Create a box around each estimated landmarks on scene image
- Using Cross-Correlation to refine the estimated landmarks

Method - Template matching



Result

Dataset includes 2 set of image ().

Each set contains 291 biological images.

1. Intel(R) Core(TM) 2 Duo CPU T8100 2.1GHz, 2 GB of RAM

No Of images	Segmentation(second)	Estimation(second)
1	0.844	31.4245
290	571.576	13000.9131

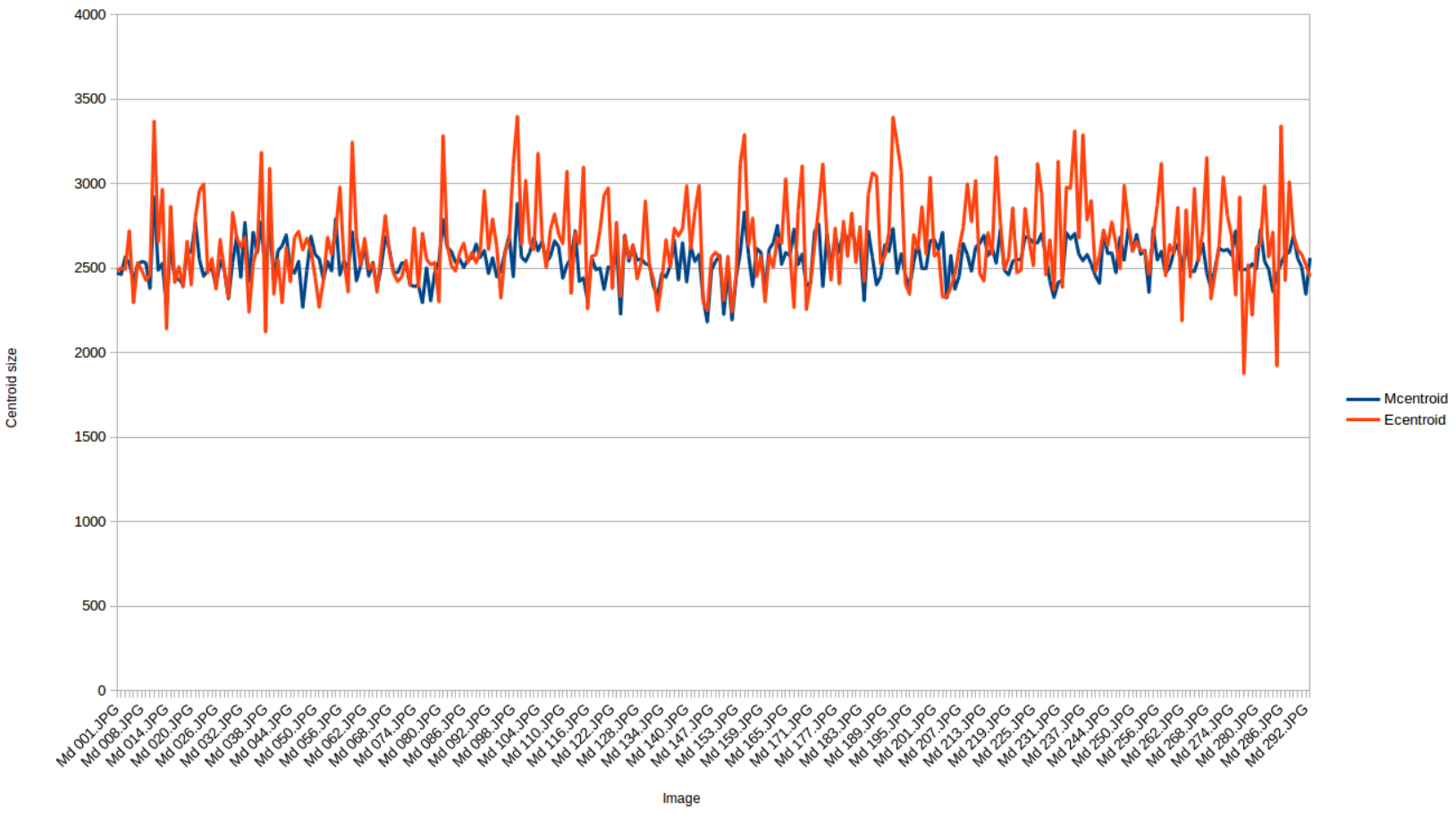
2. Intel(R) Core(TM) i7-4790 CPU 3.6GHz, 16 GB of RAM.

No Of images	Segmentation(second)	Estimation(second)
1	0.27782	10.4392
286	171.589	4665.79

Result

- Dataset: *290* images of right mandible and *286* images of left mandible.
- Landmarks are extracted: 18 landmarks for each *right mandible* and 16 landmarks for each *left mandible*.

Result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1500
1000
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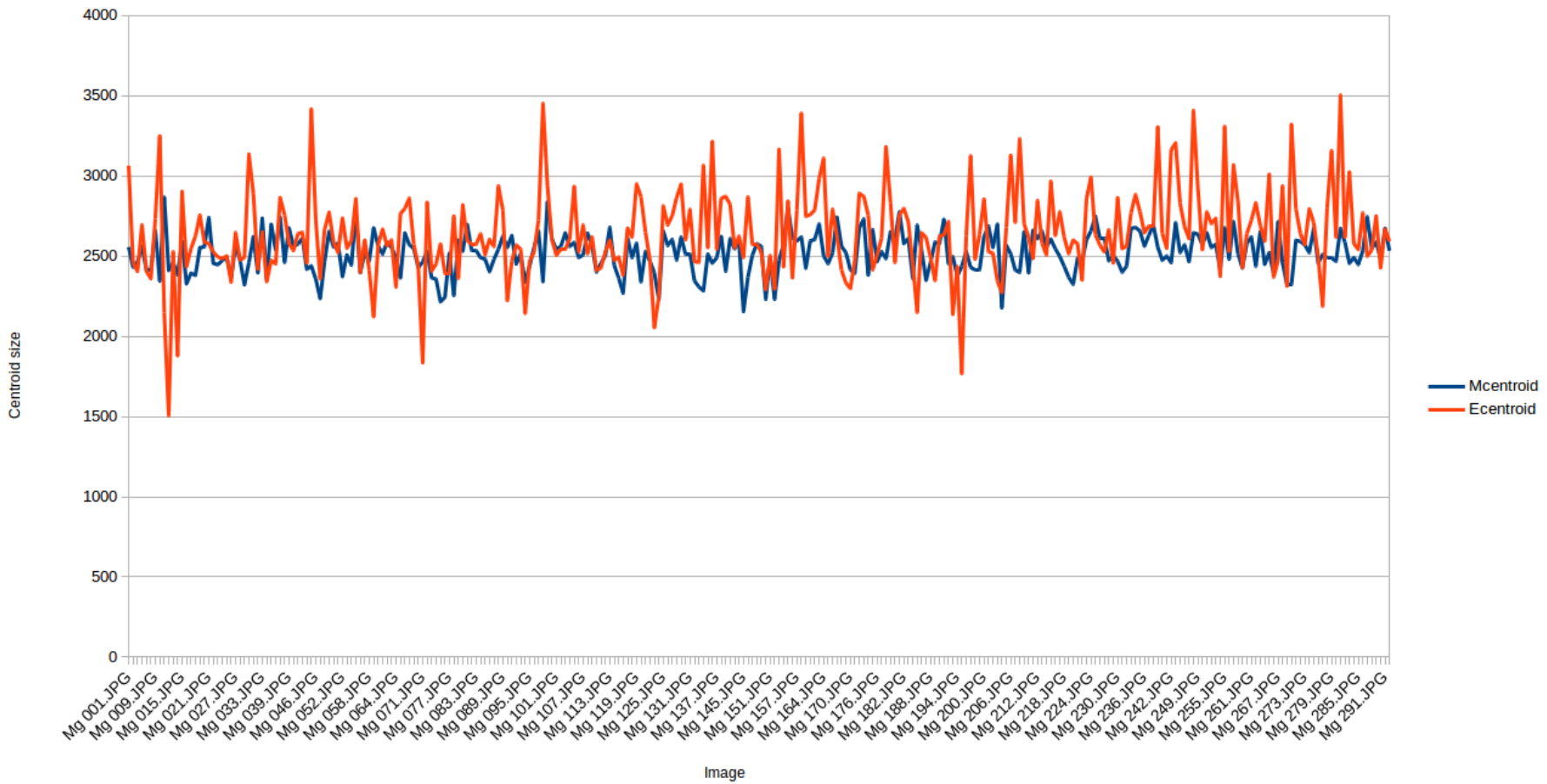
0
Centroid size
Image
Mcentroid
Ecentroid

Result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Centroid size
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Conclusion and future works

Conclusion:

- This method *(proposed by the article)* can be used to identify the landmarks. But, in some cases, the estimated landmarks are not close with manual landmarks.
- Method includes 4 steps. The result of each step can effect to next step.

Future works:

- Optimize the program based on each process
- Apply the method on other datasets: *elytre, head or pronotum*

Thank you !