Image Tampering Detection (Forgery Localization)

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***Abstract*—Image tampering has become one of the greatest issues of the digital forensics, and copy-move forgery is one of the most frequently used tools of manipulation because it is simple and can cover up or duplicate the information. In this project, we target to create a powerful image tampering detection model that can effectively localize forged areas based on a combination of segmentation based preprocessing, feature extraction schemes and feature matching schemes. The progress by the middle of the semester consists of the full workflow development, the choice of most appropriate datasets, the identification of the most effective preprocessing methods, and the integration planning of the SIFT and SURF feature extraction mechanisms.**

The project suggests to break up an image into dynamically defined parts according to the features of an image like texture, lighting conditions and sharpness variations. We will use the local features of these segments to enhance the capacity of the model in distinguishing between genuine and spoctred areas. The intended application of SIFT in the highly accurate feature detection and SURF in the computationally faster algorithm produces a complementary hybrid model which provides balance in performance and accuracy. Moreover, using a ground-truth-assisted dataset will provide an opportunity to evaluate and benchmark the system.

The general aim of the undertaking is to develop a powerful, noise-resilient and data-free system that does not only identify the occurrence of copy-move forgery but also generates heatmaps and binary masks that point out the manipulated areas. This report gives a summary of the conceptual base, the first trials, and the development that has been made up to date which is the base of the next steps in the algorithmic development and testing processes that will be carried out in the second half of the semester.

I. Implementation

A. Project Workflow Finalization

The complete workflow of the tampering detection model was finalized. The processing pipeline begins with pre-processing and segmentation, followed by feature extraction, feature matching, and tampered-region localization.

B. Segmentation Strategy

To improve the accuracy of copy-move forgery detection, the image is divided into segments based on:

- Lighting variations
- Texture differences
- Sharpness information

These segments form the basis for local feature extraction.

C. Feature Extraction Using SIFT and SURF

SIFT and SURF algorithms are used to extract stable keypoints from each segment. These algorithms are chosen because:

- SIFT provides scale- and rotation-invariant keypoints.
- SURF is faster and offers robust feature descriptors.

D. Feature Matching

The extracted features from each segment are matched with features from other segments. Similar regions indicate possible copy-move operations. Matched points are grouped to highlight potential tampered clusters.

E. Dataset Selection

The CASIA1 Ground Truth dataset was selected because it provides:

- Authentic images
- Tampered images
- Pixel-level ground truth masks

This allows accurate evaluation of the proposed method.

II. Results

The task done till the mid-semester stage was mainly to develop the theoretical and structural platform, which is required to develop a sound detection of forgery system. A number of significant gains have been made in the course of this time.

To begin with, the project methodology has been optimized so that all the parts of the system make some logical contribution to the ultimate goal of proper localization. The first experimental outcomes confirm that extracted features in image pieces differ according to texture, scale, and local lighting which means that segmentation does play an important role in enhancing the accuracy of keypoint detection. These results just confirm the choice to break the image into significant parts prior to the use of SIFT and SURF.

Second, the exploration of the vast dataset was carried out and the CASIA1 Ground Truth dataset was chosen because of the obvious division between authentic and tampered images.It is assumed that the presence of the paired tampered and authentic images is going to have a massive effect in lowering the level of ambiguity in the calculation of the various evaluation measures that include accuracy, recall, and F1-score.

This was followed by conducting research and screening of several research papers and methods according to their relevance and reliability. Articles which were not reproducible, had outdated techniques, or were founded on poor reviewing in conferences were eliminated. The team was instead concerned with powerful peer-reviewed approaches that underline feature-based and block-based approaches. This has enabled the team to have a clearer insight on the weaknesses of the traditional ones and others strengths that can be merged into the hybrid model.

Besides, initial experiments with manually chosen sample images have served to confirm that SIFT and SURF complement each other: SIFT reveals small-scale features regardless of the illumination whereas SURF is faster and less efficient in terms of computations. The combination of these feature sets will be likely to enhance the overall robustness during matching and also minimize false positives to a great extent, particularly with repetitive patterns in the images.

In general, the current achievements prove that the suggested direction is technically correct. This has all the necessary elements including dataset, methodology, segmentation strategy, and feature extraction plan, and is now ready to implement and develop the algorithm that will constitute the bulk of the second half of the semester.

III. Conclusion

It is observed that the intermediate stage of the project has effectively established a solid conceptual and structural basis of creating an effective system of copy-move forgery detection. The definition of the workflow, examination of various segmentation strategies, extensive scrutiny of feature extraction techniques, and the completeness of the dataset have taken the team out of such a general direction of the research and presented a model readable and implementable. The decision to use SIFT and SURF with the assistance of segmentation helps to make sure that the model can capture a large variety of keypoints without compromising the computational efficiency.

The elimination of weaker works and reinforcement of the research methodology by the means of trustworthy studies also guarantee that the intended approach is based on the scientifically proved principles. The availed insights into the real world manipulated images behaviour by studying the authentic, tampered, and ground-truth masks in the CASIA data point further enhance our comprehension of how manipulated images behave in the real world and how tampered areas vary in terms of texture, luminance, and structure.

The following step of the project will be based on the implementation of the algorithms, the creation of the powerful matching pipeline, and the output, in the form of heatmaps and binary masks. Such visual outputs will be used as a detection output and also as an assessment against ground truth masks. Moreover, the team will also pay attention to optimizing the system so that it could address the differences in the size, quality and noise of images, so that the model is not only accurate but also scalable.

To conclude, the achievements made to date show that the project is within the timeline and set to be completed successfully. The clarity of thinking, datasets preparation, and feature extraction planning that were achieved throughout the mid semester period would serve as a good basis to develop a strong, practical, and high performing model to detect tampering in images in the next stage of development.

References

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