Robust Feature Matching with Hough and Inverted Hough Transforms

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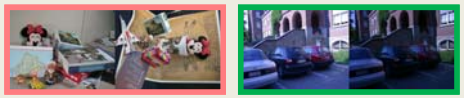
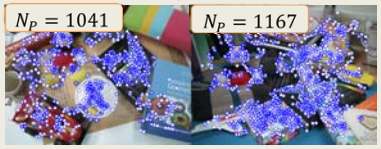
1. Introduction

1.1 Motivation

- Correspondence problem in real world:
  - Clutter background, significant amount of outliers and occlusion
  - Multiple translations, orientations, scale changes and large deformations
  - Illumination changes



- The initial feature correspondence set:



Possible correspondences : $1041 \times 1167 \approx 1.2 * 10^6$

- Contain corrupt matches: Low precision
- Can not be too large: Low recall
- Geometric checking: Less Efficient

1.2 Contribution

- A robust feature matching is proposed using **Hough and inverted Hough transforms**:
  - High precision: Hough voting
  - High recall: Inverted Hough voting
  - Low computational cost: BPLR filter

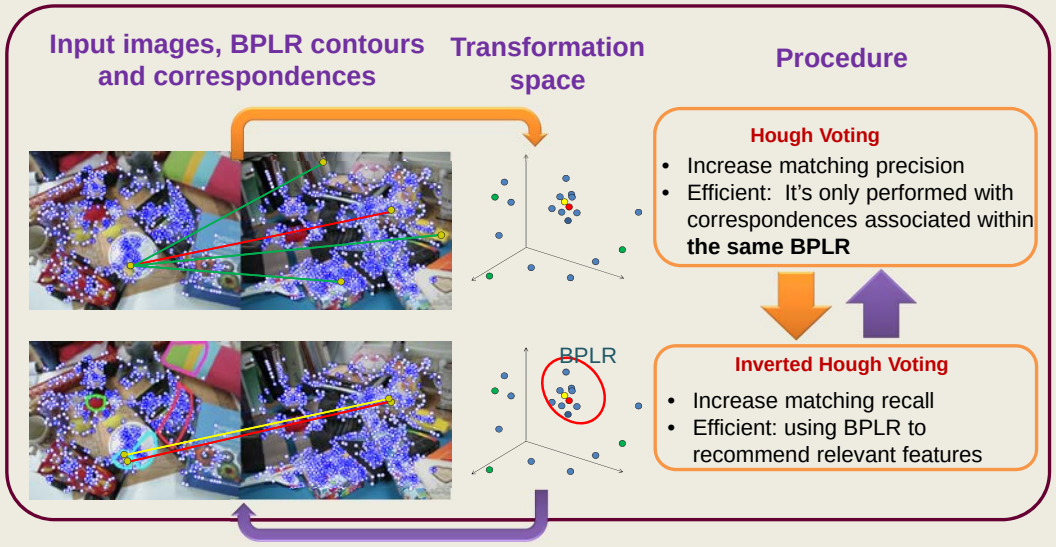
3. Main Idea

3.1 To increase precision

- The correct matches are biased to a dense cluster in the transformation space
- We cast the task of feature matching problem into a **density estimation problem**

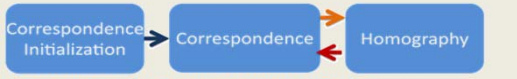
3.2 To increase recall

- Grouped features with high probability undergo similar transformations in matching
- We utilize the nature of BPLR to locate non-cross-boundary regions which correspond to groups of similar transformations



4. Overall Algorithm

- An alternate optimization procedure is used:
  - Generate initial matches by local affine feature detector and DOG descriptor
  - Project every candidate correspondence into Hough space
  - Detect correct correspondences via Hough Voting
  - Identify recommended features via inverted Hough Voting



4.1 Hough Voting

- The tentative correspondences are found via nearest-neighbor search in descriptor space and use to generate votes in the transformation space.
- We use density of each correspondence in the transformation space to verify its correctness.

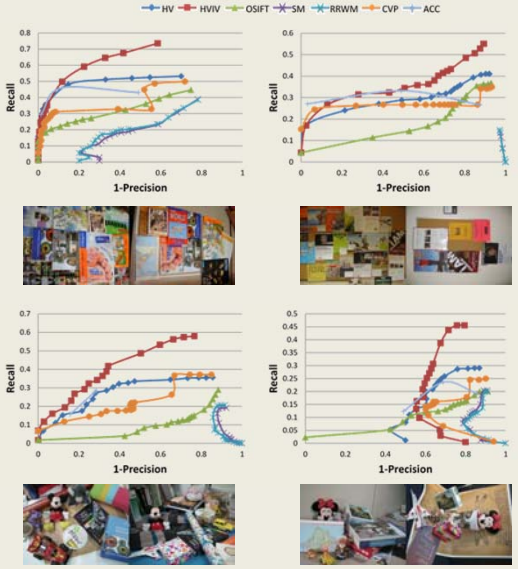
4.2 Inverted Hough Voting

- Recommend each feature additional transformations by investigating density distribution of nearby features covered by the same BPLR.

5. Experimental Results

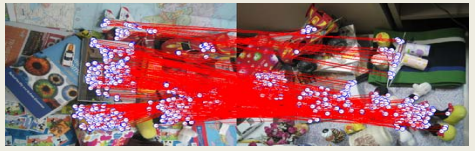
5.1 Matching with multiple common objects

- The SNU dataset is used in the experiments.
  - It consists of 6 image pairs with multiple common objects, partial occlusions and clutter backgrounds.



- We implement 3 kinds of matching method for comparison
  - Descriptor–based approach: Opponent-SIFT [van de sande,PAMI10]
  - Clustering-based approach: ACC [Cho et. al,ICCV09] and CVP [Liu et. al, CVPR10]
  - Graph-base approach: SM [Leordeanu & Hebert, ICCV05] and RRWM [Cho et. al, ECCV10]

CVP:475/504



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Sift & Hough SIFT Hough Voting

Hough Voting Inverted Hough Voting

5.2 Plug-in with other feature descriptor

- Our approach can be treated as a geometric filter and applied to various types of feature descriptors, such as LIOP[Wang et. al, ICCV11] to improve its performance