SIFT descriptor to set landmark on biological images

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Context

- Morphometry analysis is a way to characterize the shape variations of the organisms,
- Morphometric characteristics have been used to evaluate the evolution of an organism or classification.
- ...

Manual landmarks

- Morphometric landmarks are points that are a kind of points of interest,
- Landmarks are along an image outline and contain a lot of important information,
- They are defined by the biologists.

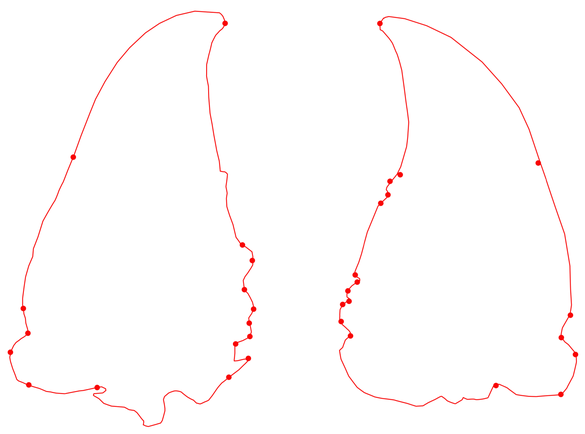


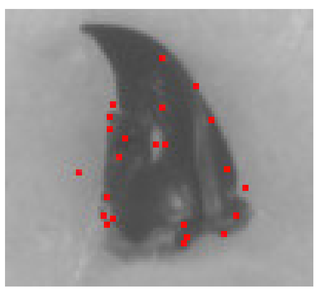
Fig. 2: The mandibles with manual landmarks

How to locate the landmarks automatically?

SIFT

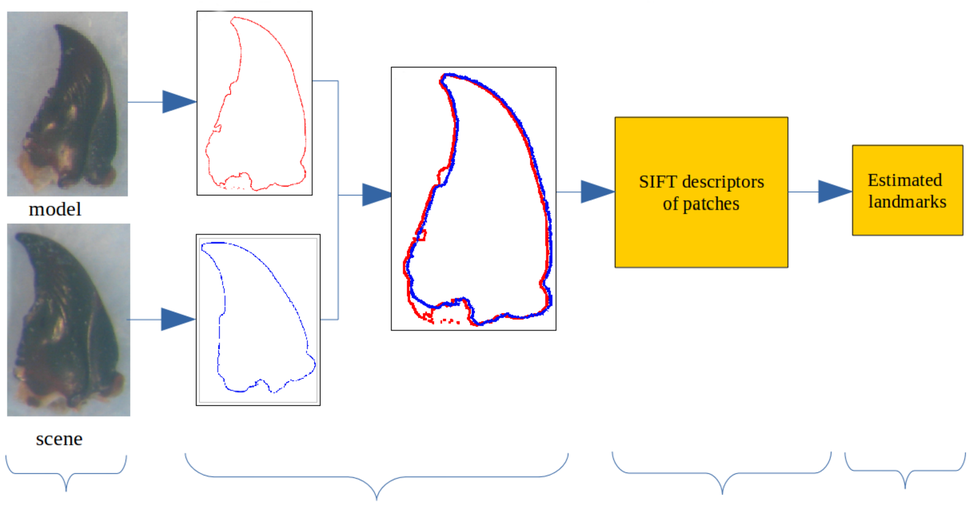
SIFT[4] is used to extract distinctive features from the images. It includes four steps:

- Scale-space extrema detection
- Keypoints localization
- Orientation assigment
- Keypoint descriptor



The original SIFT outputs many candidates for landmarks.
Solution: Limiting the searching space before computing the SIFT descriptors.

Proposed method



Segmentation

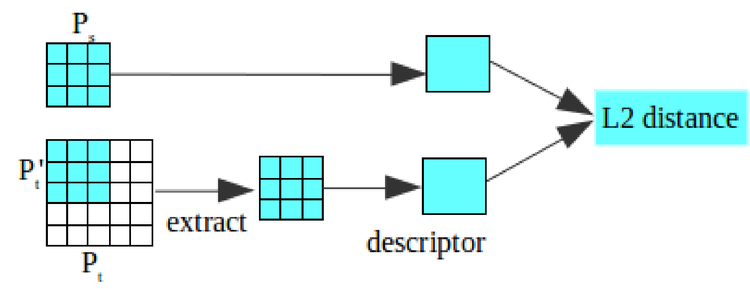
- Converting the image to binary by applying binary threshold. The threshold value is determined by analysing histogram[3].
- Contours points are extracted by Canny algorithm[1].
- The threshold ratio in Canny: $T_{lower} = (1/3) \times T_{upper}$

Registration

Two lists of contours points from segmentation step are registered by applying Principal Component Analysis[2] Iteration (PCAI).

1. Compute the centroid point and principal axis of contours.
2. Compute the transformation values between two images.
3. Register two images
4. Select a subset of contour points and repeat step 1.
5. PCAI stop automatically when the angle difference between two lists of contour points is less than 1.5 degree.

SIFT and landmarks



1. A patch P_m is initialized at each manual landmark of source image (size of 9×9),
2. Calculate the SIFT descriptor for P_m,
3. At the same position in target image, a patch P_s is created (size of 36×36),
4. For each pixel in P_s, a patch P'_s is extracted with the same size of P_m,
5. Calculate the SIFT descriptor for P'_s,
6. Compute the distance between the descriptor of P_m and each P'_m. Keep the pixel that have the minimum distance,
7. The process stops when all the pixels in P_s are considered.

Result

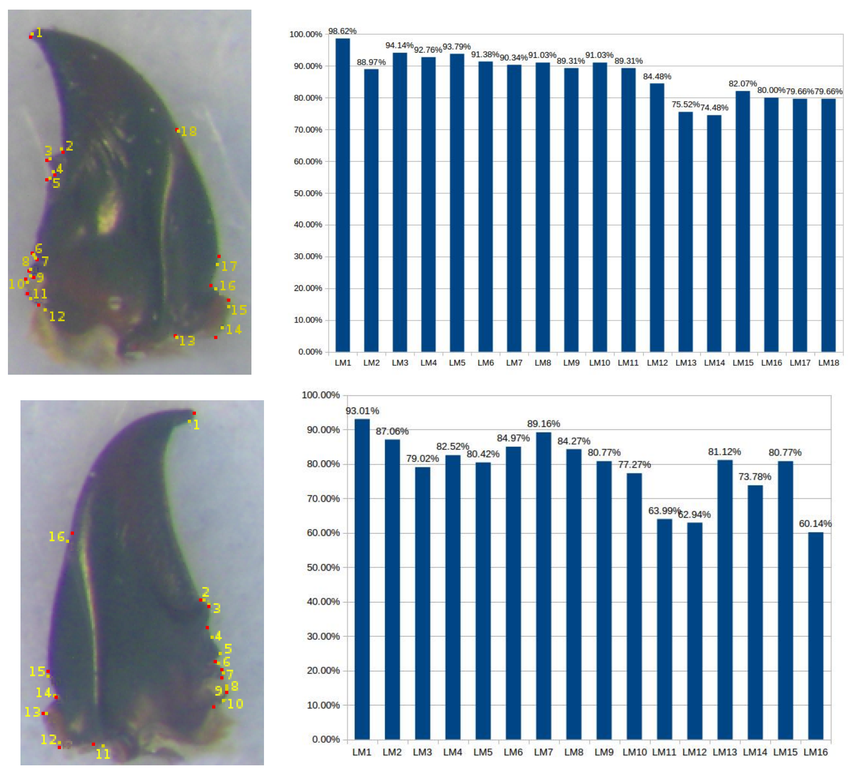


Fig. 8: The mandibles with manual landmarks

Bibliography

References

[1] John Canny. A computational approach to edge detection. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, (6):679–698, 1986.

[2] Ian Jolliffe. *Principal component analysis*. Wiley Online Library, 2002.

[3] L Lê Vãnh, M Beurton-Aimar, JP Salmon, A Marie, and N Parisey. Estimating landmarks on 2d images of beetle mandibles. *WSCG*, 2016.

[4] David G Lowe. Distinctive image features from scale-invariant keypoints. *International journal of computer vision*, 60(2):91–110, 2004.