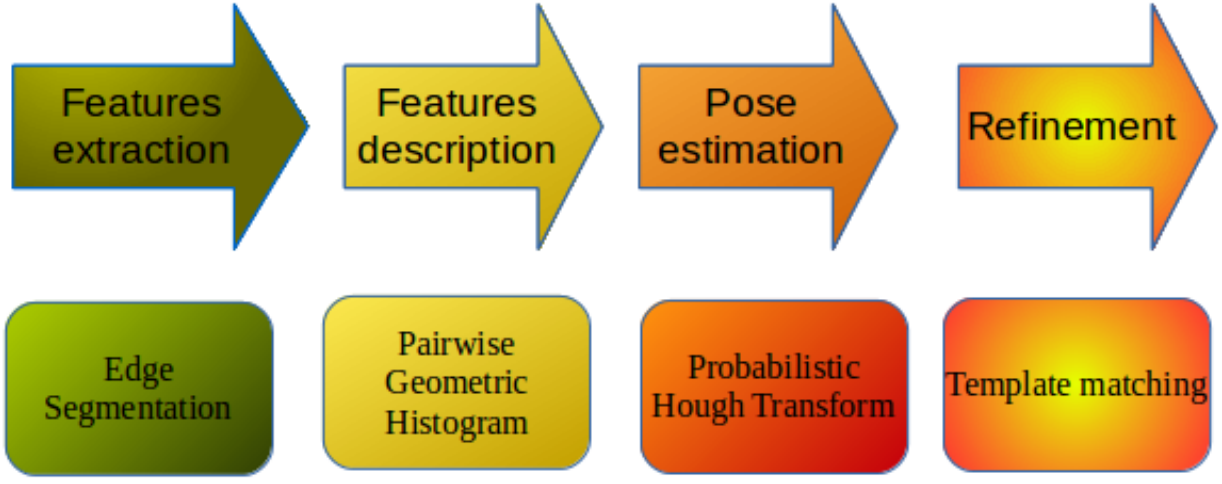
Automatic identification of landmarks by shape recognition

November 13, 2015

Introduction

- 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:

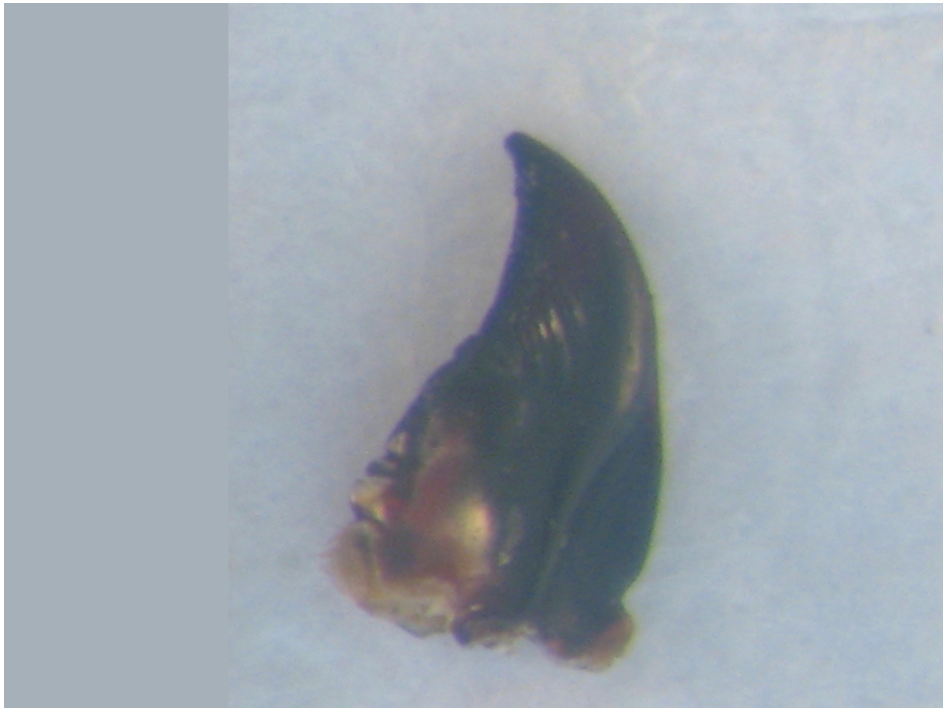
- Indicate the threshold value by analysis histogram of image
- Canny algorithm
- Break edge algorithm[1]

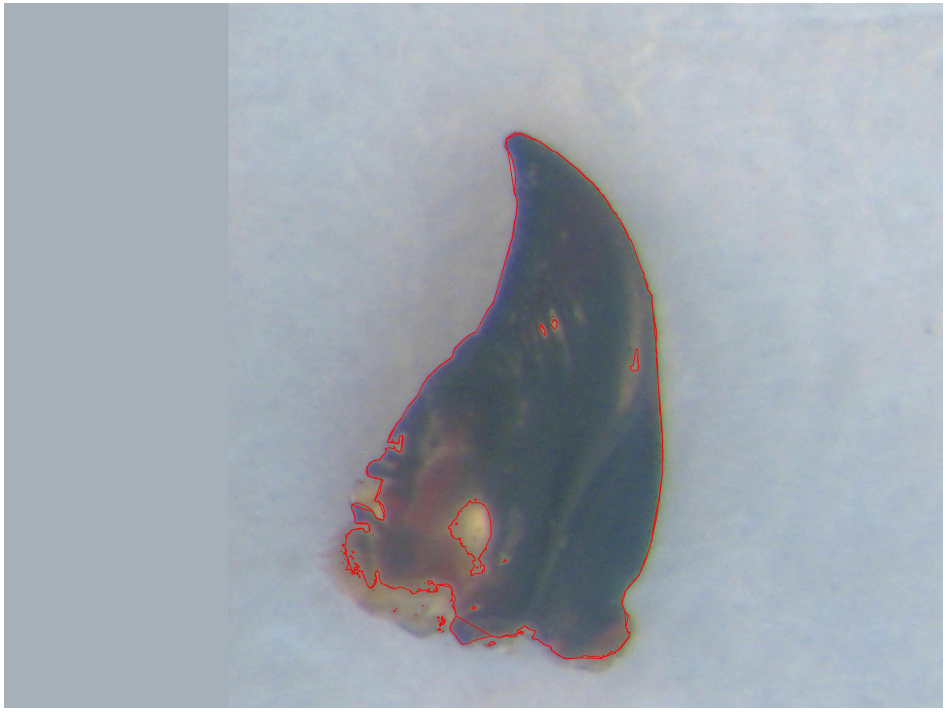
Parameters:

- Threshold value: indicated by histogram analysis
- Canny ratio: 1:3 (lower:upper)
- Minimum distance to stop break edge: 3 pixels

[1] 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[2]:

- 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.

Parameters : to build the PGH matrix (used to compute the metric)

- Rows: 90, 180, 360, 720 - presented for angle accuracy
- Columns: 250, 500, 1000 - presented for distance accuracy

[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 - 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

Result: Estimated model landmarks on scene image

Method - PHT parameters (Building the reference table)

For each **closet** pair of model lines, compute the perpendicular distance and angle from the line to **reference point** and save into table

Reference point: an arbitrary point in model image (in program, reference point is center point of model image)

Example:

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

Parameters:

- Minimum length of each line: 60 pixels
- Minimum angle between two lines: 15 degrees
- Distance from an endpoint of a line to another line: 5 pixels

Method - PHT Parameters (Find the best vote of scene)

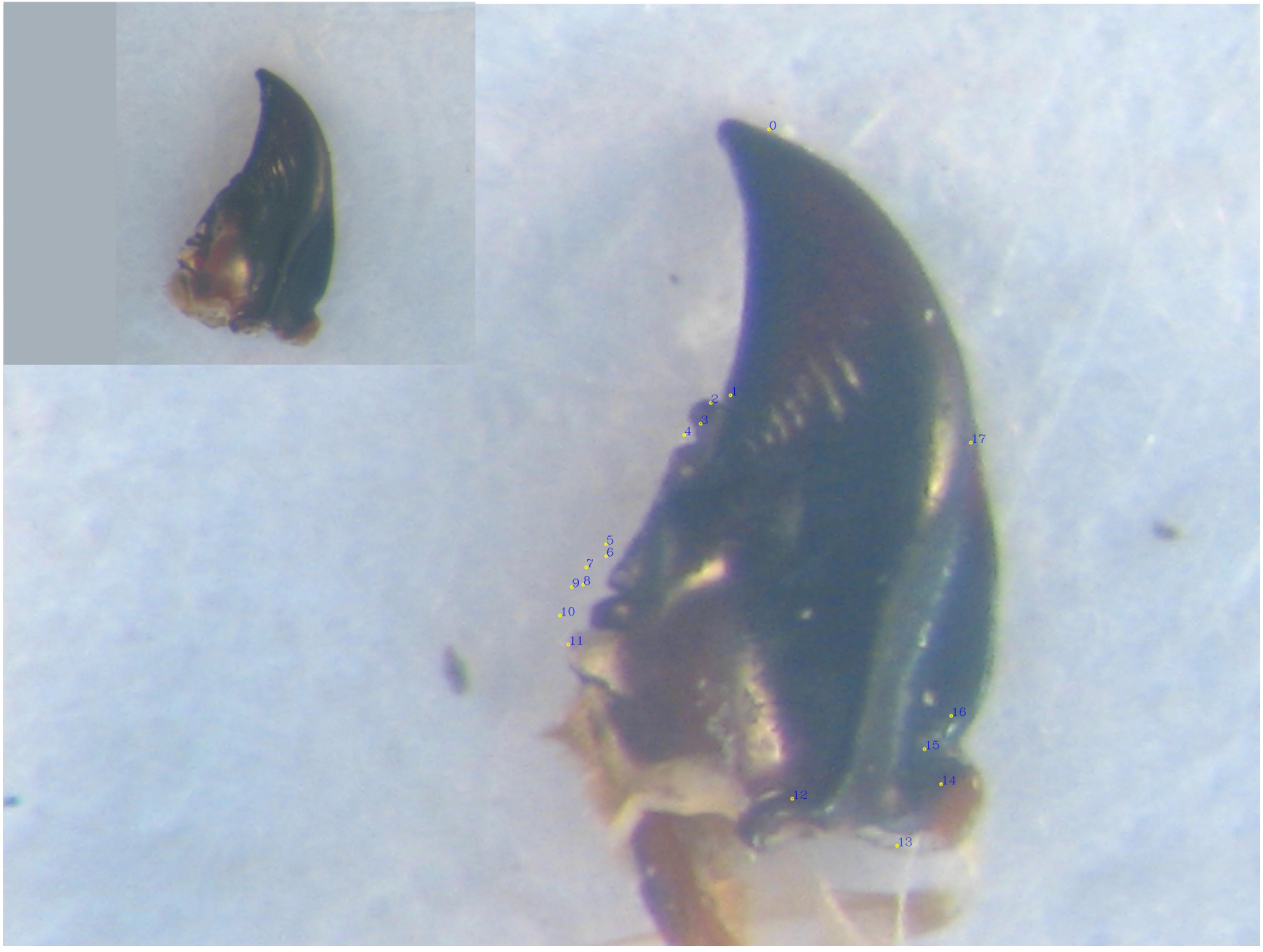
The process to find the best vote are followed:

- Create an accumulator
- For each **closet** pair of scene lines, find the pair of model line reasonable agreement about the **position, orientation and scale.** Get the information about angle and distance
- Increase the value in accumulator at relative position
- Keep the position where has the maximum value.
- Keep the pair of scene line and the entry in reference table

Parameters:

- Maximum difference angle: 1 degree
- Maximum difference scale: 1 pixel
- Maximum difference position: 2 pixels

Method - Probabilistic Hough Transform



Method - Template matching

Purpose: Refine the estimated landmarks on the scene image

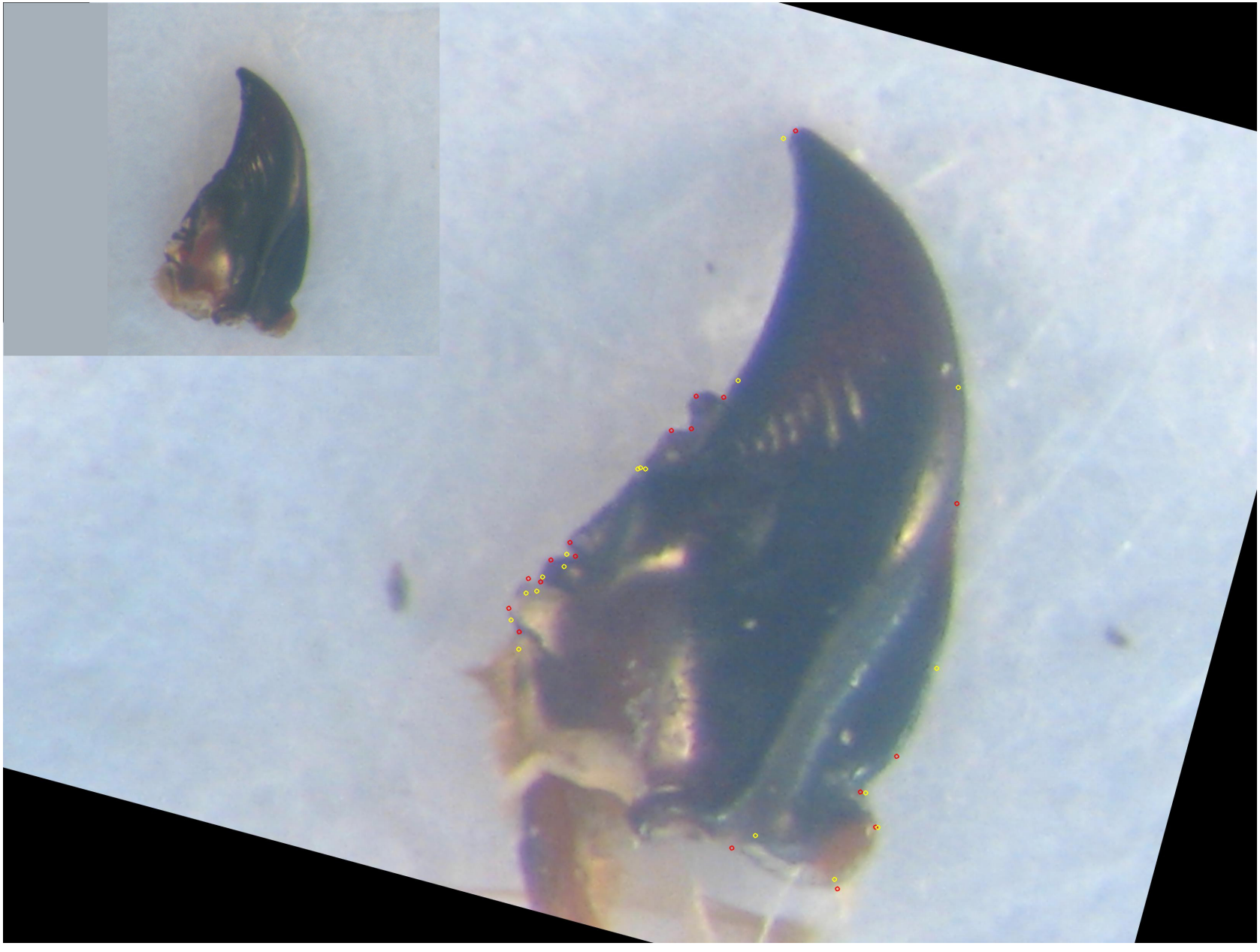
Method:

- On model image: For each landmark, create a bounding box with size "*t1*" and *landmark* is center point of box
- Rotate scene image to match with model
- On scene image: For each estimated landmark, create a bounding box with size "*t2*" and *landmark* is center point of box
- Sliding *t1* on *t2* and find the the best match (cross-correlation)

Parameters:

- Template box size: 400px (**EstTemplSize**)
- Image box size: 1400px (**EstImageSize**)

Method - Template matching



Result Examination:

Dataset includes 291 images.

1. Intel(R) Core(TM) 2 Duo CPU T8100 2.1GHz, 2 GB of RAM
   - Segmentation: 571.576 seconds
   - Estimate landmarks: 13000.9131 seconds
2. Intel(R) Core(TM) i7-4790 CPU 3.6GHz, 16 GB of RAM.
   - Segmentation: 171.589 seconds
   - Estimate landmarks: 4665.79 seconds

Result

- Dataset: *Mandibule droite* and *mandibule gauche*
- Method includes 4 steps. The result of each step can effect to next step.
- This method can be used to identify the landmarks. But, in some cases, the estimated landmarks are not close with manual landmarks.

Thank you !