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**Due: 19<sup>th</sup> April 2023 3:30 PM****Total points: 50**

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In this project you will form a panoramic image from a set of photos captured at different perspectives.

## 1 Restricted Functions and Installation

You may use numpy, cv2, os, matplotlib, and scipy to help complete the assignment.

## 2 Intro to homographies

**10 points**

The assignment contains three images; 1.jpg, 2.jpg, and 3.jpg. Using `cv2.warpPerspective` and three different homography matrices, rotate 1.jpg clockwise 10 degrees, translate 2.jpg 100 pixels right, and shrink 3.jpg by half. Use the last argument to `warpPerspective` to specify that the output image should be 1000 pixels wide and 800 pixels tall.

## 3 Panoramic Stitching

**40 points total**

In this section you will use SIFT features and the RANSAC algorithm to determine two homographies that align images 1.jpg and 3.jpg with image 2.jpg. You will then apply these homographies and fuse the images.

### 3.1 Compute SIFT features

**5 points**

Compute the SIFT features for each of the images.

### 3.2 Match features

**15 pts**

For each SIFT feature in image 2.jpg find the SIFT features in images 1.jpg and 3.jpg that are the most similar, in terms of  $\ell_2$  distance. The `distance_matrix` command in `scipy.spatial` may prove useful here. You will now have two sets of matched features, but these sets will contain many false positives.

Get rid of all but the 100 best matches (again in an  $\ell_2$  sense) between image 2.jpg's features and image 1.jpg's features. Similarly, get rid of all but the 100 best matches between image

2.jpg's features and image 3.jpg's. You will be left with 2 sets of match features; the first clearly show up in images 1 and 2 and the second clearly show up in images 2 and 3.

### 3.3 Estimate the homographies

10 pts

Use the `cv2.findHomography` command to apply RANSAC to find a homography mapping image 1.jpg's matched features to image 2.jpg's. Similarly find a homography mapping image 3.jpg's matched features to image 2.jpg's. When applying RANSAC, declare a set of matched features inliers if the reprojection error (the difference between where the homography places a feature and its true location) is less than 2 pixels.

### 3.4 Warp and translate images

10 pts

Using a single homography matrix (made of the product of two other matrices), use the `cv2.warpPerspective` command to align image 1.jpg with image 2.jpg and then translate it 350 pixels to the right and 300 pixels down.

Using a single homography matrix (made of the product of two other matrices), use the `cv2.warpPerspective` command to align image 3.jpg with image 2.jpg and then translate it 350 pixels to the right and 300 pixels down.

Using a single homography matrix, use the `cv2.warpPerspective` command to translate image 2.jpg 350 pixels to the right and 300 pixels down.

Fuse the three images using `np.maximum`. While some minor ghosting artifacts (e.g., people walking) are expected, the details around the edges of the three images should align quite well.

## Submission Instructions

There are 2 submission portals on Gradescope. You need to submit the PDF report to the submission portal named “Project 4 PDF” and also submit a ZIP file to another portal named “Project 4 Code”. Your files should be named **YourDirectoryID\_Report.pdf** and **YourDirectoryID\_Project4.zip**, respectively.

Your zip file should contain:

- Project4.py.

Do not include the datasets in your submission. Rather use relative pathing assuming the code and set1 directory are in the same parent directory.

E.g., load your training data from “./set1/”.

## Collaboration Policy

You may (optionally) work in groups of up to two people. You are encouraged to discuss ideas with peers outside your group. However, the code should be your group’s own and should represent your understanding of the assignment. Code should not be shared or copied. If you reference anyone else’s code in writing your project, you must properly cite it in your code (in comments) and in your report.

Please indicate in the report how each group member contributed to the project.

## Plagiarism

Plagiarism of any form will not be tolerated. You are expected to credit all sources explicitly. If you have any doubts regarding what is and is not plagiarism, talk to me.

## Credit

Thanks to Ashok Veeraraghavan and Mohammad Teli for sharing their course resources.