ECE501_2025_12_Group_2

Project name: **Image Tampering Detection (Forgery Localization)**

Team Details:

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Work Done Till Week 5

In the last one week, we optimized our image forgery detection strategy to enhance the accuracy of localizing forgery. Our previous efforts were partially successful and we were not able to find tampered regions with high accuracy, which is why we developed a digital image processing pipeline that is more robust.

New Pipeline Development

Our forgery detector pipeline is an implementation of a keypoint-based forgery detection pipeline, using several computer vision and pattern recognition methods.
The essence of this pipeline is the following:

```python
def keypoint_pipeline(gray,
                      orb_nfeatures=5000,
                      ratio_thresh=0.75,
                      ransac_thresh=3.0,
                      dbscan_eps=5,
                      dbscan_min_samples=5):
    """
    Steps:
    1. Detect ORB keypoints and descriptors (fast and rotation-invariant)
    2. Match descriptors using BFMatcher + kNN (k=2) with Lowe's ratio test
```

```
3. Filter out trivial self-matches and small displacements
4. Apply RANSAC to retain geometrically consistent matches
5. Cluster displacement vectors via DBSCAN to locate potential copy-move regions
"""
```

- **Feature Extraction:** ORB detector was utilized in order to extract keypoints and local descriptors to the input image in an efficient environment.
- **Matching Match:** Use Employed Brute-Force Matcher (BFMatcher) with kNN (k=2) to match descriptors with themselves to obtain potential copy-move regions.
- **Filtering:** Adopted RANSAC-based filtering to eliminate the irregular matches.
- **Clustering:** DBSCAN clustering applied to displacement vectors in order to remove coherent forged regions.

Results and Observations

- The pipeline is able to identify structural similarities in the image.
- Nevertheless, not all the forged areas are detected, particularly in the instances of subtle or low-contrast forgeries.
- The first result is encouraging, although the sensitivity and precision of detection requires improvements.

Challenges Faced

- There are also forged areas that are not detected since there are limitations on descriptors (ORB sensitivity).
- False positives are in very textured areas.
- Further optimization is needed in terms of parameter tuning (e.g. DBSCAN thresholds, ratio test limits).

Next Steps

- In order to enhance the accuracy and strength of detection, we will:
- Use a Hybrid Method: Use SIFT (Scale-Invariant Feature Transform) with DCT (Discrete Cosine Transform) to be more sensitive to texture and frequency-domain details.
- Refine Post-Processing: Add morphological and adaptive thresholding to improve the segmentation of regions.

- Parameter Optimization: Systematically sweep the parameters of ORB, RANSAC and DBSCAN to obtain an increased detection accuracy.
- Performance Evaluation: Compare our performance with the standard datasets and metrics, including Precision, Recall, and F1-score.

Conclusion

In this week, much was done to redesign and realize a more sophisticated system of keypoint-based forgery detector pipeline. The algorithm has shown better structural matching properties and we have found definite follow up in making it more sensitive and more precise in finding tampered parts.