Robust Detection by Feature Matching

Python Implementation

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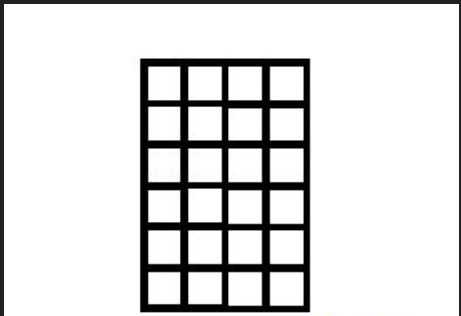
Goal

Given an object T (template), locate one or multiple (distorted/occluded) instances of the object in a test image I

1. Feature extraction

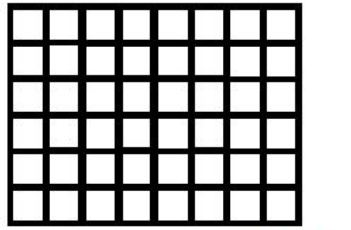
- Feature extraction with SIFT method both from TEMPLATE and from IMAGE
- Obtain two matrices of sift descriptors, and two matrices of key points

TEMPLATE



$$\boldsymbol{X_1} \in \mathbb{R}^{d \times N_1}$$

IMAGE

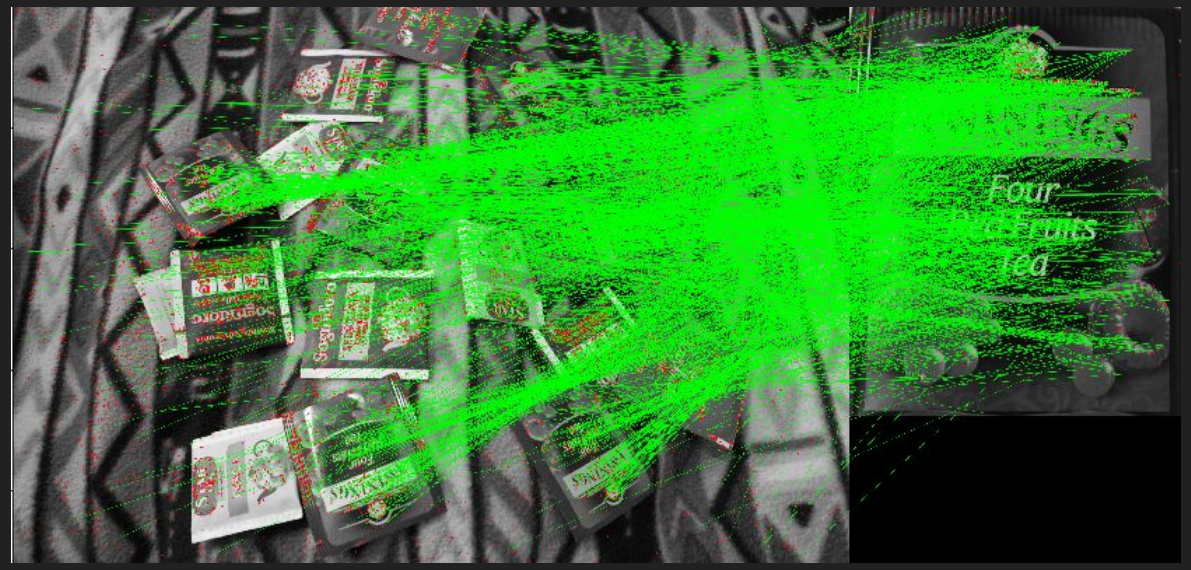


$$\boldsymbol{X_2} \in \mathbb{R}^{d \times N_2}$$

$$(d \ll r \times c)$$

2. Feature matching

- Match sift descriptors computing the 2-nearest-neighbors of each image key point in the template, using k-d tree (FLANN library)
- Validate and prune matches with the DISTANCE RATIO TEST (Lowe's test)



3. Identification and localization

- Iterative search of the best HOMOGRAPHY from remaining matches
  - Apply RANSAC method
  - Validation of homography and stopping criteria
    - Empty homography: stop searching

      ```
      Not possible to find another homography
      ```

    - Degenerate homography: discard and continue

      ```
      Degenerate homography
      ```

    - Too few inliers: stop searching

      ```
      Not enough matches are found in the last homography - 4/5
      ```

    - Too few remaining data: stop searching

      ```
      Not enough matches are found - 29/30
      ```

Ideas (1)

- PROBLEM

  Wrong identification due to inliers outside the object to recognize, generally belonging to similar objects

- INTUITION

  If an inlier is out from the projected square, it must not be considered for the current recognition

- SOLUTION

  Whether more than X (X configurable parameter) fraction of inliers are out from the current generated square, discard the homography. Then, from the inliers, eliminate the farther key point from the centroid of inliers, adding it to a temporary list, and reiterate the process. Discarded points will be considered again after having found a new homography

Ideas (2)

- PROBLEM

  Inaccurate identification due to matches which refers to different details within the object currently identified

- INTUITION

  The homography can be refined using more points, physically close to the current inliers. Applying again ransac wrong matches could become outliers

- SOLUTION

  Reiterate ransac starting from all points in the computed square and find a new homography. All checks are applied also to the new homography

Ideas (3)

- PROBLEM

  Double recognition of the same object

- INTUITION

  If the current recognition is good, all points in the recognized square are useless for future recognitions

- SOLUTION

  Elimination of all key points inside the recognized square, also if outliers of the current homography, before reiterating the process

Results (1)

Results (2)


TWININGS
Four Red Fruits Tea
STAR TEA
PESCA
Sogni d'oro
SETACCIATA

References

- https://github.com/ineveLoppiliF/ComputerVision_breakthroughs
- IC_Lez3_a_Computer_Vision_Features.pdf (G. Boracchi)