CVE Assignment 4 Report

Question 1 (PS4-1)

Algorithm and Observations

The objective of the program was to stitch together three images after transforming them to align 4 common features on each image for each stitch. This involved selecting the common features manually on each image and using them to perform perspective transformation of the side images with reference to the centre image being stationary, and combining them. The results of picking the common features were stored in a json file in the same directory to reuse the same points while testing any changes in the source code.

The following algorithm was used to perform the task:

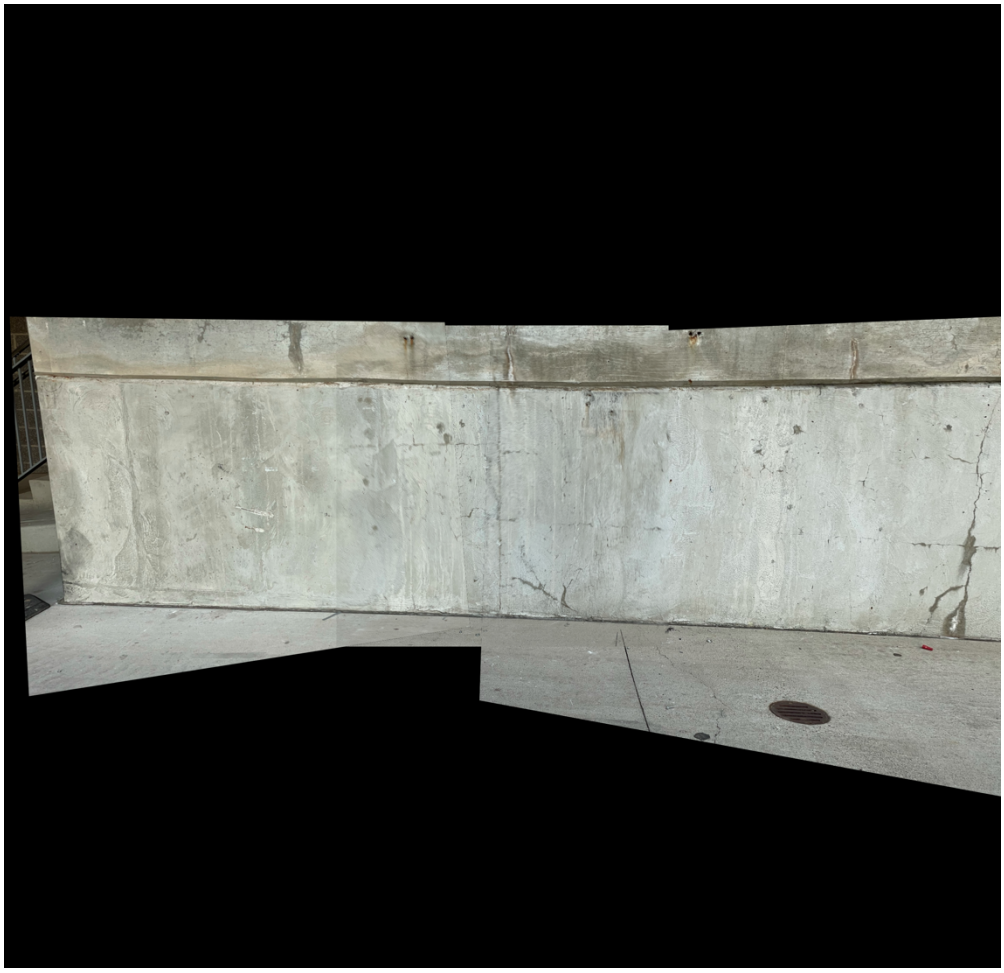
1. Ask the user for the dataset of the images to be used. Import the left, center and right images of that dataset.
2. If an existing datapoint set exists, choose to use them, or make new selections.
3. Choose 4 points on the right image (highlighted by red); once satisfied, confirm the selection, and repeat the process for the central image.
4. Repeat the process for the left image and the central image pair (features highlighted in blue).
5. Generate a black surface and place the centre image in the middle of the surface. Use perspective transformation to change the image and place it in the appropriate position of the black surface.
6. For pixels with input from multiple overlapping images, apply a weight at each input to normalize the values to 1.
7. Display and save the final image.

Observation from the images:

The images given along with the question were implemented in the code to create their stitiched equivalents. The following observations were made while performing the operations.

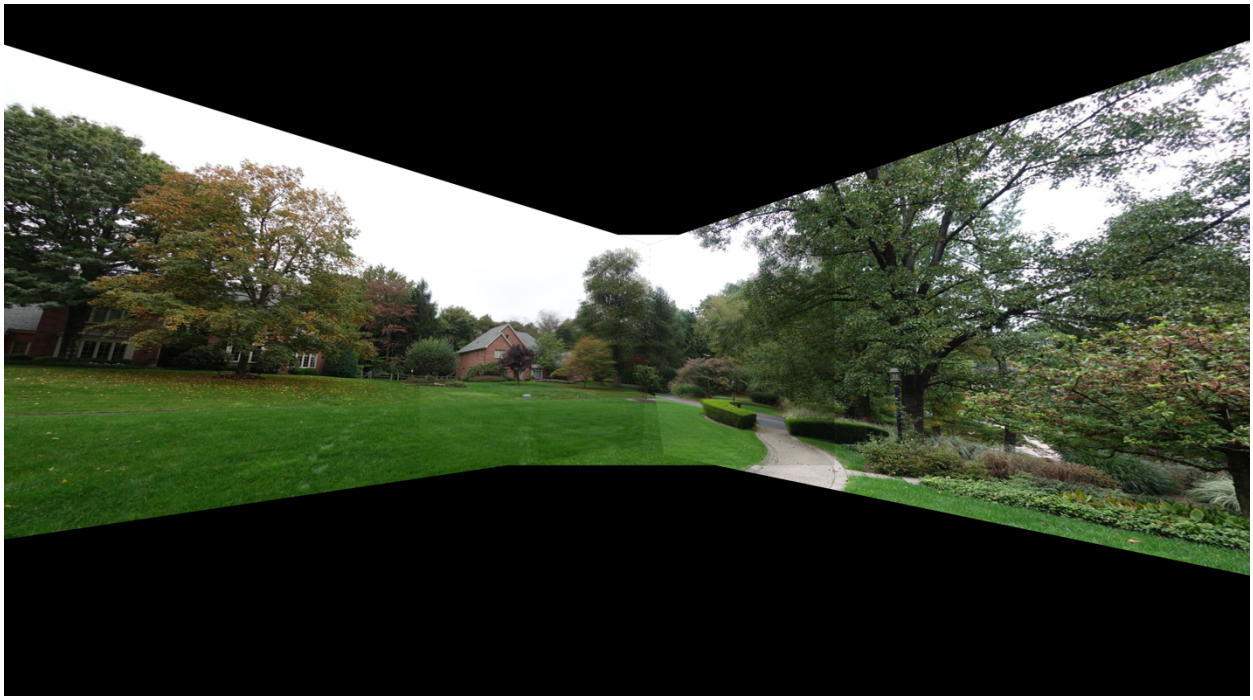
1. It was relatively easy to apply this image mosacing technique on images with a smaller number of distinctive feature like the “wall” dataset.
2. Geometric features like lines and grids were useful in testing the efficiency of the feature choice for that dataset (“door” dataset).
3. Features selected over a wider area and in a rough approximation of the targeting perspective transform yielded better results.
4. Images taken over a wider angle were more difficult to stitch without creating distinctive borders because of the variation in the brightness of the images (“house” dataset).
5. It was difficult to prevent overlap blurring in larger images with several distinctive features like the “pittsburgh” dataset. Instead of taking standard weigths for each pixel, weights created in favour of each image could have reduced the blurring in the images, giving a smoother transformation.
6. It was difficult to accurately select feature points for large images owing to human error while making the selection of the features with a mouse.

Results



wall-stiched.png

door-stiched.png



house-stiched.png

pittsburgh-stiched.png

Source Code

```
# import the necessary packages
import cv2
import numpy as np
import json

def savePick():
    global pick
    data = {}
    data["pick"] = pick
    with open("JSON/"+f+'-result.json', 'w') as outfile:
        json.dump(data, outfile)

def loadPick():
    global pick
    with open("JSON/"+f+'-result.json') as file:
        data = json.load(file)

    pick = data["pick"]

def combine():
    global result, imageC, imageL, imageR, pick
    (h,w) = imageC.shape[:2]

    cng = cv2.cvtColor(result, cv2.COLOR_BGR2GRAY)
    th, mask_c = cv2.threshold(cng, 1, 255, cv2.THRESH_BINARY)
    mask_c = mask_c / 255

    # right
    src_pnts = np.empty([4,2], np.float32)
    dst_pnts = np.empty([4,2], np.float32)
    for i in range(4):
        src_pnts[i][0] = float(pick[0][i][0])
        src_pnts[i][1] = float(pick[0][i][1])
        dst_pnts[i][0] = float(pick[1][i][0]+w)
        dst_pnts[i][1] = float(pick[1][i][1]+h)
    M = cv2.getPerspectiveTransform(src_pnts, dst_pnts)
    rn = cv2.warpPerspective(imageR, M, (w*3,h*3))
    rng = cv2.cvtColor(rn, cv2.COLOR_BGR2GRAY)
    th, mask_r = cv2.threshold(rng, 1, 255, cv2.THRESH_BINARY)
    mask_r = mask_r / 255

    #left
    src_pnts = np.empty([4,2], np.float32)
```

```
    dst_pnts = np.empty([4,2], np.float32)
    for i in range(4):
        src_pnts[i][0] = float(pick[2][i][0])
        src_pnts[i][1] = float(pick[2][i][1])
        dst_pnts[i][0] = float(pick[3][i][0]+w)
        dst_pnts[i][1] = float(pick[3][i][1]+h)

    M = cv2.getPerspectiveTransform(src_pnts, dst_pnts)
    ln = cv2.warpPerspective(imageL, M, (w*3,h*3))
    lng = cv2.cvtColor(ln, cv2.COLOR_BGR2GRAY)
    th, mask_l = cv2.threshold(lng, 1, 255, cv2.THRESH_BINARY)
    mask_l = mask_l / 255

    mask = np.array(mask_c + mask_l + mask_r, float)

    ag = np.full(mask.shape, 0.0, dtype=float)
    # weight: 1.0 / (num of picture)
    ag = 1.0 / np.maximum(1,mask) # avoid 0 division

    # generate result image from 3 images + alpha weight
    result[:,:,0] = result[:,:,0]*ag[:,:] + ln[:,:,0]*ag[:,:] +
rn[:,:,0]*ag[:,:]
    result[:,:,1] = result[:,:,1]*ag[:,:] + ln[:,:,1]*ag[:,:] +
rn[:,:,1]*ag[:,:]
    result[:,:,2] = result[:,:,2]*ag[:,:] + ln[:,:,2]*ag[:,:] +
rn[:,:,2]*ag[:,:]

    if dataset == 4:
        cv2.imwrite("ps4-images/Test/"+f+"-stiched.png", result)
    else:
        cv2.imwrite("ps4-images/"+f+"-stiched.png", result)
    cv2.imshow("result", result)

'''
pick 4 points from right image (red point)
'''
def right_click(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONUP:
        mousePick(x, y, 0)

'''
pick 4 points from center (correspond to right, red point)
'''
def center_click_r(event, x, y, flags, param):
```

```
    if event == cv2.EVENT_LBUTTONUP:
        mousePick(x, y, 1)

'''
pick 4 points from left (blue point)
'''
def left_click(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONUP:
        # add your code to select 4 points
        mousePick(x, y, 2)

'''
pick 4 points from center (correspond to left, blue point)
'''
def center_click_l(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONUP:
        # add your code to select 4 points
        mousePick(x, y, 3)

'''
idea: handle mouse pick
idx
0: right
1: center (correspond to right)
2: left
3: center (correspond to left)

you can also create your own function for left + center selection
'''
def mousePick(x, y, idx):
    global rn, cn, ln, imageR, imageC, imageL, pick
    if idx == 0:
        src = imageR
        dst = rn
        wn = "right"
    elif idx == 1:
        src = imageC
        dst = cn
        wn = "center"
    # you need to add idx 2, 3 cases
    elif idx == 2:
        src = imageL
        dst = ln
        wn = "left"
```

```
    elif idx == 3:
        src = imageC
        dst = cn
        wn = "center"

    pick[idx].append((x,y))
    dst = src.copy()
    # red BGR color in OpenCV, you need to set to blue on left side
    if idx == 0 or idx == 1:
        col = (0, 0, 255)
    else:
        col = (255,0,0)
    # place circle on the picked point and text its serial (0-3)
    for i in range(len(pick[idx])):
        if idx == 3:    #to retain the red points on the center image
            for j in range(len(pick[1])):
                dst = cv2.circle(dst, pick[1][j], 5, (0,0,255), 2)
                dst = cv2.putText(dst, str(j), (pick[1][j][0]+10,
pick[1][j][1]-10),
                                  cv2.FONT_HERSHEY_SIMPLEX,1, (0,0,255), 1)
        dst = cv2.circle(dst, pick[idx][i], 5, col, 2)
        dst = cv2.putText(dst, str(i), (pick[idx][i][0]+10,
pick[idx][i][1]-10),
                          cv2.FONT_HERSHEY_SIMPLEX,1, col, 1)
    # please make sure when idx == 3, you need to show red color circle
in dst
    # this example erases red circle

    cv2.imshow(wn, dst)
    # to make sure image is updated
    cv2.waitKey(1)
    if len(pick[idx]) >= 4:
        print('Is it OK? (y/n)')
        i = input()
        if i == 'y' or i == 'Y':
            if idx >= 3:
                savePick()
                combine()
            elif idx == 0:
                print('center 4 points')
                cv2.setMouseCallback("center", center_click_r)
            elif idx == 1:
                savePick()
                print('left 4 points')
```

```
                cv2.setMouseCallback("left", left_click)
            elif idx == 2:
                savePick()
                print('center 4 points')
                cv2.setMouseCallback("center", center_click_l)
        else:
            pick[idx] = []
            dst = src.copy()
            cv2.imshow(wn, dst)

# Enter Dataset number to use: 0 for wall dataset, 1 for door data, 2
for house data, 3 for pittsburgh data
dataset = int(input("ENTER DATASET TO BE USED: "))
global f

if dataset == 0:
    f = "wall"
    imageL = cv2.imread("ps4-images/"+f+"-left.png")
    imageC = cv2.imread("ps4-images/"+f+"-center.png")
    imageR = cv2.imread("ps4-images/"+f+"-right.png")

elif dataset == 1:
    f = "door"
    imageL = cv2.imread("ps4-images/"+f+"-left.jpg")
    imageC = cv2.imread("ps4-images/"+f+"-center.jpg")
    imageR = cv2.imread("ps4-images/"+f+"-right.jpg")

elif dataset == 2:
    f = "house"
    imageL = cv2.imread("ps4-images/"+f+"-left.jpg")
    imageC = cv2.imread("ps4-images/"+f+"-center.jpg")
    imageR = cv2.imread("ps4-images/"+f+"-right.jpg")
elif dataset == 3:
    f = "pittsburgh"
    imageL = cv2.imread("ps4-images/"+f+"-left.jpg")
    imageC = cv2.imread("ps4-images/"+f+"-center.jpg")
    imageR = cv2.imread("ps4-images/"+f+"-right.jpg")
else:
    f = "sorrel"
    imageL = cv2.imread("ps4-images/Test/"+f+"-left.jpg")
    imageC = cv2.imread("ps4-images/Test/"+f+"-center.jpg")
    imageR = cv2.imread("ps4-images/Test/"+f+"-right.jpg")
```

```
result =
cv2.copyMakeBorder(imageC,imageC.shape[0],imageC.shape[0],imageC.shape[
1],imageC.shape[1],

borderType=cv2.BORDER_CONSTANT,value=[0,0,0])

print(imageL.shape,imageC.shape,imageR.shape, result.shape)

cv2.namedWindow("left",cv2.WINDOW_NORMAL)
cv2.namedWindow("center",cv2.WINDOW_NORMAL)
cv2.namedWindow("right",cv2.WINDOW_NORMAL)
cv2.namedWindow("result",cv2.WINDOW_NORMAL)

ln = imageL.copy()
cn = imageC.copy()
rn = imageR.copy()

cv2.imshow("left", ln)
cv2.imshow("center", cn)
cv2.imshow("right", rn)
cv2.imshow("result", result)

pick = []
pick.append([])
pick.append([])
pick.append([])
pick.append([])

print('use saved points? (y/n)')
i = input()
if i == 'y' or i == 'Y':
    loadPick()
    combine()
else:
    print("right 4 points")
    cv2.setMouseCallback("right", right_click)

cv2.waitKey()

# close all open windows
cv2.destroyAllWindows()
```

System Specifications

Operating System: macOS Monterey Version 12.5.1
Hardware: MacBook Air 2017 (Intel Core i5)
Python: Conda environment utilizing Python 3.9.1
IDE: Visual Studio Code