Assignment 4

CGRA252 Report

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Introduction

This assignment focuses on implementing techniques for image local feature matching, image warping, and video stabilization. The project involves processing a sequence of images from a video to extract and match feature points, estimate transformations, and align images to stabilize the video content.

Objectives:

1. **Feature Matching and Homography Estimation**: Extract and match SIFT feature points between image pairs and estimate the homography transformation using RANSAC.
2. **Image Alignment**: Use the estimated homography matrix to warp images for alignment.
3. **Video Stabilization**: Implement a method to stabilize a video by smoothing the homography transformations between consecutive frames.
4. **Best Cropping Window**: Find the best cropping window to remove invalid pixels and maintain the original aspect ratio of the frames.

SIFT Feature Extraction and Matching - Core Part 1

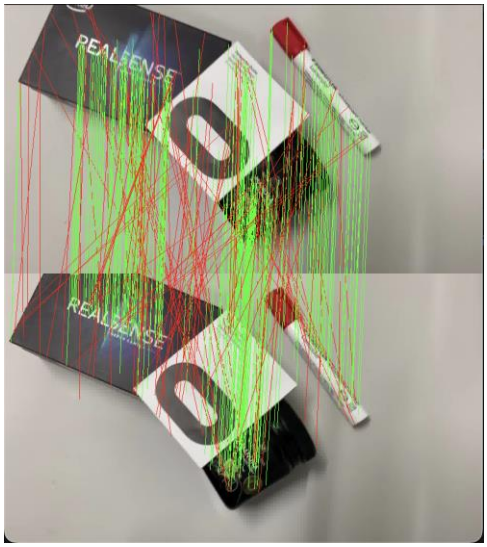
Extracted SIFT features from two frames, matched the features, and visualized the matches.

Feature matching between frame 39 and 41

The results show the matching features between frames 39 and 41. This clearly depicts the matching objects between the two frames.

Estimate Homography Transformation - Core Part 2

Used RANSAC to estimate the homography matrix and identify inliers and outliers.



Inliers and outliers

This image shows the results of RANSAC, showing the inliers in green and the outliers in red.

Generate an image aligned result - Core Part 3

Warp one image to align with another using the estimated homography matrix.

Frame 39 and 41 warped together

Here, frame 39 and 41 have been warped and aligned with each other using the homography matrix, to create this image.

The aligned area is evident from the subtle black outline near the image's edges.

A Video Stabilizer - Completion

Smoothed the sequence of homography transformations to stabilize the video content.

Frame 50 (stabilized)

Frame 50 (un-stabilized)

Here I have placed the stabilized and un-stabilized versions of frame 50 to compare the two. Although it is subtle, a slight black line, under the stabilized image, shows the result of the homography transformation.

Best Cropping Window - Challenge

Determined the largest inscribed rectangular region to crop the stabilized video, removing invalid pixels and maintaining aspect ratio.

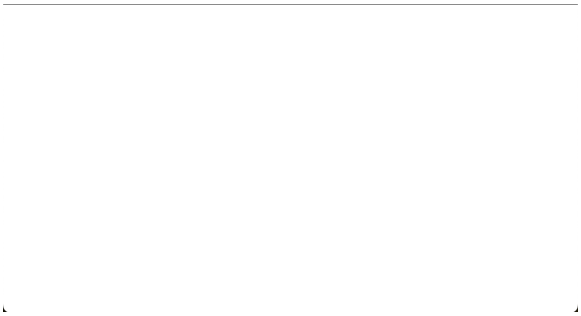
Frame 2 (Cropped)

Frame 2 (Stabilized)

Both the above images are the second frames. The crop can be seen when comparing the two images. On the stabilized frame, there is a slight black edge unlike the cropped frame which has no edge. Also, the “R” on the “RealSense” box is closer to the edge, so much so that the corner of the R is slightly clipped.

The final dimension of the cropped image is 789x421, whereas the stabilized image maintained the dimension of 800x450.

Merged Mask (800x450 including black pixels @ 0,0)



Final crop (789x421 from 6,12)

The left is the combined mask from the stabilization algorithm. The right image is the final rect that was cropped using the largest inscribed rectangle algorithm. This has simply removed the edges that contained black.

How to run

In a terminal, change directory (cd) to the directory of the executable (in ./build), and run any of the following commands:

./a4 - Runs all functions

./a4 [core/comp/chal] - To run the selected part of the assignment

- e.g.) ./a4 core

- Runs program for core task

This will run all the functions in the program including core part 1, core part 2, core part 3, Completion and Challenge.

Functions:

Each class contains the functions for each section of the assignment.

Notes:

Both the Completion and Challenge part of the code will create a separate folder for the resulting images. The completion folder will also include .xml files containing the resulting homographies from completion that Challenge will use.

There is also a results directory that contains mp4 files with the results of completion and challenge converted to a video format.