COMPUTER VISION
ASSIGNMENT 2

Guru Pradeep Reddy (14CO246)

Note : All the experiments are performed on resized_image1.png and resized_image2.png files and as the images is little big zoom in to see the gradient images clearly.

1. Gaussian filter to reduce Noise
Varied size of the Gaussian window and compared the results .
As the original image itself looks clear without much noise application of filters just blurs the image a little the effect is little more prominent in case of 5*5 window size but as the image is of high resolution you can't exactly notice this difference until you zoom in.
Observation : 3*3 gives better results compared to 5*5, so rest of the experiments using gaussian filter of size 3*3.

2. Finding Corners using Harris Corner Detection using Gaussian Filter :
Harris corner detector was used to find the corners in both the images. Gaussian window of size 3 and 5 and tried, similarly sobel operator with size 3 and 5 are tried. Out of them the combination of gaussian window of size 3 and sobel of size 3 gave better results.

Observation : As we are focussed in getting all the corner points which are common to both the images, low threshold value is used, even though it gives few extra corners. As we are picking the common corners manually out of this, we can discard the unwanted ones, but we can make sure that all the required corners are detected. All the corner points are written in a file for future use.

Results :
Corners in first image : corner1.png
Corners in second image : corner2.png
Coordinates of corners in first Image : corner1.txt
Coordinates of corners in second image : corner2.txt

3. Manually Choosing the Corner points :
Next step is to manually choose the corners which are common to both the images. This is done with the help of corner images which are plotted using harris corner detector. OpenCV Image viewer was used to get the exact coordinates of the images. After this the common points are marked on the images.

NOTE :
As it is difficult to notice the corners if just one pixel is colored, I colored the pixels in neighbourhood (5*5 to be precise). This is done only to make the visualization of the corners easier on the image. Approximately 25 common corners have been marked.

Results :
Common Corners in Image1 : common_corners1.png
Common Corners in Image2 : common_corners2.png

4. Getting the Homography matrix :
Used a function which calculates a matrix using several pairs of the points(common corner points) in both coordinate systems and then the Homography matrix is computed by using SVD method.

$$\mathbf{SVD}\ (A) = UL(V\text{^}\mathbf{transpose})$$

The last column of the **V** matrix is reshaped into 3*3 matrix to get the required Homography matrix.

5. Getting the Perspective changed Image :
After obtaining the Homography matrix the first image can be projected into the image plan of the second plane by taking dot product of every coordinate(by making it homogenous) with the Homography matrix. After getting the result we have to make it homogenous again, we can do this by dividing the X and Y (transformed coordinates) with the third coordinate. So the final transformed version of the coordinate will be (X1, Y1, 1) which is a homogeneous coordinate.
Problem Identified :
If we directly do this conversion some coordinates of the first image will have negative values after the transformation, so we can't display them.
Solution :
There are two ways of dealing with the situation.

1. Ignore all the points in the first image which are getting negative coordinates after the transformation. If we do this we will miss some portion of the first image but the overlapping part will come properly. We can use this approach if there is a lot of overlap among the images.
2. If we don't want to miss any part of the first image we can use this approach. In this approach all the transformed points will be translated by same amount(**Tx and Ty**) such that it won't result in any negative coordinates. To obtain Tx and Ty we calculate the transformation for the corners of the first image and the minimum value in both the X and Y directions are used **Tx and Ty.** This translation guarantees that all the coordinates of the first image have positive values in perspective changed Image.

Results :
Perspective Changed Image : perspective.png

6. Stitching the Images :

After getting the perspective changed image of the first one. The required stitched image can be obtained by superimposing the second on the first one. This is done by simply translating all the coordinate values of the second image by **Tx and Ty** in X and Y directions respectively.

Results :
Final Stitched Image : stitched_image.png

7. Further Observations :

1. The last row in the Homography matrix should look like this [0,0,1]. If it looks likes then we can say that transforms one homogeneous coordinate to another. But the result which is obtained from the SVD doesn't satisfy this property. I rectified this by dividing all the transformed coordinates with the third coordinate to make them homogenous.
2. The approach used computes the transformed co ordinate of source image just by simple multiplication with the Homography matrix. But this doesn't guarantee that the transformed coordinates will be adjacent to each other as they are there in the original image. This is because the transform switches the original image thereby occupying more area and also all the coordinates in the transformed image won't be occupied due to some rounding off errors. As we can see that it is easy to notice if the area of transformed image is more all the pixels of it won't be mapped which leaves some dark patches in the transformed image. But they are thin and won't affect the transformed image too much.
3. **Steps that can be taken to get better results :** We can do some sort of interpolation to fill the missing pixels in the stitched image or else closing operation can be done using some 3*3 kernel. The above approaches have been tried but in the pictures which i have taken the transformed image is stretched a lot resulting in little thin dark patches. So the results haven't improved much.