Overview

The project involves implementing various computer vision techniques to perform feature matching and corner detection on images. It employs different algorithms like Shi-Tomasi Corner Detector, Harris Corner Detector, and feature matching using Normalized Cross-Correlation (NCC) and L2 distance metrics. The primary objective is to detect key points in images, extract feature descriptors around these points, and then match these features between two images.

Methodology

1. Preprocessing and Interest Point Detection

- **Shi-Tomasi Corner Detector**: Used for detecting interest points in images. The method identifies corners in the image, which are good features for matching due to their distinctiveness.

2. Harris Corner Detection at Multiple Scales

- **Harris Corner Detector**: Applied at different scales (0.5, 1, 2, 4) to detect corners. The detector finds locations in the image with large variations in intensity in all directions, indicating potential corners.
- **Scaling**: The image is resized to different scales to observe how corner detection performs at each scale.

3. Feature Description and Matching

- **SIFT (Scale-Invariant Feature Transform)**: Used to detect keypoints and compute descriptors in the images. SIFT is robust to changes in scale, noise, and illumination.
- **Normalized Cross-Correlation (NCC)**: Implemented to match features between images. It measures the similarity between feature descriptors.
- **L2 Distance Matching**: Another method to match features based on the Euclidean distance between descriptors.

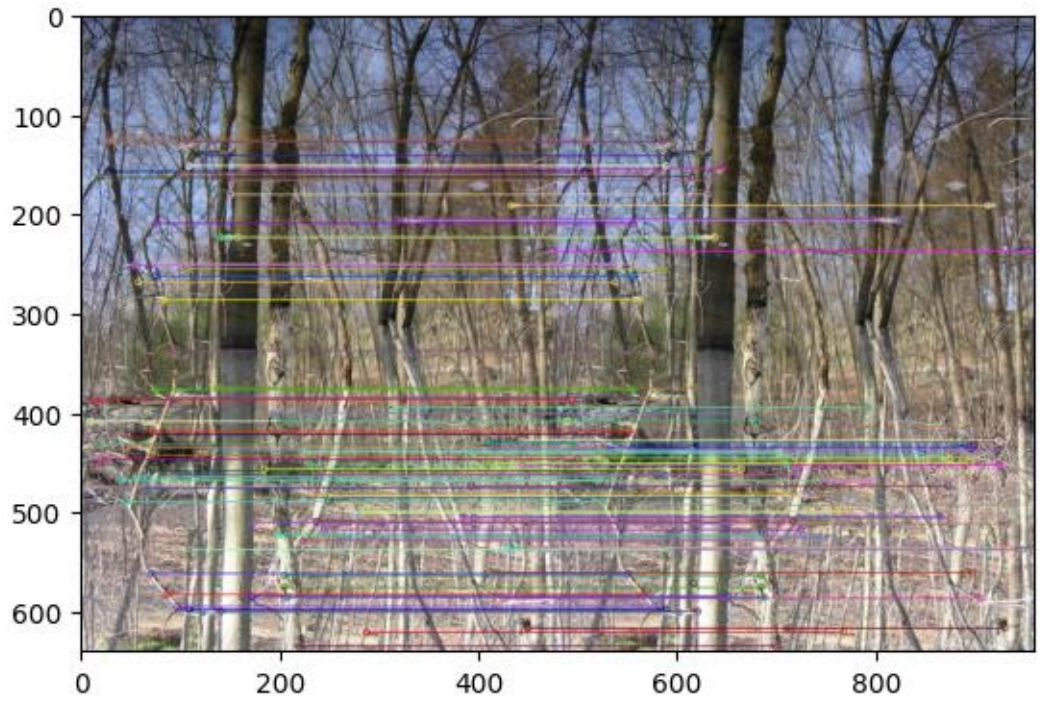
4. Displaying Results

- Visualization of matched features and corners using matplotlib. Images are displayed after each key step to show the intermediate and final results.

Results and Discussion

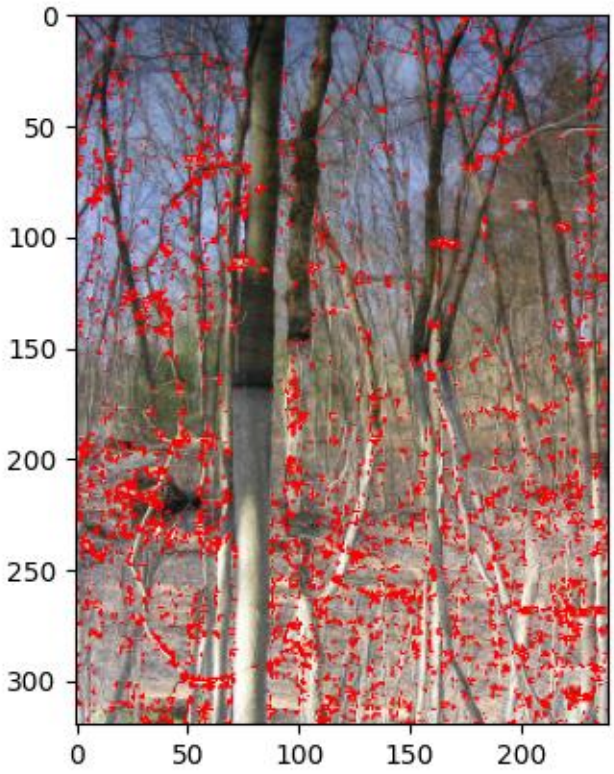
Interest Point Detection

- The Shi-Tomasi Corner Detector successfully identified interest points. These points serve as a basis for extracting feature descriptors.



Harris Corner Detection

- The application of the Harris Corner Detector at different scales revealed how corner detection varies with image size. At smaller scales, finer details might be missed, while at larger scales, more corners are detected.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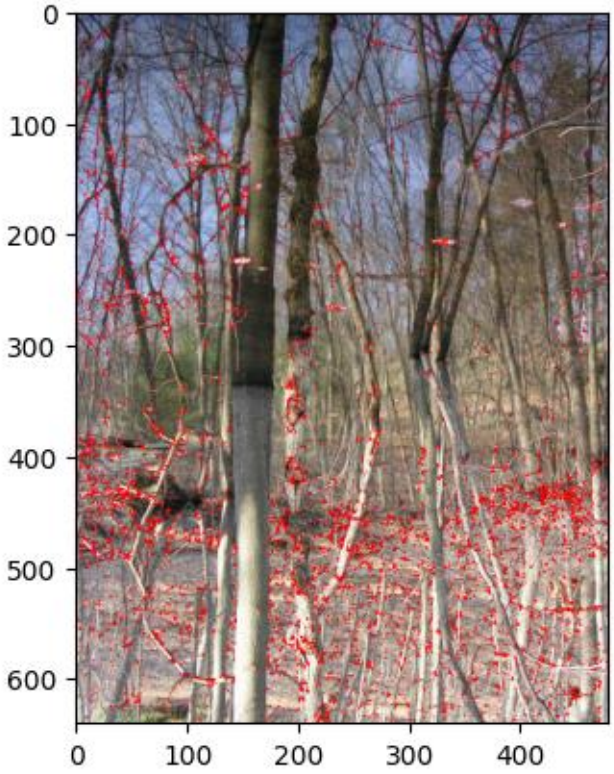
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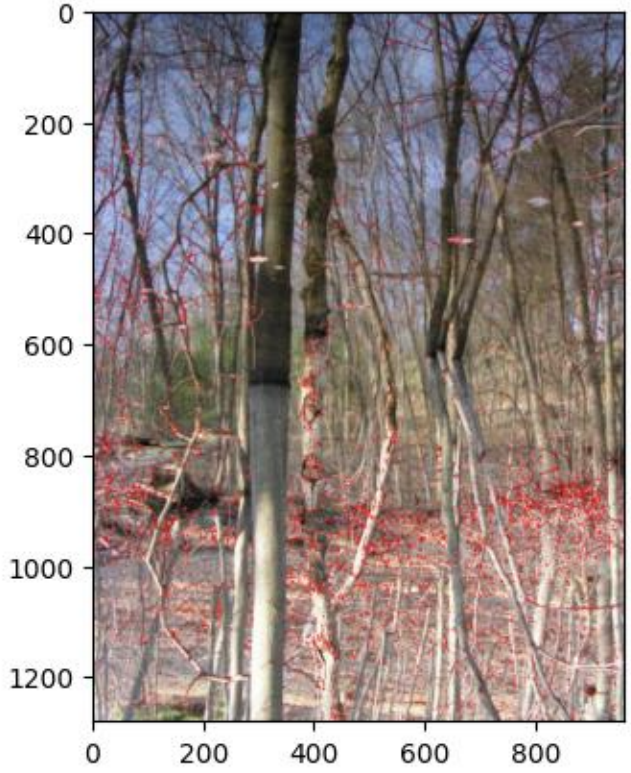
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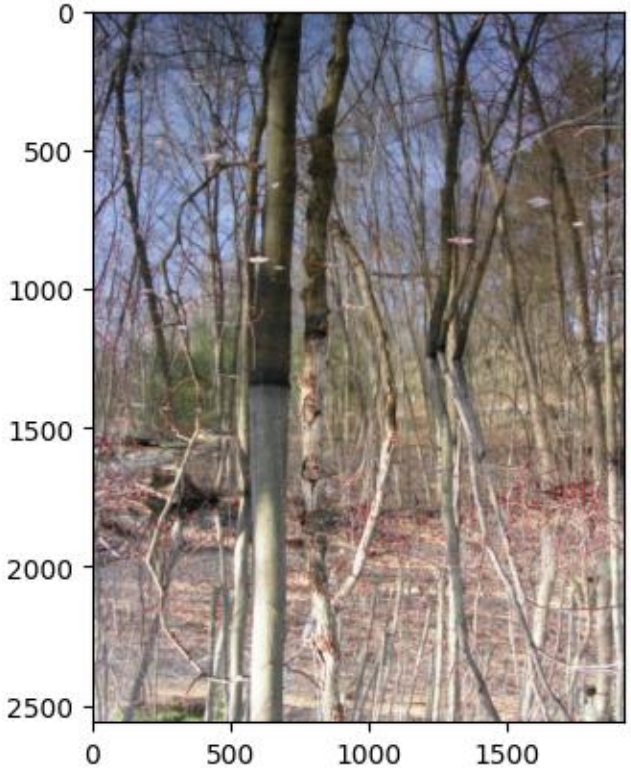
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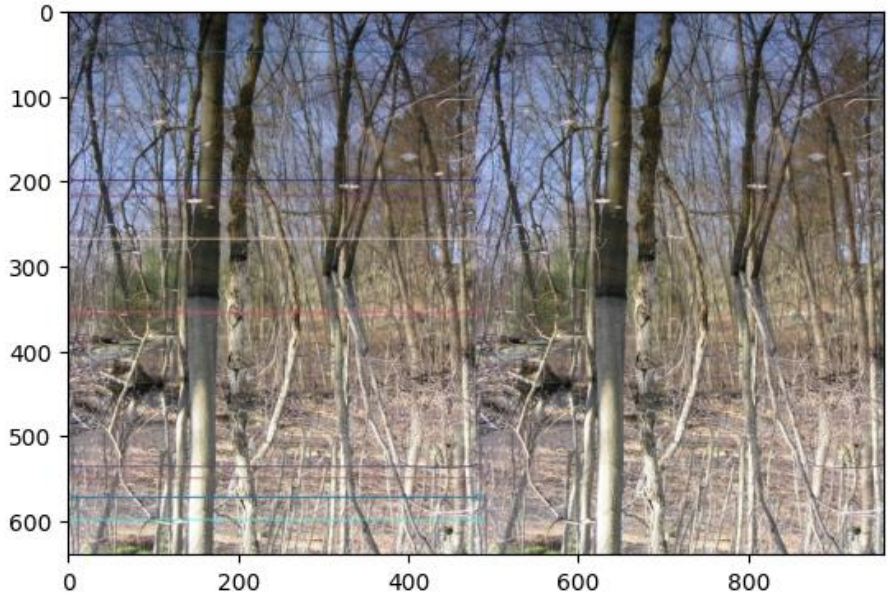
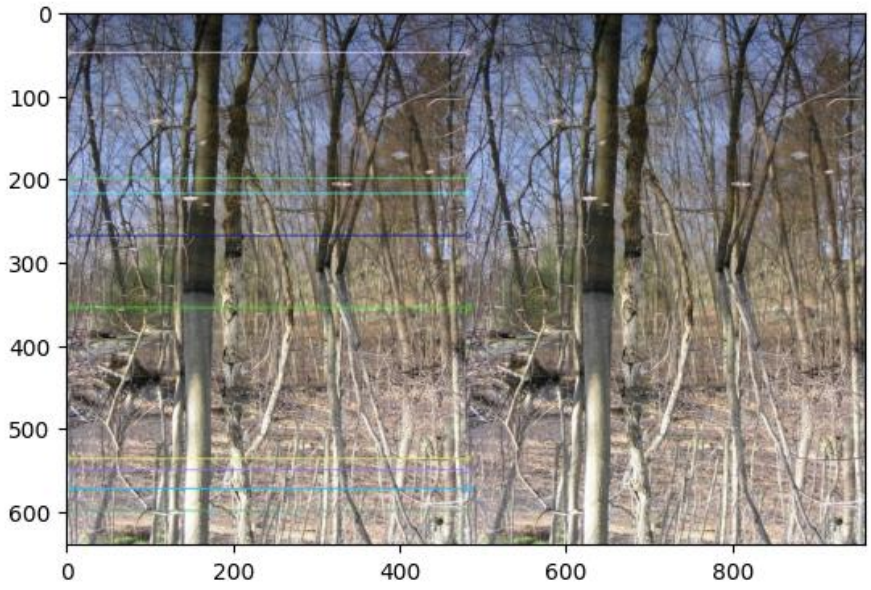
Feature Matching

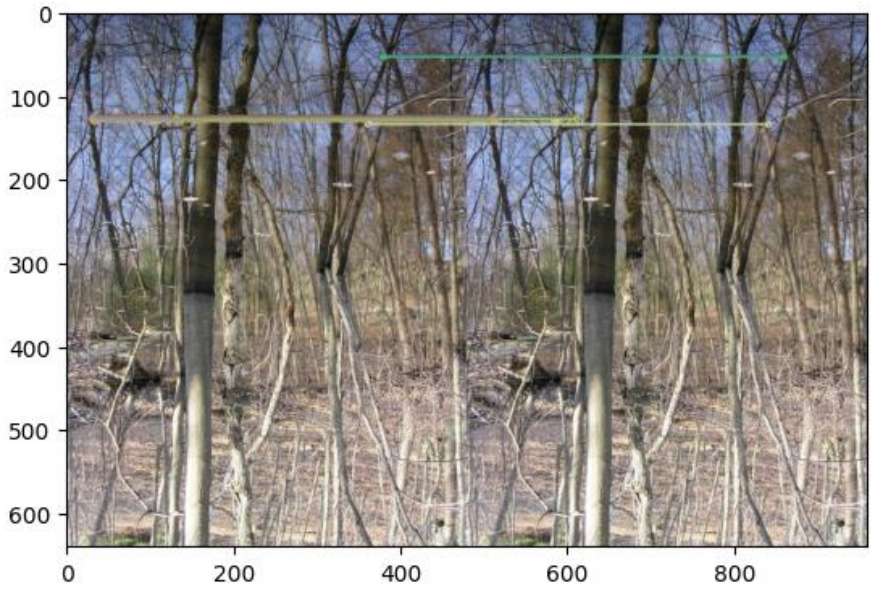
- **NCC-Based Matching**: The NCC method effectively matched features by comparing the similarity of the descriptors. It showed robustness in matching features even under some variations.
- **L2 Distance Matching**: Provided a different set of matches based on the Euclidean distance between feature descriptors. This method complements NCC by offering an alternative perspective on feature similarity.

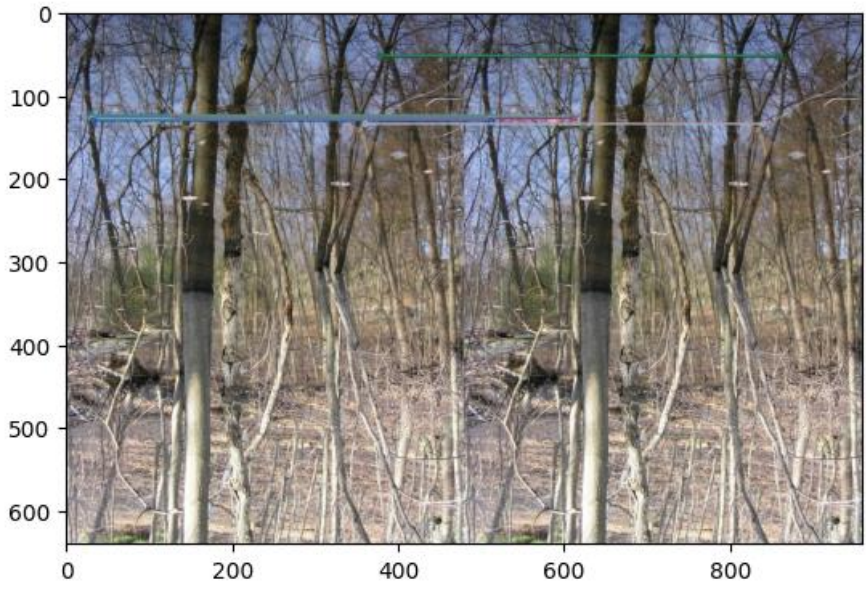




Visualizations

- The visualizations clearly illustrated the detected corners and matched features. These visuals are crucial for understanding the effectiveness of the algorithms used.





Conclusion

The project successfully demonstrates the application of corner detection and feature matching algorithms in computer vision. It highlights the effectiveness of Shi-Tomasi and Harris corner detectors, as well as the robustness of SIFT for feature description. Both NCC and L2 distance metrics proved useful for feature matching, each offering unique insights into feature similarity. The results from different scales and methods provide a comprehensive understanding of feature matching in images. The visualizations serve as an excellent tool for analyzing and presenting the outcomes of these algorithms.