MAELab: a framework to automatize landmark estimation

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Context

How to characterize the information at the macro level of animal?

- Directly on their body: width, length, diameter, **landmarks**, ...
- Via the pictures with **image processing** techniques: contours, histogram analysis, ...

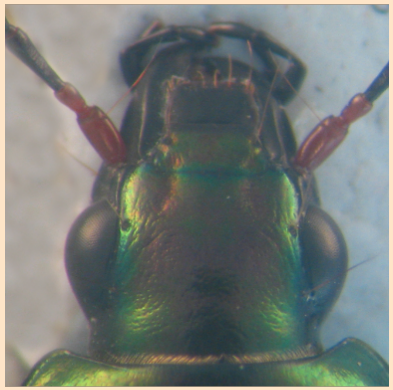
Landmark

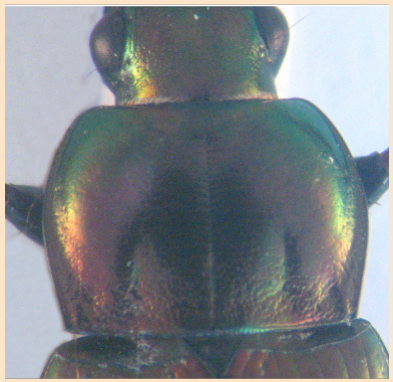
- A kind of **point of interest**.
- Point defined by biologist.
- For examples: the tip of mandible, the outer corner of the wings, ...

Collection of 293 Beetle images

Dataset

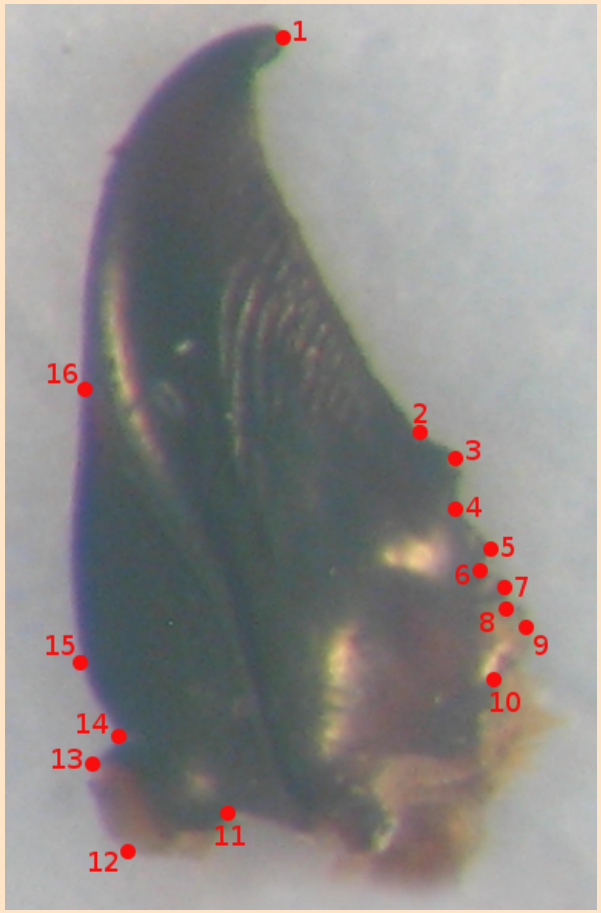
- Two dimensions and color images.
- Five images by animal: head, pronotum, wing, left and right mandibles.
- Focus on left and right mandibles.

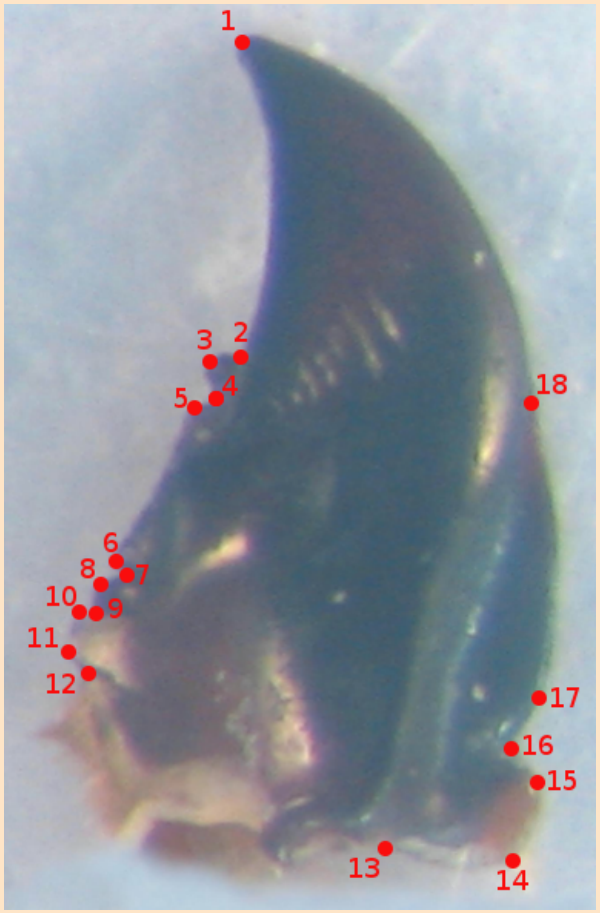




Collection of 293 Beetle images

How to locate automatically the landmarks?

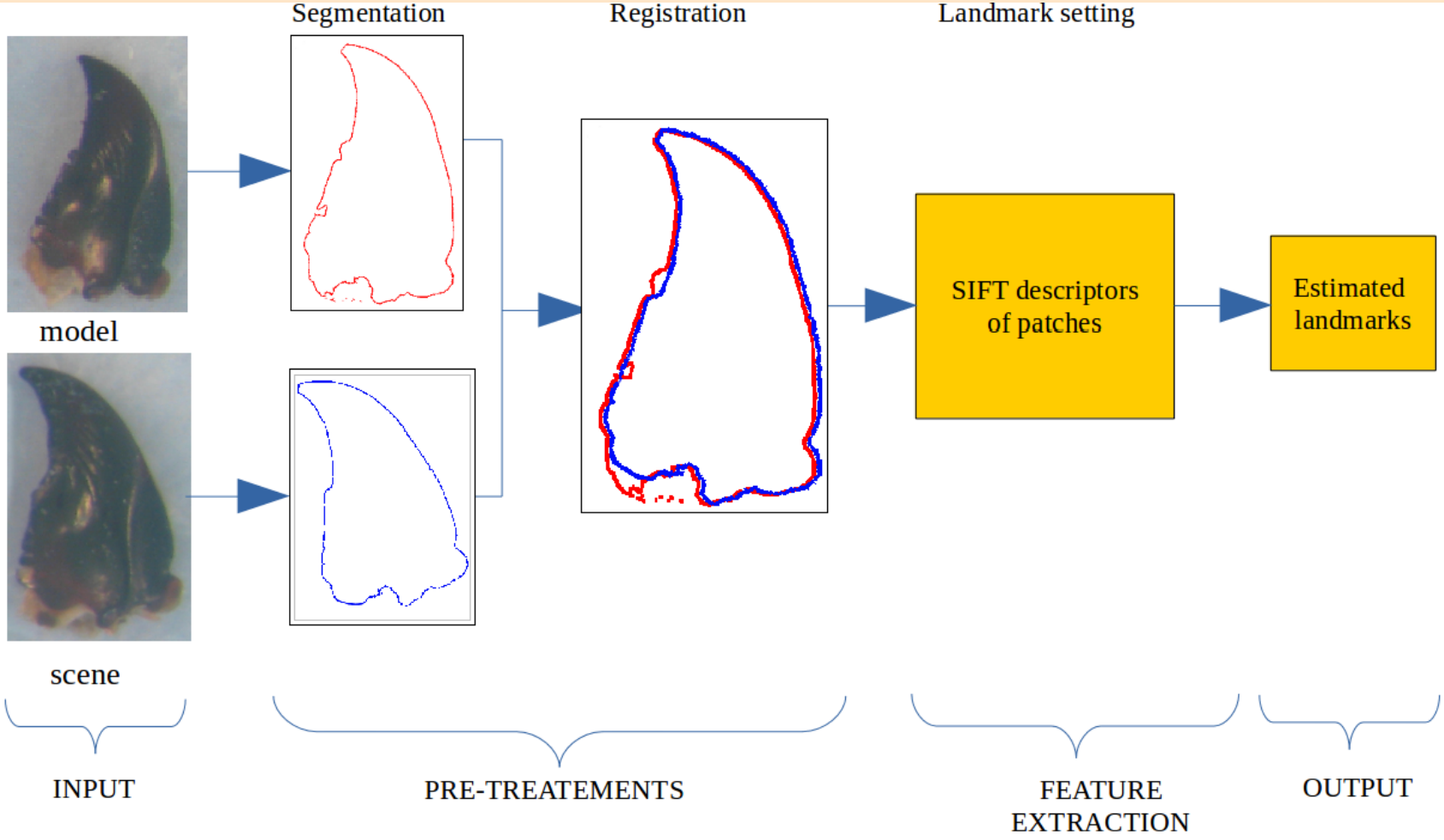




Plan

1. Introduction: overview about the method
2. Method: segmentation, registration, SIFT descriptor of patches
3. Result: final result and evaluation
4. Conclusion and future works

Overview about the method



Segmentation

Algorithm

- Contours as list of points: Canny algorithm[1].
- Threshold ratio: $T_{lower} = (1/3) \times T_{upper}$.
- Threshold value (T_{lower}): determined by analysing histogram.

[1] John Canny, *A computational approach to edge detection*, Pattern Analysis and Machine Intelligence, IEEE Transactions on (6):679698, 1986.

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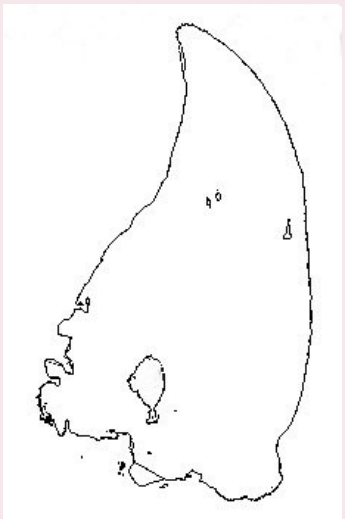
Result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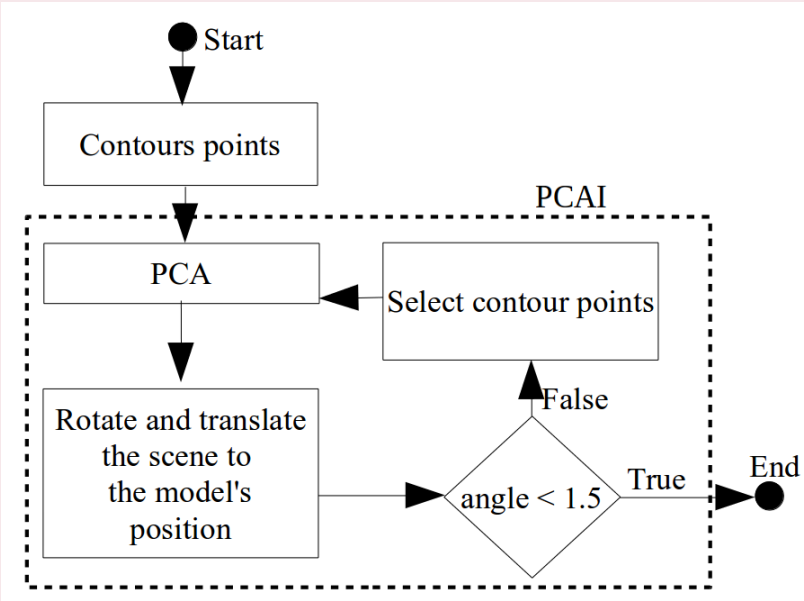
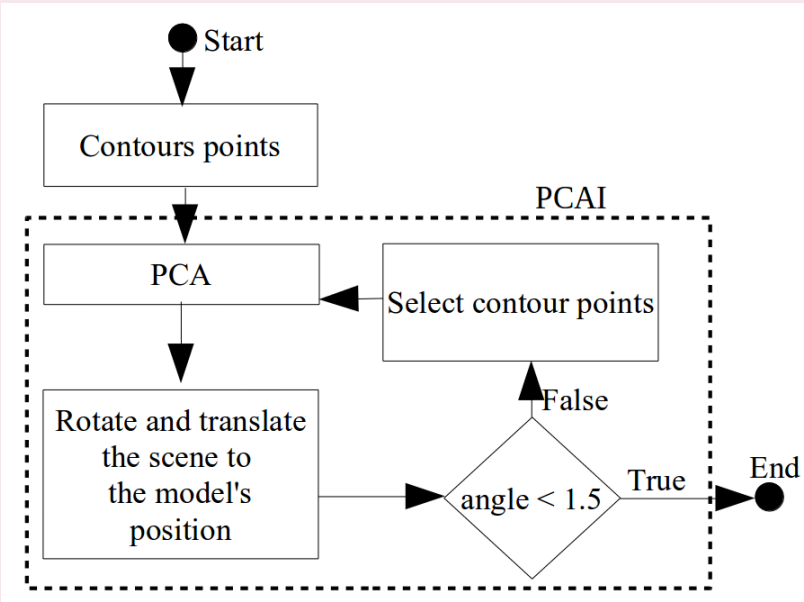
Registration

PCA Iteration

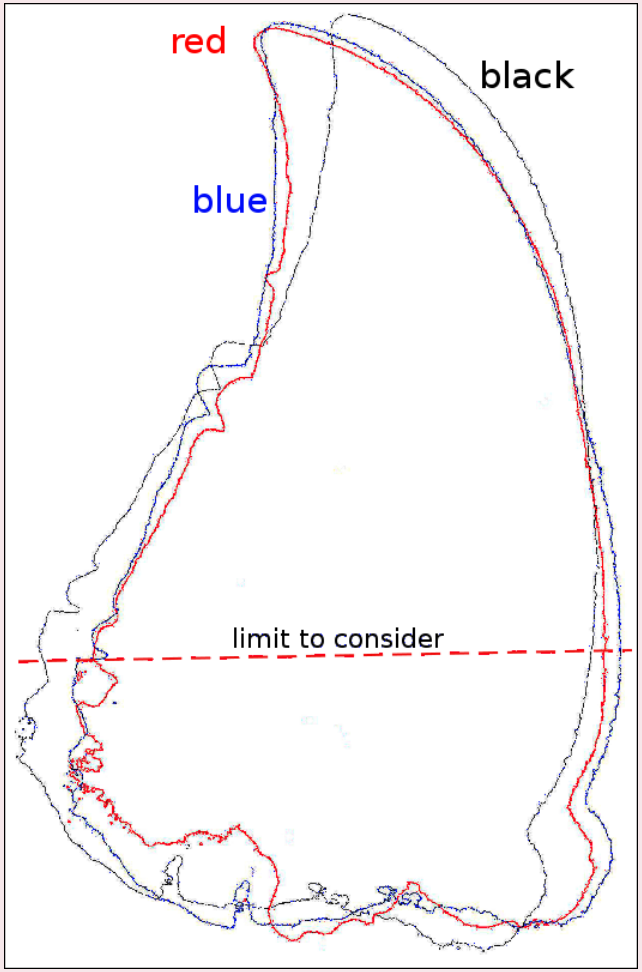


Registration

PCA Iteration



Result

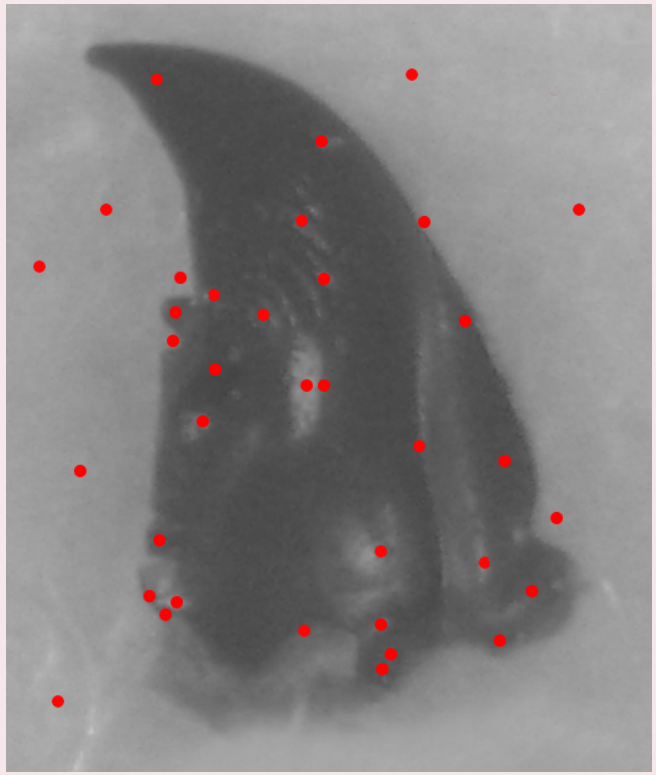


Landmark setting

SIFT descriptor

- Proposed by David G Lowe[2].
- Detect and describe local features in images.
- Many applications: object recognition, robotic mapping, points of interest,...

SIFT



[2] David G Lowe, *Distinctive image features from scale-invariant keypoints*, International journal of computer vision 60(2):91110, 2004

Landmark setting

Define the features of landmark

Define:

- A patch P_m for each model's landmark.
- A patch P_s at the same position.
- A patch P'_s for every pixels in P_s.

Compute:

- SIFT descriptor for P_m.
- SIFT descriptor for P'_s.
- Compute distance $L(P_m, P'_s)$.

Keep the pixel that has the minimum distance.

Illustration

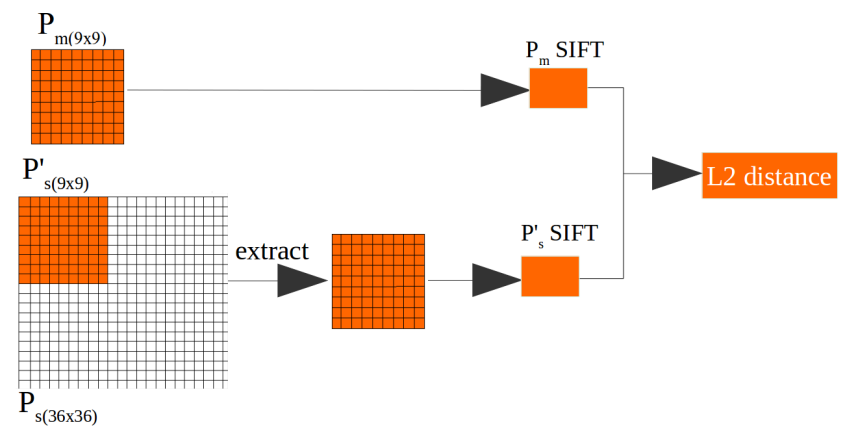


Illustration of SIFT computing.

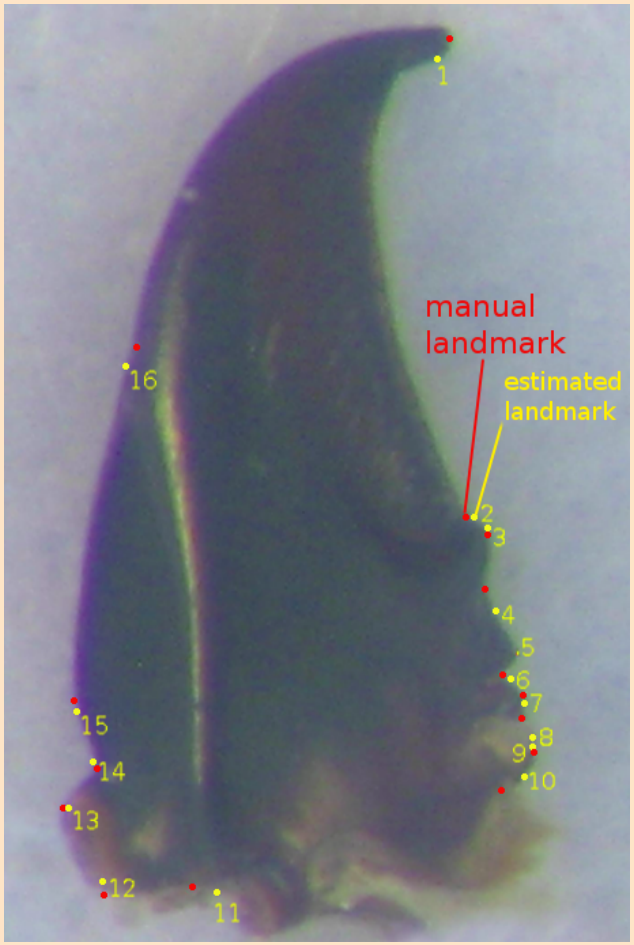
MAELab

- Library[3].
- Graphic user interface.

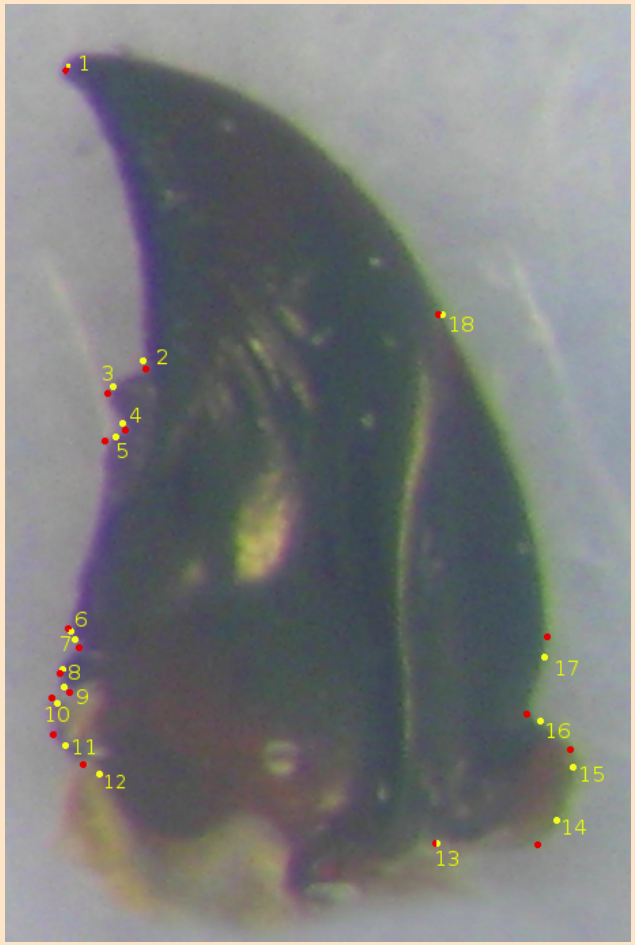
[3] https://github.com/linhlevandlu/MAELab.git

Landmarks position

model



scene



scene

model

Red: manual landmarks. **Yellow**: estimated landmarks

Evaluation

Statistic

- Calculate the distance between the estimated landmark p and corresponding manual landmark q

  .

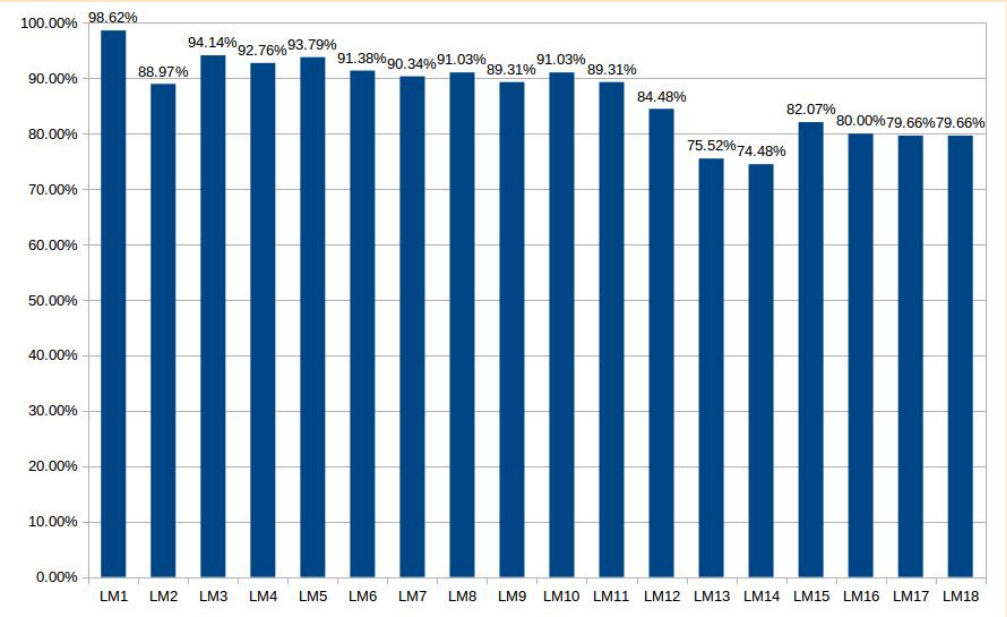
$$d(p,q) = \sqrt{(p_x - q_x)^2 + (p_y - q_y)^2}$$

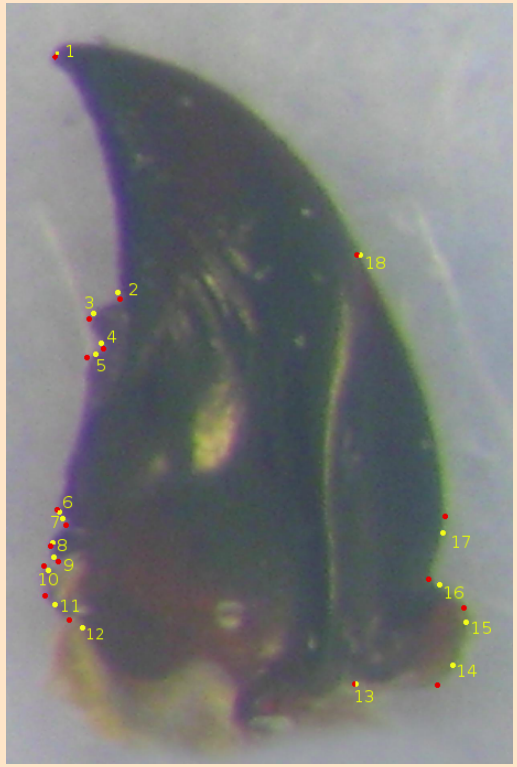
- The statistic is done on all images with a standard deviation error.

Statistic on right mandible

Summary

- Highest accuracy: 1^{st} landmark with 98.62%.
- Lowest accuracy: $13^{th}, 14^{th}$ landmark with app. 75%.

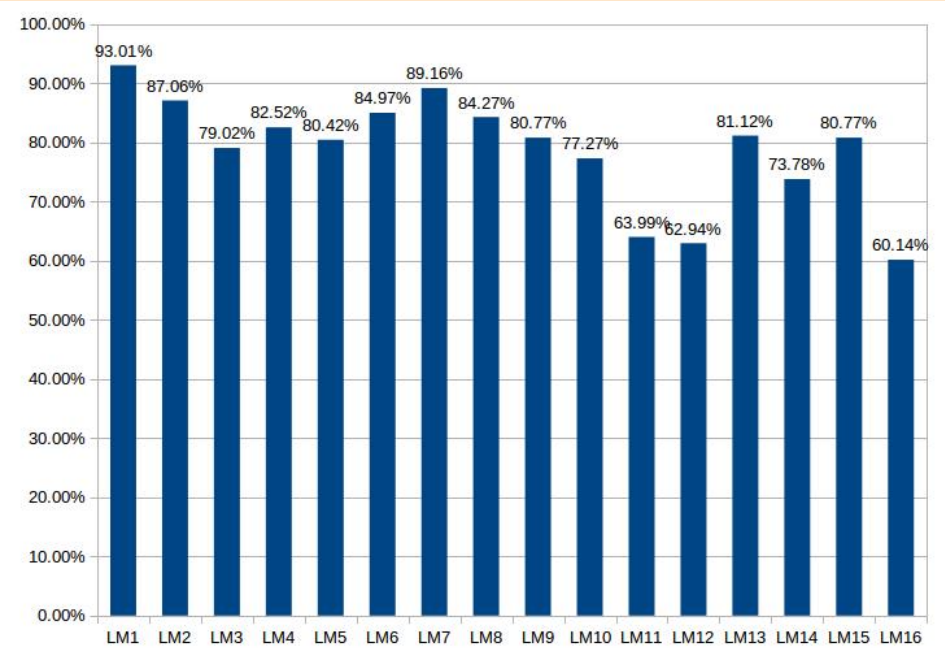


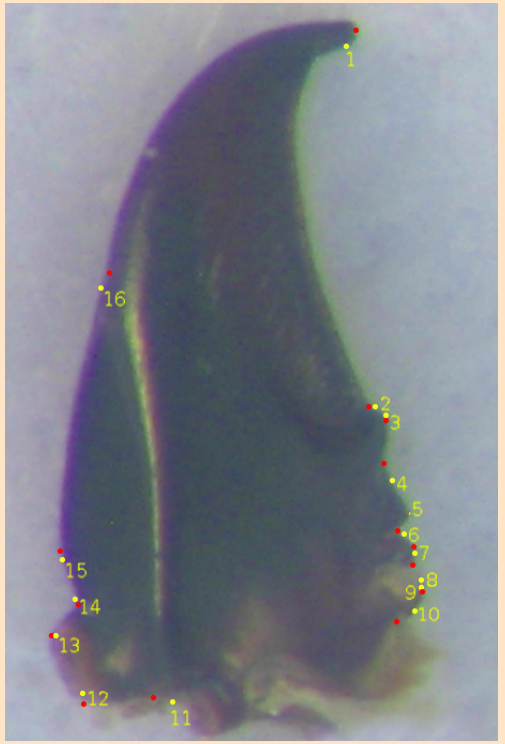


Statistic on left mandible

Summary

- Highest accuracy: 1^{st} landmark with 93.01%.
- Lowest accuracy: $11^{th}, 12^{th}$ *and* 16^{th} landmark with 60.14%.

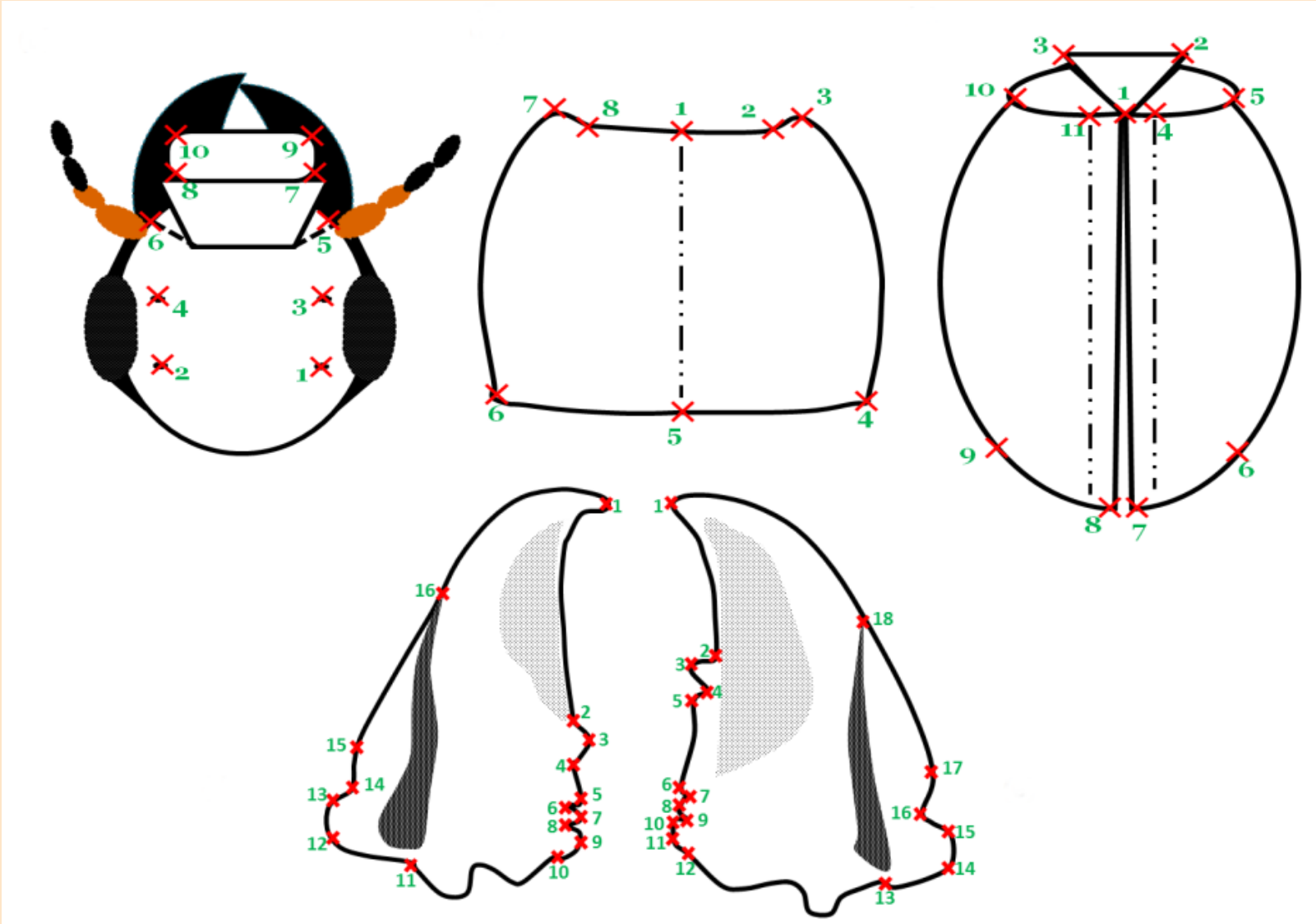




Conclusion

- Proposed method to determine landmarks automatically on beetle mandibles including: segmentation, registration and estimation.
- The location of the estimated landmarks are workable with high proportion.
- Perspective, when considering the centroid of the object, the result from method is very good.
- Method is useful for biologist. It solves the time-consuming problem during setting the landmarks.

Working with other parts



Thank you

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