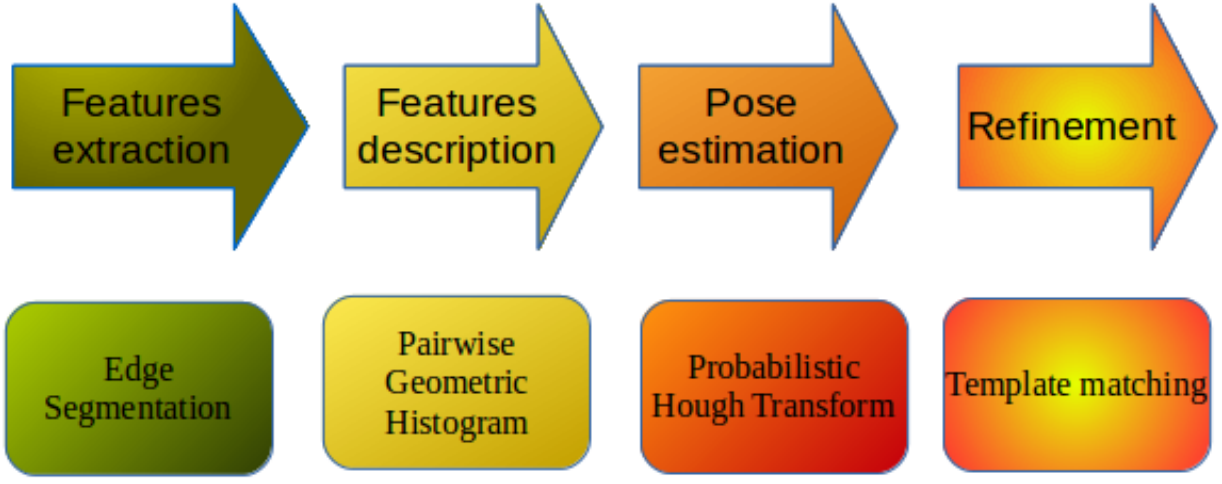
# Automatic identification of landmarks by shape recognition

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:

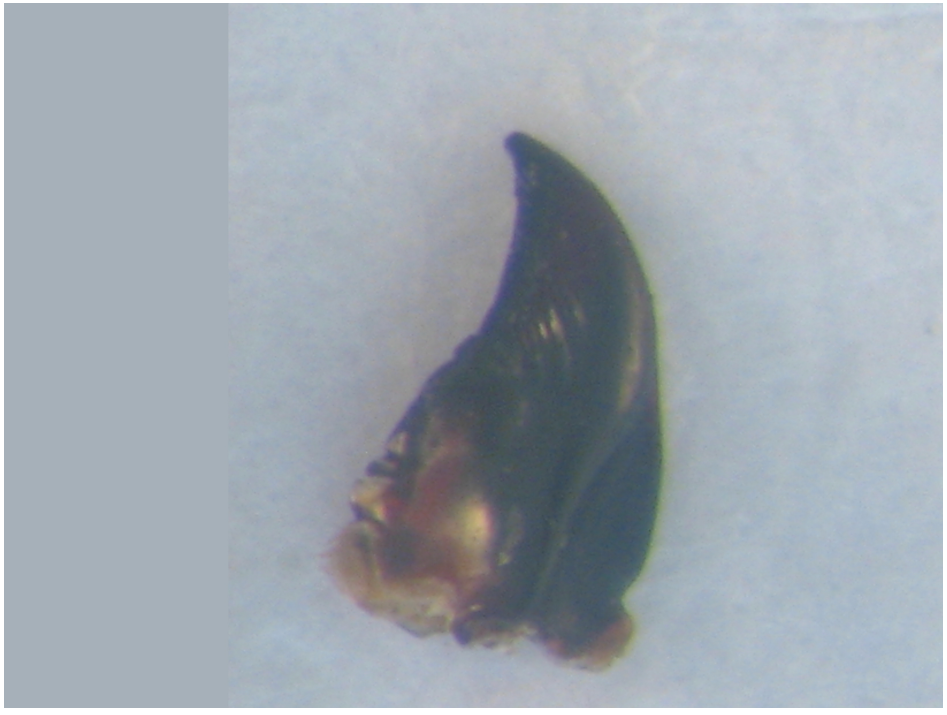
- Indicate the threshold value by analysis histogram of image
- Canny algorithm
- Break edge algorithm[1]

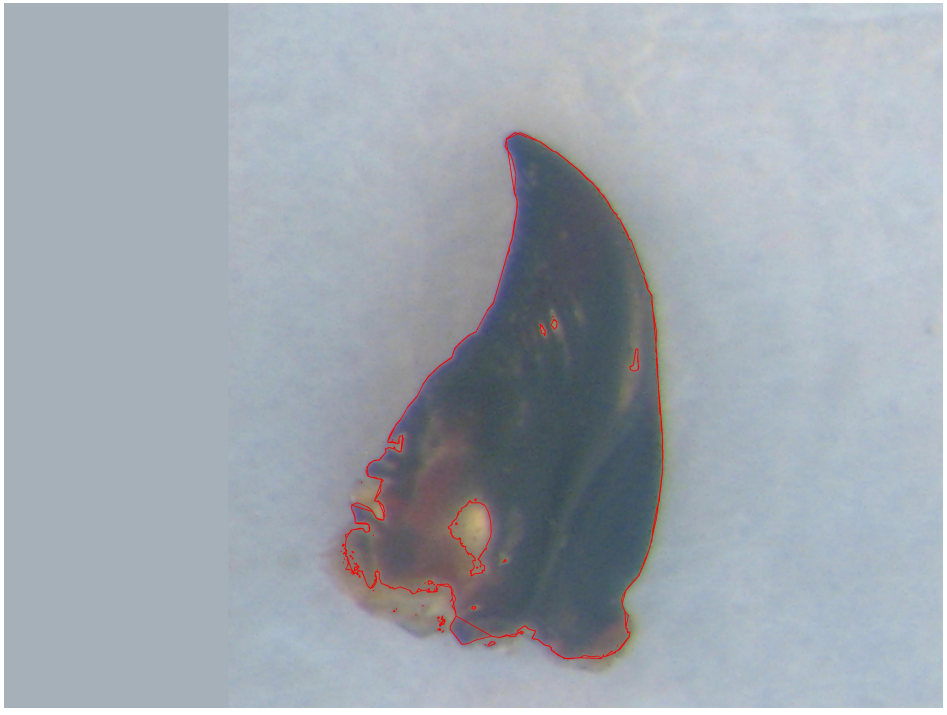
Parameters:

- 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

# 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)

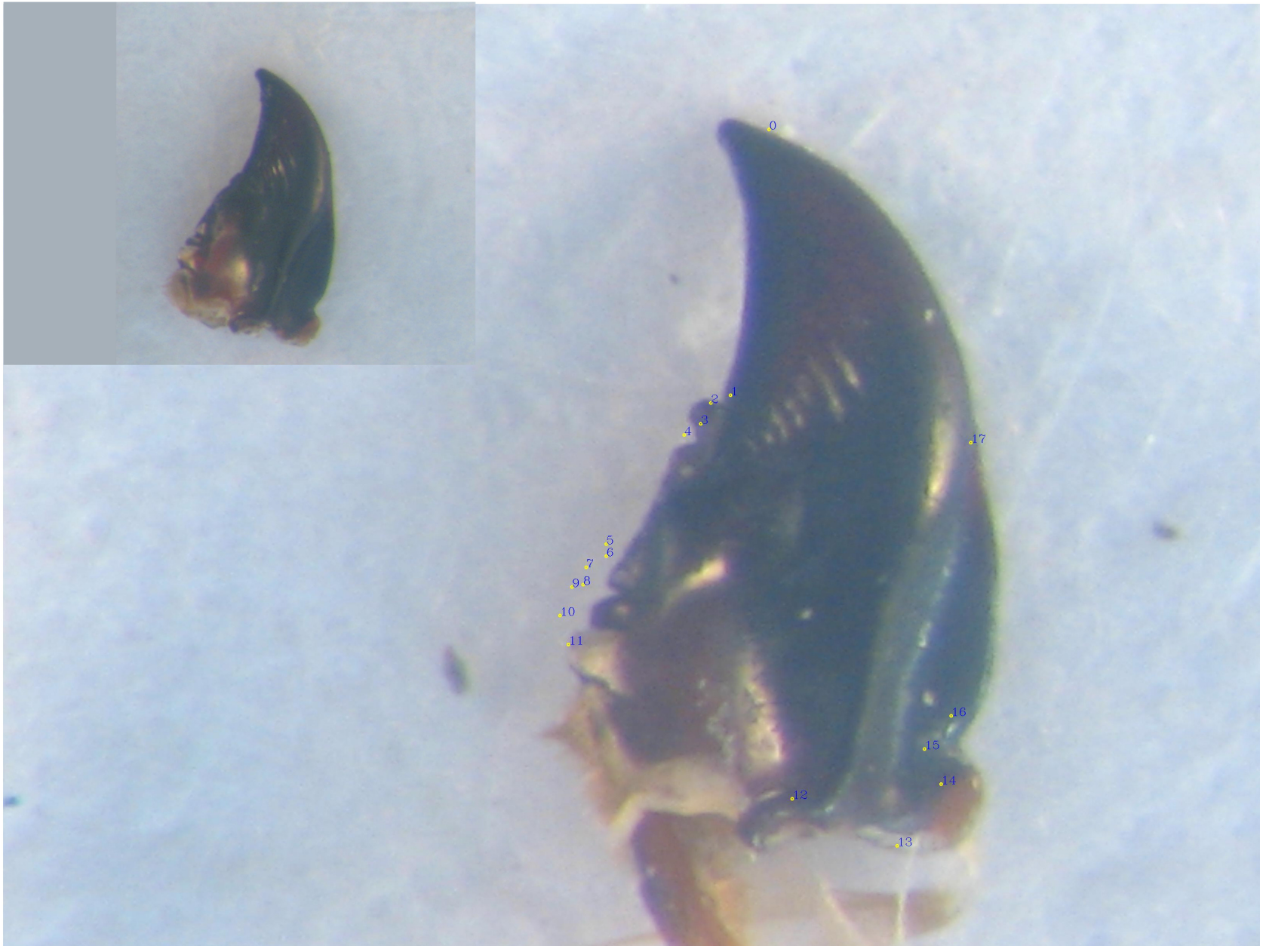
The process to find the best vote are followed:

- 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

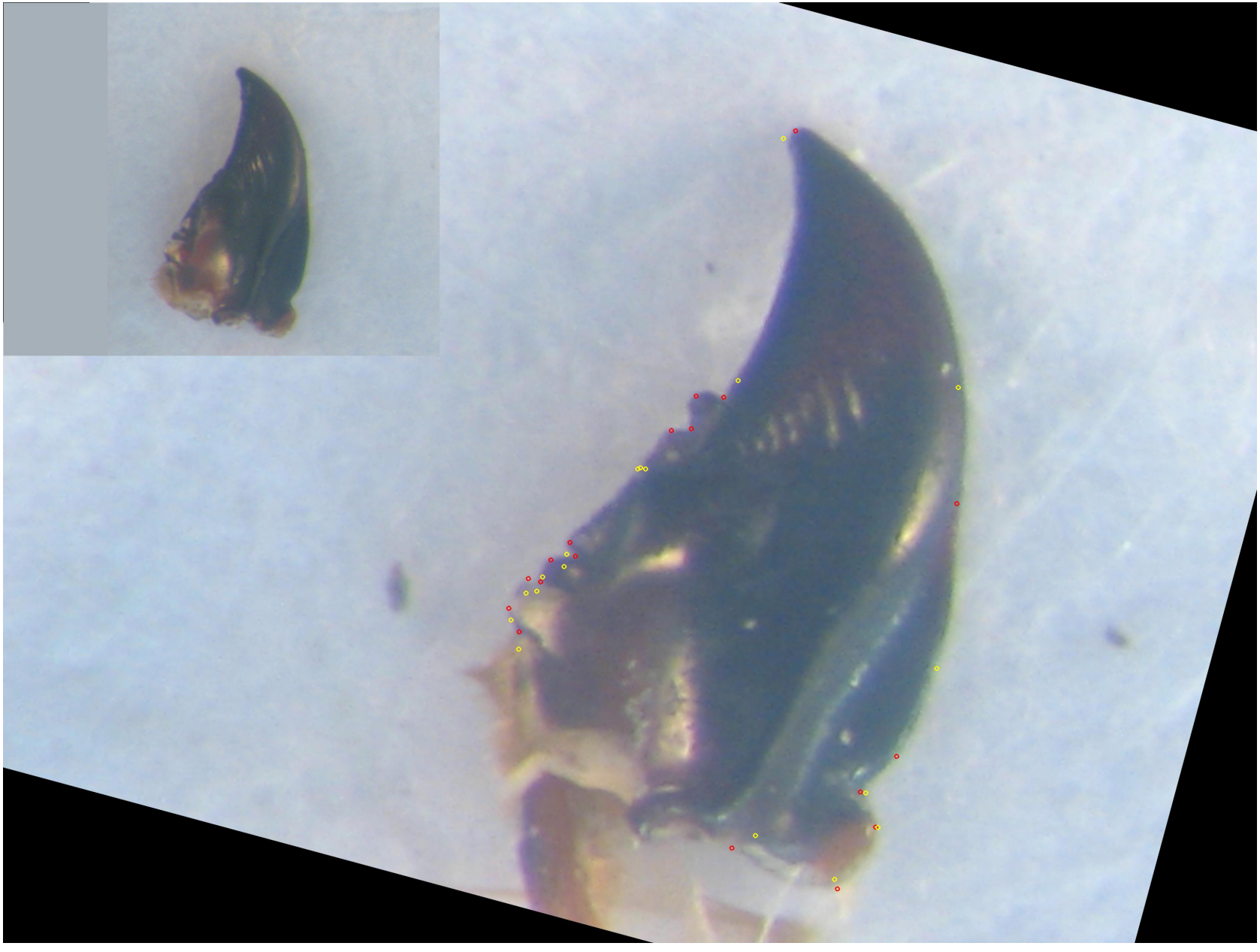
**Method:**

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

**Parameters:**

- Template box size: 400px (**templSize**)
- Image box size: 1400px (**imageSize**)

# Method - Template matching



Result Examination:

Dataset includes 291 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 |
| 291 | 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 |
| 291 | 171.589 | 4665.79 |

# 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 !