VR Assignment 1: Coin Detection and Panorama Stitching

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Abstract

This report presents the implementation of two tasks: (1) detecting, segmenting, and counting coins from an image, and (2) stitching multiple overlapping images to create a panorama. The methodologies employed include edge detection, contour detection, Hough Circle Transform, Watershed segmentation, and ORB-based feature matching.

1 Introduction

The assignment is divided into two parts:

- **Part 1: Coin Detection and Segmentation** - The goal is to detect, segment, and count Indian coins from an image.
- **Part 2: Image Stitching** - The objective is to generate a stitched panorama using multiple overlapping images.

2 Part 1: Coin Detection and Segmentation

2.1 Methodology

1. **Preprocessing:** The input image is converted to grayscale and smoothed using a Gaussian blur to reduce noise.
2. **Edge Detection:** The Canny edge detector is applied to highlight the boundaries of coins.

3. **Coin Detection:** Circular shapes corresponding to coins are detected using the Hough Circle Transform.
4. **Segmentation:** A combination of Otsu thresholding and the Watershed algorithm is used to separate individual coins.
5. **Counting:** The total number of coins is determined based on the number of detected circles.

2.2 Implementation

The implementation utilizes OpenCV for image processing. The pipeline includes grayscale conversion, Gaussian blurring, edge detection, Hough Circle Transform, and Watershed segmentation.

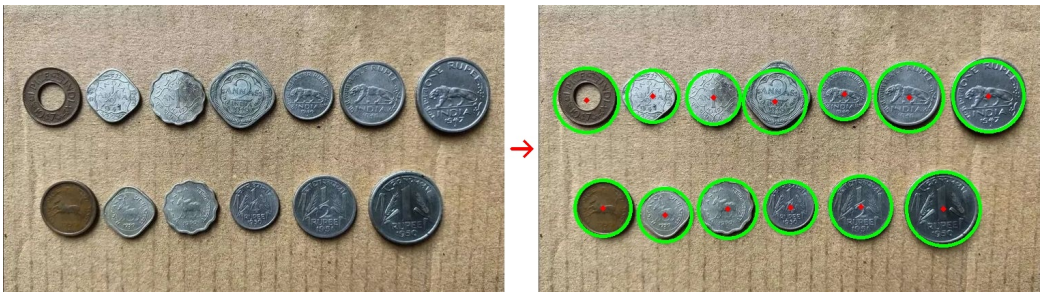

Figure 1: Before and after detection

2.3 Results and Observations

- The algorithm successfully detects and segments coins in clear images with minimal overlap.
- The Hough Circle Transform effectively identifies coins, but performance may degrade with occlusions or poor lighting.
- The Watershed algorithm refines the segmentation, though it may struggle in cases with excessive noise or closely packed coins.

3 Part 2: Image Stitching

3.1 Methodology

The image stitching process consists of the following steps:

1. **Feature Detection:** SIFT (Scale-Invariant Feature Transform) is used to extract keypoints and descriptors from input images.
2. **Feature Matching:** A Brute-Force Matcher (BFMatcher) is used to match keypoints between overlapping images using Lowe's ratio test.
3. **Homography Estimation:** RANSAC (Random Sample Consensus) is applied to compute the transformation matrix aligning images.
4. **Image Warping and Stitching:** The second image is warped using the homography matrix and overlaid onto the base image.
5. **Black Border Removal:** Non-relevant black regions caused by warping are cropped out to refine the final stitched panorama.

3.2 Implementation

The implementation is carried out using OpenCV and follows these steps:

- Extract SIFT keypoints and descriptors for each image.
- Match keypoints using BFMatcher with Lowe's ratio test.
- Estimate the homography matrix using RANSAC.
- Warp and blend the images to create a seamless panorama.
- Optionally, visualize the keypoint correspondences.

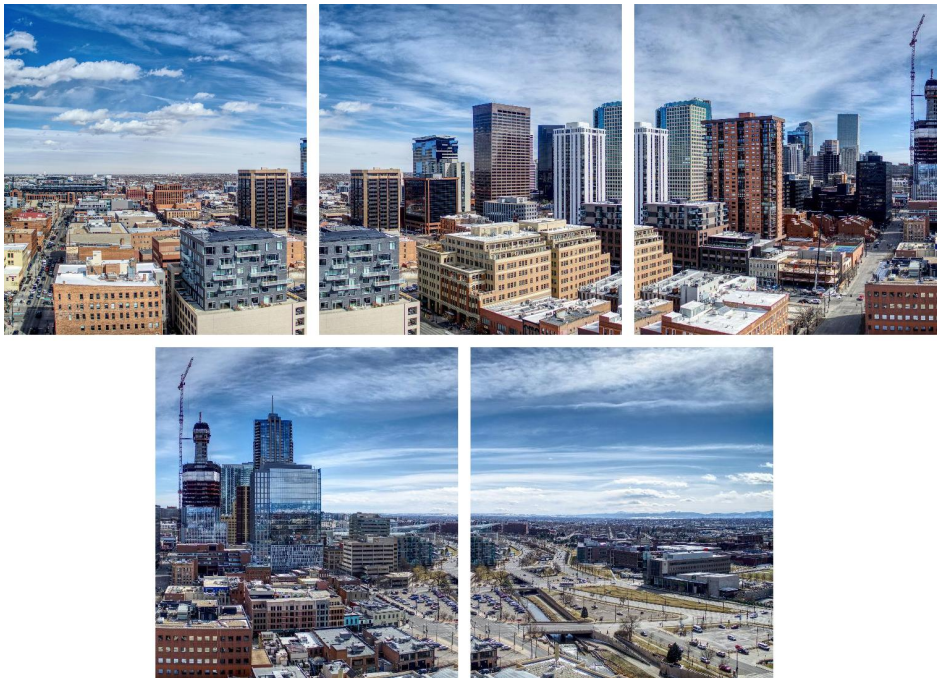

Figure 2: Input images

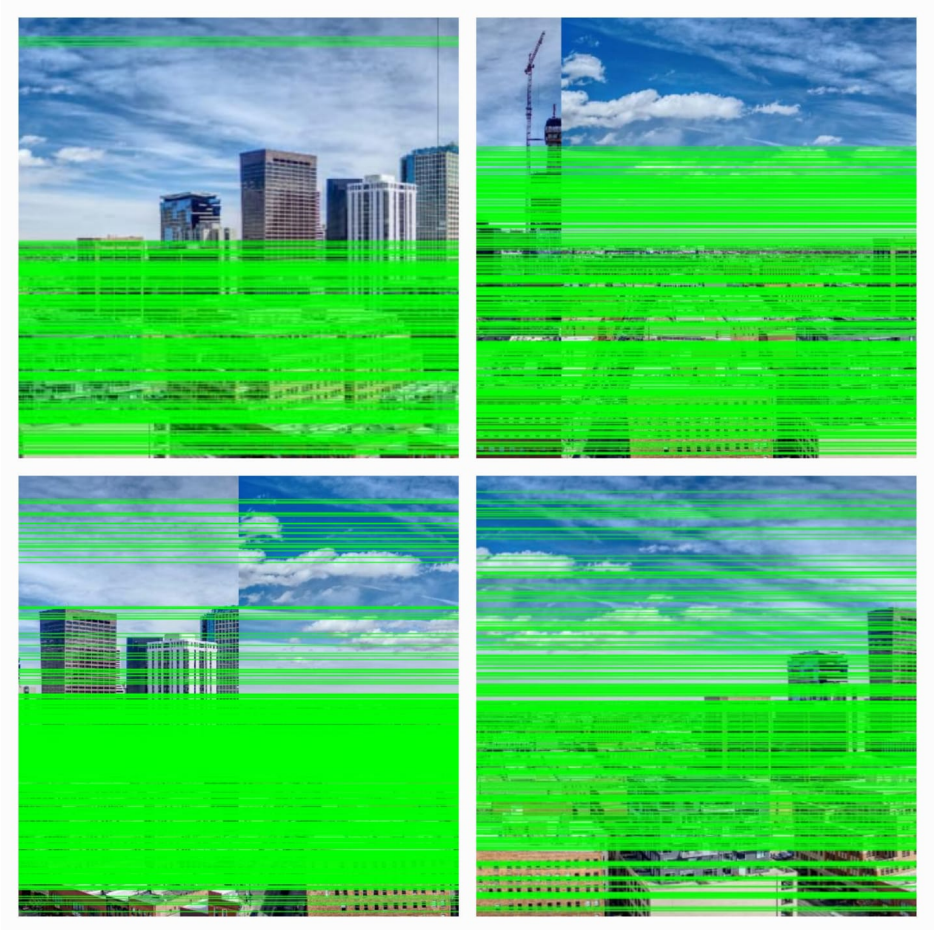

Figure 3: Matched images

Figure 4: Final output: Stitched image

3.3 Results and Observations

- The approach successfully stitches images with significant overlapping regions.
- Insufficient feature matches lead to failures in homography estimation.
- Black border artifacts occur if images are not properly aligned.
- The method struggles with images having large perspective variations.

4 Conclusion

4.1 Coin Detection and Segmentation

- Successfully detected and outlined coins in most cases.
- Performed well with clear, well-lit images but struggled with overlapping or shadowed coins.
- Watershed-based segmentation helped isolate individual coins effectively.

4.2 Panorama Stitching

- Successfully stitched images with sufficient overlap and alignment.
- Worked best when images had distinct, well-distributed features.
- Failed when images had little overlap or significant distortion.

5 How to Run

5.1 Folder Structure

The project files are organized as follows:

```
VR_Assignment_Harsh_IMT2022008/
├── coin_detection/
│   ├── images/
│   │   └── coins.jpg
│   ├── output/
│   │   └── detected_coins.jpg
```

```
            ├──segmented_coins.jpg
        ├── coin_detection.py

├── panaroma_stiching/
        ├──input/
            ├──0.jpg
            ├──1.jpg
            ├──2.jpg
            ├──3.jpg
            ├──4.jpg
        ├──output/
            ├──final_panaroma.jpg
            ├──matched.jpg
            ├──matched2.jpg
            ├──matched3.jpg
            ├──matched4.jpg
        ├── panorama.py
├── README.md
├──requirenments.txt
├── report.pdf
```

5.2 Requirements

Ensure Python is installed with OpenCV and NumPy.

```
pip install opencv-python numpy matplotlib
```

5.3 Execution

```
cd coin_detection than python3 coin_detection.py
cd panaroma_stiching than python3 panorama.py
```

6 GitHub Repository

The complete project, including the code and dataset, is available on GitHub: GitHub Repository.