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Homework 2

Parameters for methods:

detect_corners:

- w_diam: the diameter of the square window used to construct the H matrix (second moment matrix). This parameter defines the scope of corner detection (large scale vs. small scale corners).
- k: coefficient of the $(\text{trace})^2$, used to calculate the R value at each pixel. This affects the R-values and thus how likely a pixel is to be identified as a corner.
- s_size: the size of the sobel filter used to calculate the gradients of the image. This defines the size of edges that are detected.
- r_thresh: the threshold for R-values to be considered a strong corner, multiplied by the max value of all R-values to determine the final threshold. This affects the required 'cornerness' of a pixel for it to be identified as a true corner. Tuning this essentially increases/decreases the number of corners detected.
- nms_window: the size of the window used for non-max suppression. This affects how far apart two corners must be to be detected as corners.

match_corners:

- wsize: size of patches from each corner to extract, where patches are used to match corners. A larger patch size results in more accurate matches between two corners.

compute_affine_xform:

- p: desired probability of at least one of the N trials of RANSAC having no outliers
- e: approximated proportion of outliers in given data
- s: number of data points to randomly take in each sample
- inlier_thresh: max Euclidian distance between a transformed point and the true match for the pair of points to be considered an inlier

BIKES

Optimized parameters:

Parameter	Value
w_diam	7
k	0.05
s_size	3
r_thresh	0.01
nms_window	7
wsize	9
p	0.999
e	0.5
s	3
inlier_thresh	20

bikes1 → bikes2

Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transformation matrix:

```
[[ 1.0090e+00 -1.0000e-03  2.2330e+01]
 [-2.0000e-03  1.0000e+00 -2.5082e+01]
 [ 0.0000e+00  0.0000e+00  1.0000e+00]]
```

Results of image stitching using the calculated transform

Discussion: This alignment worked very well. At the borders of the two overlaid images, it is clear that artifacts, such as the curb, roof, and bricks in the wall on the left all line up between both images. There is very little visible blurring or discrepancy in overlaid objects.

bikes1 → bikes3

Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transform matrix:

```
[[ 1.0120e+00 -1.0000e-03 -1.0260e+00]
 [-2.0000e-03  1.0120e+00 -3.1616e+01]
 [ 0.0000e+00  0.0000e+00  1.0000e+00]]
```

Results of image stitching using the calculated transform

Discussion: This alignment worked very well, possibly better than the bike1 and bike2 alignment. At the borders of the two overlaid images, it is clear that artifacts, such as the curb, roof, and bricks in the wall on the left all line up between both images. There is very little visible blurring or discrepancy in overlaid objects.

GRAF

Optimized parameters:

Parameter	Value
w_diam	7
k	0.05
s_size	3
r_thresh	0.01
nms_window	7
wsize	9
p	0.999
e	0.5
s	3
inlier_thresh	20

graf1 → graf2

Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transform matrix:

```
[[  0.793   0.34  -20.152]
 [ -0.27    0.915  81.827]
 [  0.      0.      1.   ]]
```

Results of image stitching using the calculated transform

Discussion: This alignment worked decently. Some points, such as the bottom left of the bug-person, are very well lined up, while the peripheral artifacts of graf1 are not as well aligned. It is likely that a projective transformation would be better, since it seems that the scaling requires another dimension.

graf1 → graf3

Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transform matrix:

```
[[ 2.31000e+00 -1.10100e+00  1.06599e+02]
 [ 1.53000e-01  1.66900e+00 -2.70155e+02]
 [ 0.00000e+00  0.00000e+00  1.00000e+00]]
```

Results of image stitching using the calculated transform

Discussion: Evidently, this alignment was very poor. No parts of the image line up, and the matched features that are considered inliers after RANSAC do not even really match up. It is likely because of the geometric relationship between the two images; they are taken from very different angles, which would require a projective transformation.

LEUVEN

Optimized parameters:

Parameter	Value
w_diam	7
k	0.05
s_size	3
r_thresh	0.01
nms_window	7
wsize	9
p	0.999
e	0.5
s	3
inlier_thresh	20

leuven1 → leuven2

Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transform matrix:

```
[[ 1.003 -0.006  5.147]
 [ 0.008  0.993 -2.856]
 [ 0.     0.     1.   ]]
```

Results of image stitching using the calculated transform

Discussion: This alignment worked pretty much perfectly. There is a small amount of blurring that can be seen, but otherwise the transform is very accurate. This is corroborated by the high proportion of blue to red lines in the RANSAC results image.

leuven1 → leuven3

Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transform matrix:

```
[[ 1.002e+00  3.000e-03  4.555e+00]
 [ 2.000e-03  9.930e-01 -3.314e+00]
 [ 0.000e+00  0.000e+00  1.000e+00]]
```

Results of image stitching using the calculated transform

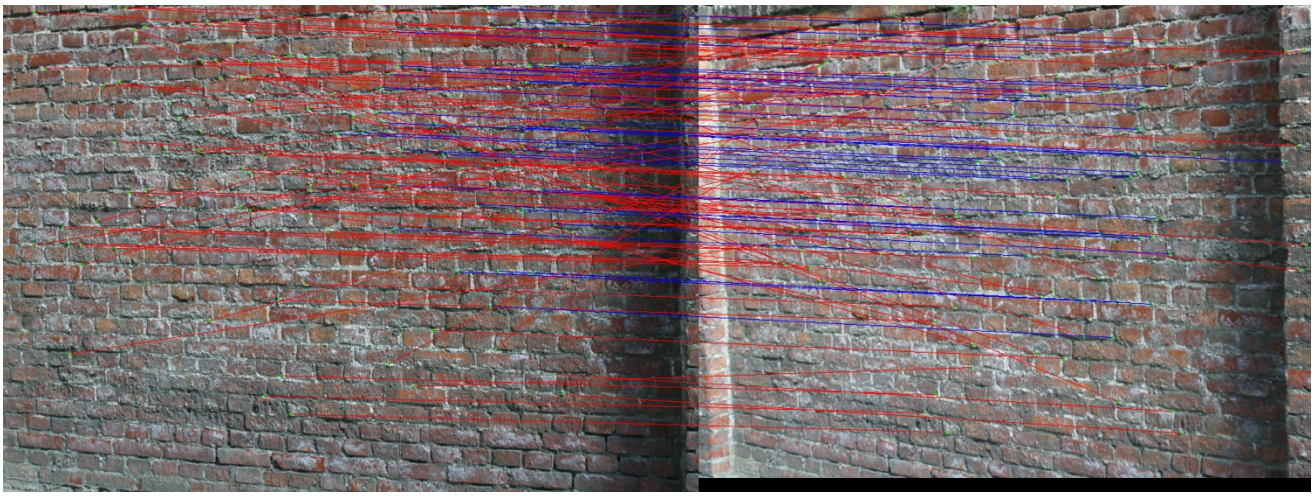
Discussion: This alignment also worked pretty much perfectly. There is a small amount of blurring that can be seen, but otherwise the transform is very accurate. This is corroborated by the high proportion of blue to red lines in the RANSAC results image.

WALL

Optimized parameters:

Parameter	Value
w_diam	7
k	0.05
s_size	3
r_thresh	0.2
nms_window	15
wsize	9
p	0.999
e	0.5
s	3
inlier_thresh	50

wall1 → wall2:



Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

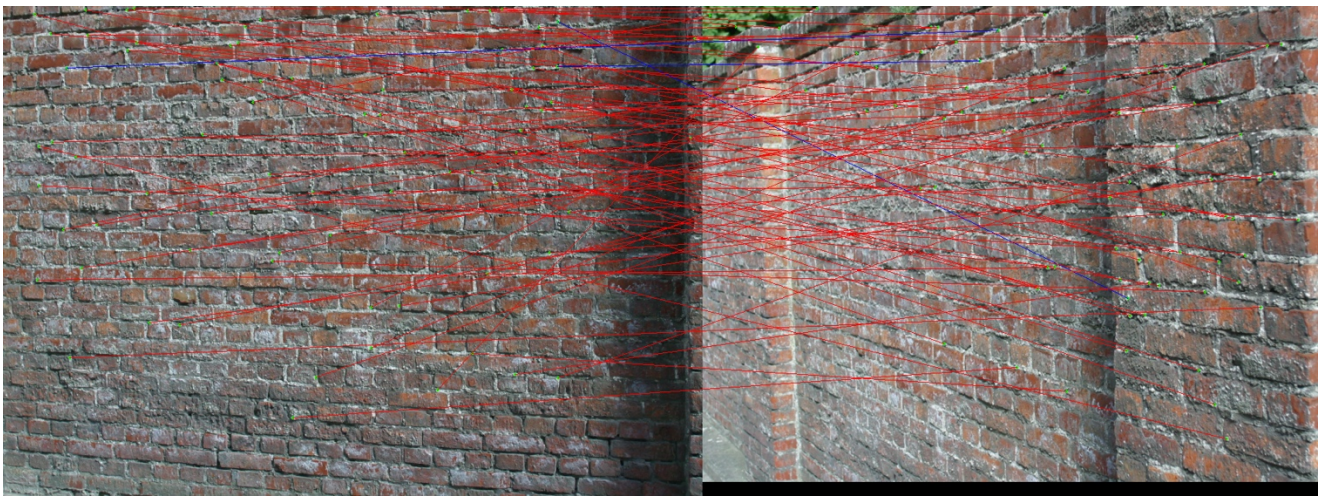
Calculated affine transform:

```
[[ 8.8400e-01  2.4000e-02 -3.3284e+01]
 [-8.0000e-03  1.0260e+00  3.9107e+01]
 [ 0.0000e+00  0.0000e+00  1.0000e+00]]
```

Results of image stitching using the calculated transform

Discussion: This alignment worked fairly well. Around the center-right of the image, the alignment is near perfect, but surrounding it, there is a good amount of blurring caused by discrepancies in the overlaid images. It is likely due to the difference in angles of the images, which a projective transformation would be better able to account for.

wall1 → wall3



Results of RANSAC: outliers (red) and inliers (blue) with the optimal affine transform

Calculated affine transform matrix:

```
[[-4.70000e-02 -3.31300e+00  7.17799e+02]
 [ 4.80000e-02 -5.29600e+00  4.95723e+02]
 [ 0.00000e+00  0.00000e+00  1.00000e+00]]
```

Results of image stitching using the calculated transform

Discussion: This alignment was extremely poor, with little to no correlation between the transformed image and the second image. Looking at the two images, there is a very large difference between the angle used to capture each image, resulting in a large difference in the way these appear in a 2D plane. A projective transformation is required to accurately perform an alignment of these two images.