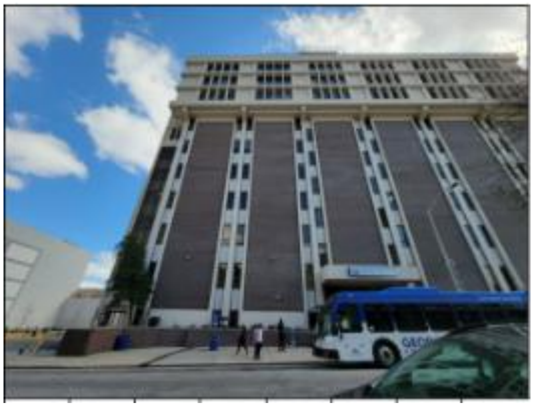
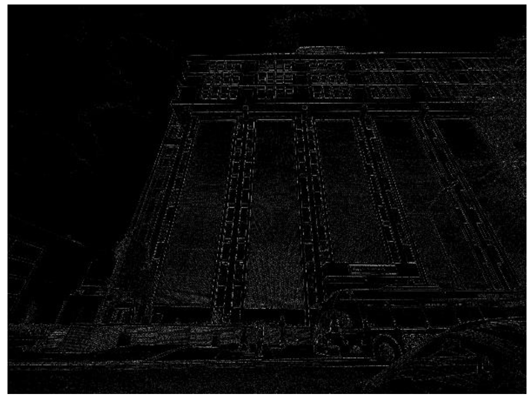
CV Assignment-2

Part-A

Canny Edge Detection





Original Image | Canny edge detected Image

```
In [2]: def gaussian_kernel(size, sigma=10):
            size = int(size) // 2
            x, y = np.mgrid[-size:size+1, -size:size+1]
            normal = 1 / (2.0 * np.pi * sigma**2)
            g =  np.exp(-((x**2 + y**2) / (2.0*sigma**2))) * normal
            return g
```

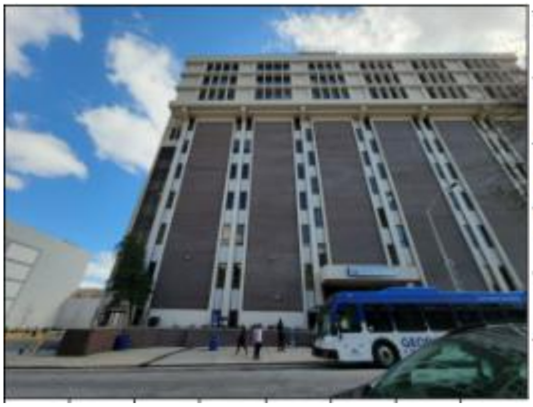
Custom Gaussian Kernel with 5*5 filter

```
def sobel_filters(img):
    Kx = np.array([[-1, 0, 1], [-2, 0, 2], [-1, 0, 1]], np.float32)
    Ky = np.array([[1, 2, 1], [0, 0, 0], [-1, -2, -1]], np.float32)

    Ix = ndimage.filters.convolve(img, Kx)
    Iy = ndimage.filters.convolve(img, Ky)

    G = np.hypot(Ix, Iy)
    G = G / G.max() * 255
    theta = np.arctan2(Iy, Ix)

    return (G, theta)
```

Custom build Sobel_filters

Using these custom functions, we can manipulate our image and do a non-max suppression then select only pixels that meets a weak and strong threshold value range. Also magnitudes and directions are taken and multiplied along the direction to get an edge. This is how we can get edges using canny edge detection algorithm.

Harris Corner Detection



Original Image

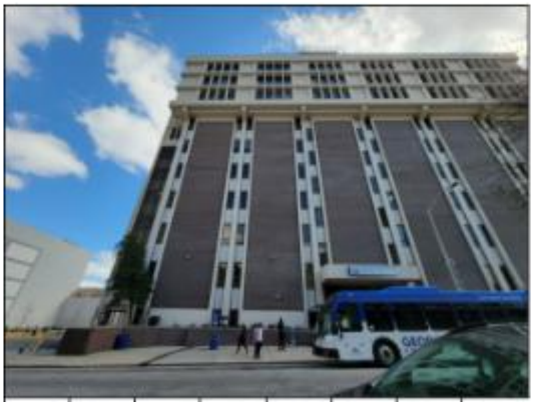
Harris Corner Detection

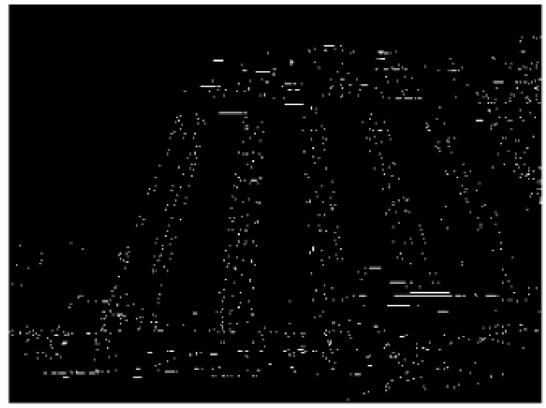
```
image = frame
operatedImage = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
operatedImage = np.float32(operatedImage)
dest = cv2.cornerHarris(operatedImage, 2, 3, 0.07)
dest = cv2.dilate(dest,gaussian_kernel(5,5))
image[dest > 0.01 * dest.max()]=[0, 0, 255]
plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
if cv2.waitKey(0) & 0xff == 27:
    cv2.destroyAllWindows()
image
```

```
array([[[211, 208, 204],
        [211, 208, 204],
        [211, 208, 204],
        ...,
        [217, 224, 221],
        [217, 224, 221],
        [217, 224, 221]],

       [[211, 208, 204],
        [211, 208, 204],
        [211, 208, 204],
        ...,
        [217, 224, 221],
        [217, 224, 221],
        [217, 224, 221]],

       [[211, 208, 204],
        [211, 208, 204],
        [211, 208, 204],
        ...,
        [217, 224, 221],
        [217, 224, 221],
        [217, 224, 221]],

       ...,
```

Part-B

MATLAB Internal Canny edge detector

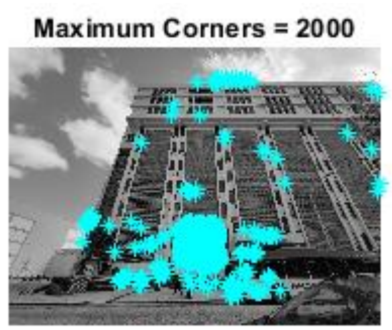




Original Image   Canny edge detected Image

```
img=imread('sample.jpg')
img= rgb2gray(img)
img=imgaussfilt(img,10)
img=edge(img,'sobel')
img=edge(img,'canny',0.175,5)
imshow(img)
```

MATLAB Internal Canny edge detector



As we can see the corners are shown as dots and stars MATLAB Harris corner detection works on how many corners you want. So, if I give 200 corners, it only see first 200 corners. In the above image I took around 2000 corners as my threshold value.

Image Stitching in MATLAB

3 images that we took to stitch together

After the images are stitched and by the way it is T-deck 😉

Function that can calculate integral image in real time

```
def integral_image(image, *, dtype=None):
    if dtype is None and image.real.dtype.kind == 'f':
        dtype = np.promote_types(image.dtype, np.float64)

    S = image
    for i in range(image.ndim):
        S = S.cumsum(axis=i, dtype=dtype)
    return S


def integrate(ii, start, end):
    start = np.atleast_2d(np.array(start))
    end = np.atleast_2d(np.array(end))
    rows = start.shape[0]

    total_shape = ii.shape
    total_shape = np.tile(total_shape, [rows, 1])

    start_negatives = start < 0
    end_negatives = end < 0
    start = (start + total_shape) * start_negatives + \
             start * ~(start_negatives)
    end = (end + total_shape) * end_negatives + \
           end * ~(end_negatives)

    if np.any((end - start) < 0):
        raise IndexError('end coordinates must be greater or equal to start')

    S = np.zeros(rows)
    bit_perm = 2 ** ii.ndim
    width = len(bin(bit_perm - 1)[2:])
    for i in range(bit_perm):
        binary = bin(i)[2:].zfill(width)
        bool_mask = [bit == '1' for bit in binary]

        sign = (-1)**sum(bool_mask)

        bad = [np.any(((start[r] - 1) * bool_mask) < 0)
               for r in range(rows)]

        corner_points = (end * (np.invert(bool_mask))) + \
                        ((start - 1) * bool_mask)

        S += [sign * ii[tuple(corner_points[r])] if(not bad[r]) else 0
              for r in range(rows)]
    return S
```

Integral Image of live feed of the rgb camera….

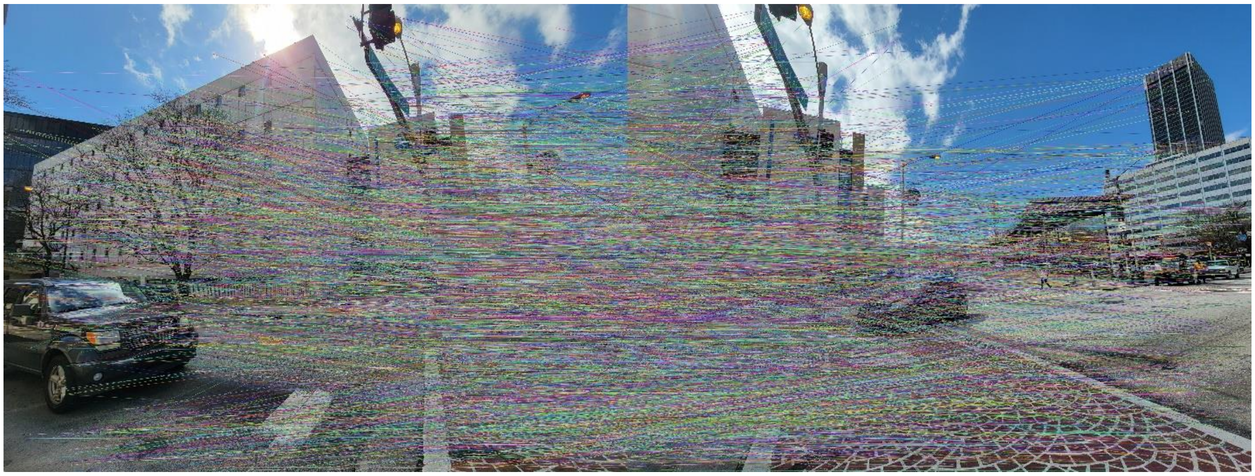
Stitched Image

Parts of images to be stitched

Image Stitching

```
class Image_Stitching():
    def __init__(self) :
        self.ratio=0.85
        self.min_match=10
        self.sift=cv2.SIFT_create()
        self.smoothing_window_size=800

    def registration(self,img1,img2):
        kp1, des1 = self.sift.detectAndCompute(img1, None)
        kp2, des2 = self.sift.detectAndCompute(img2, None)
        matcher = cv2.BFMatcher()
        raw_matches = matcher.knnMatch(des1, des2, k=2)
        good_points = []
        good_matches=[]
        for m1, m2 in raw_matches:
            if m1.distance < self.ratio * m2.distance:
                good_points.append((m1.trainIdx, m1.queryIdx))
                good_matches.append([m1])
        img3 = cv2.drawMatchesKnn(img1, kp1, img2, kp2, good_matches, None, flags=2)
        cv2.imwrite('matching.jpg', img3)
        if len(good_points) > self.min_match:
            image1_kp = np.float32(
                [kp1[i].pt for (_, i) in good_points])
            image2_kp = np.float32(
                [kp2[i].pt for (i, _) in good_points])
            H, status = cv2.findHomography(image2_kp, image1_kp, cv2.RANSAC,5.0)
        return H

    def create_mask(self,img1,img2,version):
        height_img1 = img1.shape[0]
        width_img1 = img1.shape[1]
        width_img2 = img2.shape[1]
        height_panorama = height_img1
        width_panorama = width_img1 +width_img2
        offset = int(self.smoothing_window_size / 2)
        barrier = img1.shape[1] - int(self.smoothing_window_size / 2)
        mask = np.zeros((height_panorama, width_panorama))
        if version== 'left_image':
            mask[:, barrier - offset:barrier + offset ] = np.tile(np.linspace(1, 0, 2 * offset ).T, (height_panorama, 1))
            mask[:, :barrier - offset] = 1
        else:
            mask[:, barrier - offset :barrier + offset ] = np.tile(np.linspace(0, 1, 2 * offset ).T, (height_panorama, 1))
            mask[:, barrier + offset:] = 1
        return cv2.merge([mask, mask, mask])

    def blending(self,img1,img2):
        H = self.registration(img1,img2)
        height_img1 = img1.shape[0]
        width_img1 = img1.shape[1]
        width_img2 = img2.shape[1]
        height_panorama = height_img1
```

Class to calculate panorama in realtime.



Sift Feature matching before creating a panorama. The feature selecting is done by SSD which is sum of squared distances.

```
img=imread('sample.jpg')
```

```
img = 3000×4000×3 uint8 array
img(:,:,1) =

  Columns 1 through 1,666

   204   204   204   204   204   204   204   204   205   205   205   205   205   205   205   205   204   204   204
    ⋮
```

```
img= rgb2gray(img)
```

```
img = 3000×4000 uint8 matrix
   207   207   207   207   207   207   207   207   208   208   208   208   208 ···
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
    ⋮
```

```
img=imgaussfilt(img,10)
```

```
img = 3000×4000 uint8 matrix
   207   207   207   207   207   207   207   207   207   207   207   207   207 ···
   207   207   207   207   207   207   207   207   207   207   207   207   207
   207   207   207   207   207   207   207   207   207   207   207   207   207
   207   207   207   207   207   207   207   207   207   207   207   207   208
   207   207   207   207   207   207   207   207   207   207   207   208   208
   207   207   207   207   207   207   207   207   207   207   207   208   208
   207   207   207   207   207   207   207   207   207   207   208   208   208
   207   207   207   207   207   207   207   207   207   208   208   208   208
   207   207   207   207   207   207   207   207   208   208   208   208   208
   207   207   207   207   207   207   207   208   208   208   208   208   208
    ⋮
```

```
img=edge(img,'sobel')
```

```
img = 3000×4000 logical array
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 ···
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    ⋮
```

```
img=edge(img,'canny',0.175,5)
```

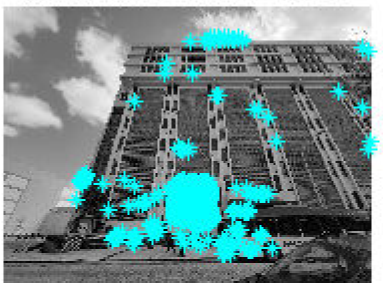
```
img = 3000×4000 logical array
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 ···
```

```
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  ⋮
```

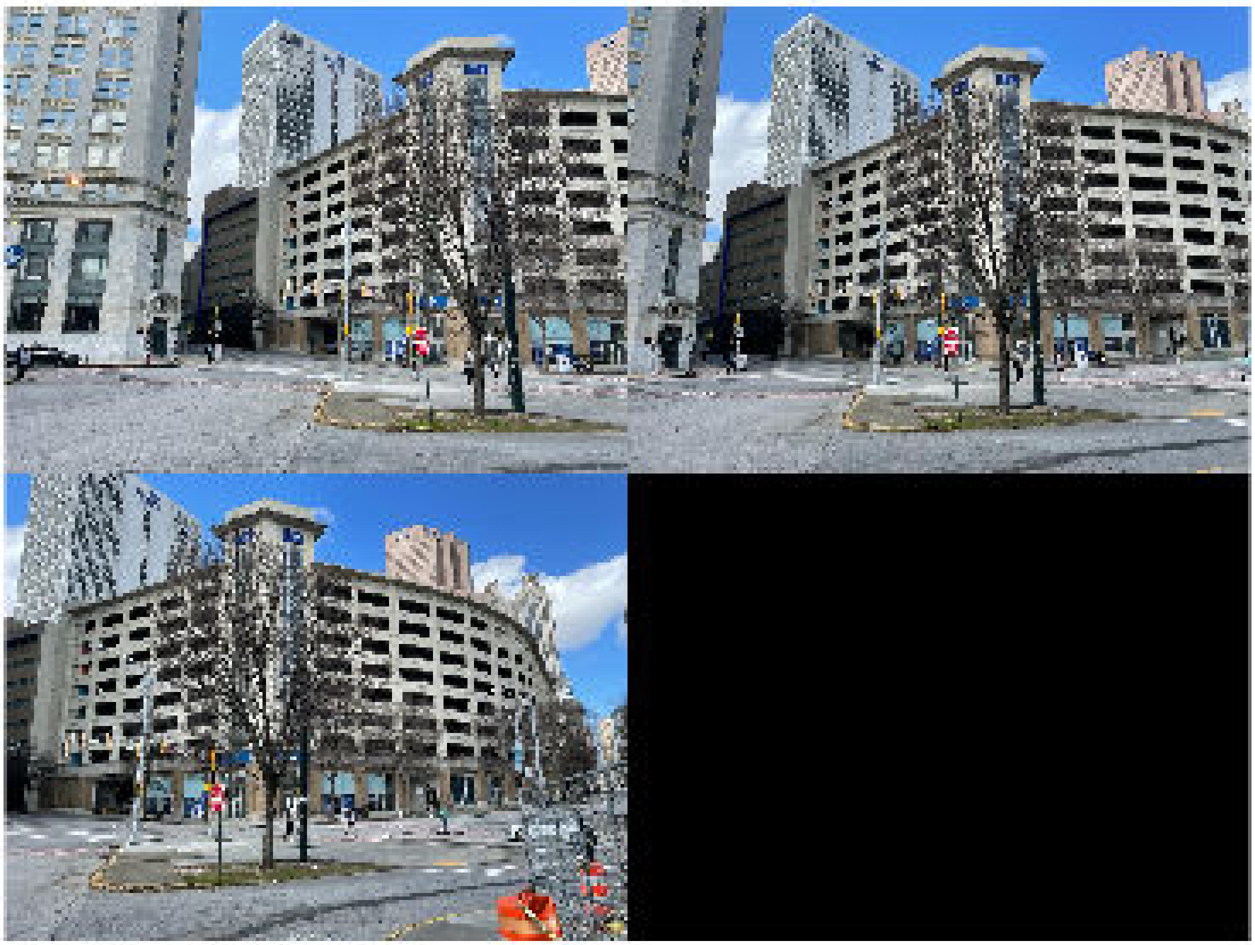
```
imshow(img)
```

```
I = imread('sample.jpg');
I = rgb2gray(I);
C=corner(I,'Harris',2000);
subplot(1,2,1);
imshow(I);

hold on
plot(C(:,1), C(:,2), '*', 'Color', 'c')
title('Maximum Corners = 2000')
hold off
```

Maximum Corners = 2000



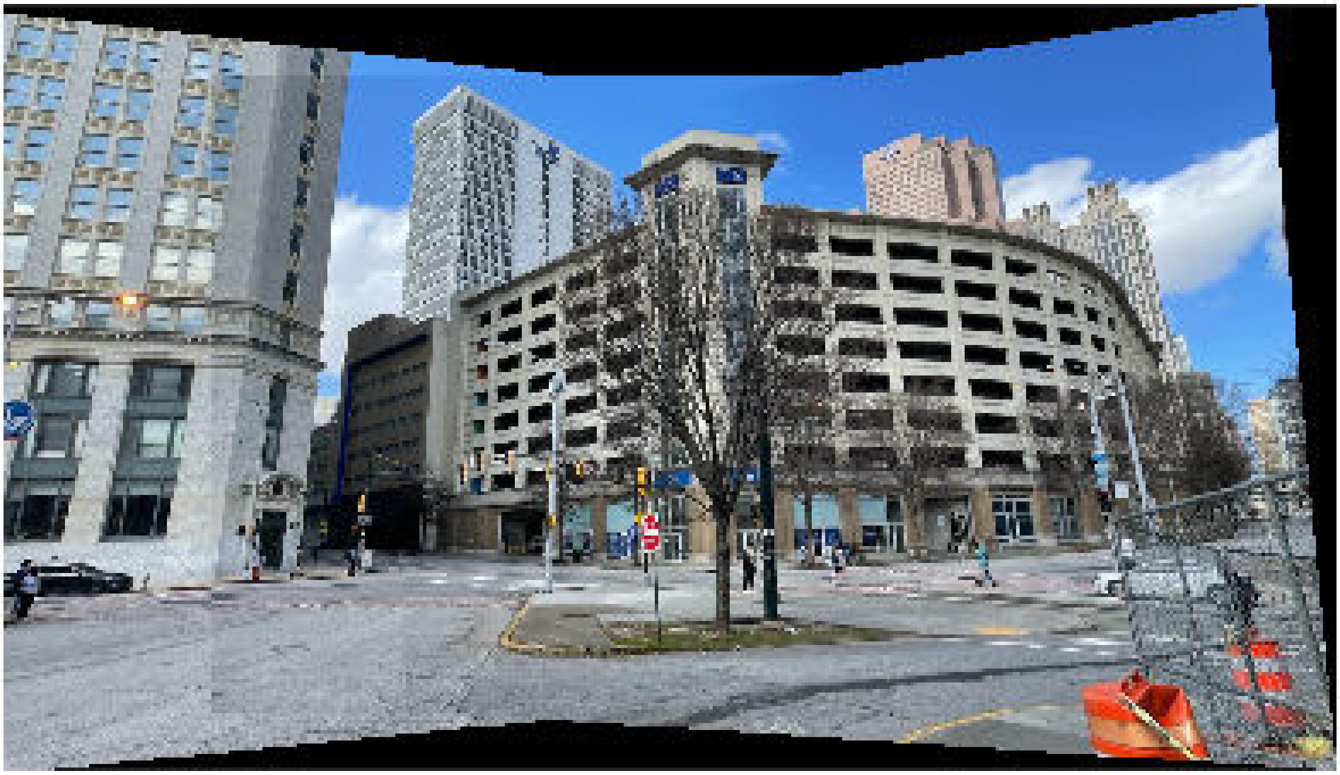
```
clc;
clear;
clear all;

% Load images.
buildingDir = fullfile('C:\Users\anant\Documents\MATLAB\data\myimages\building5');
buildingScene = imageDatastore(buildingDir);

% Display images to be stitched.
montage(buildingScene.Files)
```



```
% Read the first image from the image set.
I = readimage(buildingScene,1);

% Initialize features for I(1)
grayImage = im2gray(I);
points = detectSURFFeatures(grayImage);
[features, points] = extractFeatures(grayImage,points);


numImages = numel(buildingScene.Files);
tforms(numImages) = projective2d(eye(3));
```

```
imageSize = zeros(numImages,2);

% Iterate over remaining image pairs
for n = 2:numImages

    % Store points and features for I(n-1).
    pointsPrevious = points;
    featuresPrevious = features;

    % Read I(n).
    I = readimage(buildingScene, n);

    % Convert image to grayscale.
    grayImage = im2gray(I);

    % Save image size.
    imageSize(n,:) = size(grayImage);

    % Detect and extract SURF features for I(n).
    points = detectSURFFeatures(grayImage);
    [features, points] = extractFeatures(grayImage, points);

    % Find correspondences between I(n) and I(n-1).
    indexPairs = matchFeatures(features, featuresPrevious, 'Unique', true);

    matchedPoints = points(indexPairs(:,1), :);
    matchedPointsPrev = pointsPrevious(indexPairs(:,2), :);

    % Estimate the transformation between I(n) and I(n-1).
    tforms(n) = estimateGeometricTransform2D(matchedPoints, matchedPointsPrev,...
        'projective', 'Confidence', 99.9, 'MaxNumTrials', 2000);

    % Compute T(n) * T(n-1) * ... * T(1)
    tforms(n).T = tforms(n).T * tforms(n-1).T;
end
% Compute the output limits for each transform.
for i = 1:numel(tforms)
    [xlim(i,:), ylim(i,:)] = outputLimits(tforms(i), [1 imageSize(i,2)], [1 imageSize(i,1)]);
end
avgXLim = mean(xlim, 2);
[~,idx] = sort(avgXLim);
centerIdx = floor((numel(tforms)+1)/2);
centerImageIdx = idx(centerIdx);
Tinv = invert(tforms(centerImageIdx));
for i = 1:numel(tforms)
    tforms(i).T = tforms(i).T * Tinv.T;
end
for i = 1:numel(tforms)
    [xlim(i,:), ylim(i,:)] = outputLimits(tforms(i), [1 imageSize(i,2)], [1 imageSize(i,1)]);
end

maxImageSize = max(imageSize);
```

```
% Find the minimum and maximum output limits.
xMin = min([1; xlim(:)]);
xMax = max([maxImageSize(2); xlim(:)]);

yMin = min([1; ylim(:)]);
yMax = max([maxImageSize(1); ylim(:)]);

% Width and height of panorama.
width  = round(xMax - xMin);
height = round(yMax - yMin);

% Initialize the "empty" panorama.
panorama = zeros([height width 3], 'like', I);
blender = vision.AlphaBlender('Operation', 'Binary mask', ...
    'MaskSource', 'Input port');

% Create a 2-D spatial reference object defining the size of the panorama.
xLimits = [xMin xMax];
yLimits = [yMin yMax];
panoramaView = imref2d([height width], xLimits, yLimits);

% Create the panorama.
for i = 1:numImages

    I = readimage(buildingScene, i);

    % Transform I into the panorama.
    warpedImage = imwarp(I, tforms(i), 'OutputView', panoramaView);

    % Generate a binary mask.
    mask = imwarp(true(size(I,1),size(I,2)), tforms(i), 'OutputView', panoramaView);

    % Overlay the warpedImage onto the panorama.
    panorama = step(blender, panorama, warpedImage, mask);
end

figure
imshow(panorama)
```



In [1]:
```
import numpy as np
from scipy import ndimage
import cv2
from PIL import Image
import matplotlib.pyplot as plt
from matplotlib.pyplot import figure
```

In [2]:
```
def gaussian_kernel(size, sigma=10):
    size = int(size) // 2
    x, y = np.mgrid[-size:size+1, -size:size+1]
    normal = 1 / (2.0 * np.pi * sigma**2)
    g =  np.exp(-((x**2 + y**2) / (2.0*sigma**2))) * normal
    return g
```

In [3]:
```
def sobel_filters(img):
    Kx = np.array([[-1, 0, 1], [-2, 0, 2], [-1, 0, 1]], np.float32)
    Ky = np.array([[1, 2, 1], [0, 0, 0], [-1, -2, -1]], np.float32)

    Ix = ndimage.filters.convolve(img, Kx)
    Iy = ndimage.filters.convolve(img, Ky)

    G = np.hypot(Ix, Iy)
    G = G / G.max() * 255
    theta = np.arctan2(Iy, Ix)

    return (G, theta)
```

In [4]:
```
def visualize(img,dst):
    plt.subplot(121),plt.imshow(img),plt.title('Original')
    plt.xticks([]), plt.yticks([])
    plt.subplot(122),plt.imshow(dst,cmap="gray"),plt.title('Blurred')
    plt.xticks([]), plt.yticks([])
    plt.show()
```

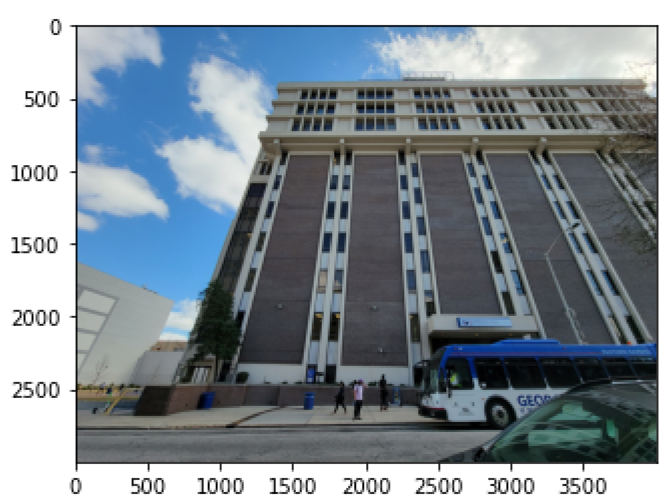
Canny Detector

In [5]:
```
def Canny_detector(img):
    weak_th = None
    strong_th = None
    # conversion of image to grayscale
    img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

    # Noise reduction step
    g=gaussian_kernel(5,5)

    img= cv2.filter2D(src=img, kernel=g, ddepth=19)

    mag,ang=sobel_filters(img)

    # setting the minimum and maximum thresholds
    # for double thresholding
    mag_max = np.max(mag)
    if not weak_th:weak_th = mag_max * 0.1
    if not strong_th:strong_th = mag_max * 0.5

    # getting the dimensions of the input image
    height, width = img.shape

    # Looping through every pixel of the grayscale
    # image
    for i_x in range(width):
        for i_y in range(height):

            grad_ang = ang[i_y, i_x]
            grad_ang = abs(grad_ang-180) if abs(grad_ang)>180 else abs(grad_ang)

            # selecting the neighbours of the target pixel
            # according to the gradient direction
            # In the x axis direction
            if grad_ang<= 22.5:
                neighb_1_x, neighb_1_y = i_x-1, i_y
                neighb_2_x, neighb_2_y = i_x + 1, i_y

            # top right (diagonal-1) direction
            elif grad_ang>22.5 and grad_ang<=(22.5 + 45):
                neighb_1_x, neighb_1_y = i_x-1, i_y-1
                neighb_2_x, neighb_2_y = i_x + 1, i_y + 1

            # In y-axis direction
            elif grad_ang>(22.5 + 45) and grad_ang<=(22.5 + 90):
                neighb_1_x, neighb_1_y = i_x, i_y-1
                neighb_2_x, neighb_2_y = i_x, i_y + 1

            # top left (diagonal-2) direction
            elif grad_ang>(22.5 + 90) and grad_ang<=(22.5 + 135):
                neighb_1_x, neighb_1_y = i_x-1, i_y + 1
                neighb_2_x, neighb_2_y = i_x + 1, i_y-1

            # Now it restarts the cycle
            elif grad_ang>(22.5 + 135) and grad_ang<=(22.5 + 180):
                neighb_1_x, neighb_1_y = i_x-1, i_y
                neighb_2_x, neighb_2_y = i_x + 1, i_y
```

```
            # Non-maximum suppression step
            if width>neighb_1_x>= 0 and height>neighb_1_y>= 0:
                if mag[i_y, i_x]<mag[neighb_1_y, neighb_1_x]:
                    mag[i_y, i_x]= 0
                    continue

            if width>neighb_2_x>= 0 and height>neighb_2_y>= 0:
                if mag[i_y, i_x]<mag[neighb_2_y, neighb_2_x]:
                    mag[i_y, i_x]= 0

    weak_ids = np.zeros_like(img)
    strong_ids = np.zeros_like(img)
    ids = np.zeros_like(img)
    # double thresholding step
    for i_x in range(width):
        for i_y in range(height):

            grad_mag = mag[i_y, i_x]

            if grad_mag<weak_th:
                mag[i_y, i_x]= 0
            elif strong_th>grad_mag>= weak_th:
                ids[i_y, i_x]= 1
            else:
                ids[i_y, i_x]= 2


    # finally returning the magnitude of
    # gradients of edges
    return mag
```

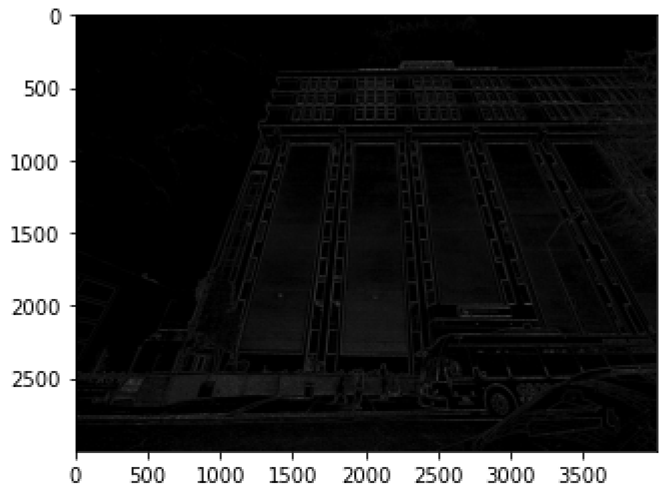
In [6]:
```
frame = cv2.imread('sample.jpg')
canny_img = Canny_detector(frame)

plt.imshow(cv2.cvtColor(frame, cv2.COLOR_BGR2RGB))
```

Out[6]: <matplotlib.image.AxesImage at 0x27292510f40>



In [7]:
```
plt.imshow(canny_img,cmap='gray')
```

Out[7]: <matplotlib.image.AxesImage at 0x2728db72dc0>



In [8]:
```
cv2.imwrite("canny_img.jpg",canny_img)
```

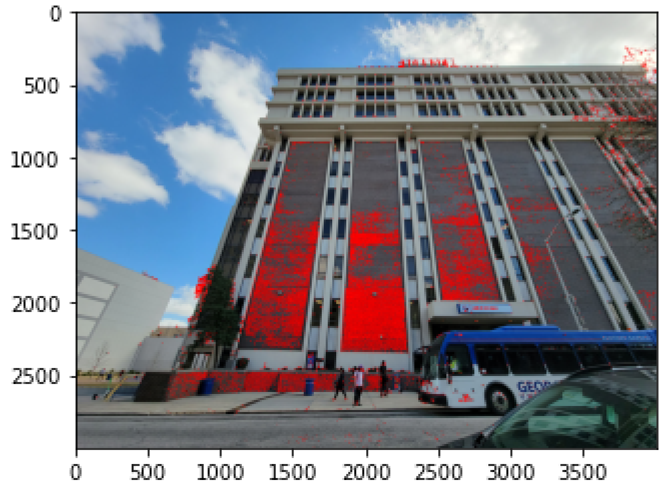
Out[8]: True

Harris Edge Detection

In [9]:
```
image = frame
operatedImage = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
operatedImage = np.float32(operatedImage)
dest = cv2.cornerHarris(operatedImage, 2, 3, 0.07)
dest = cv2.dilate(dest,gaussian_kernel(5,5))
image[dest > 0.01 * dest.max()]=[0, 0, 255]
plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
if cv2.waitKey(0) & 0xff == 27:
    cv2.destroyAllWindows()
image
```

Out[9]:
```
array([[[211, 208, 204],
        [211, 208, 204],
        [211, 208, 204],
        ...,
        [217, 224, 221],
        [217, 224, 221],
        [217, 224, 221]],

       [[211, 208, 204],
        [211, 208, 204],
        [211, 208, 204],
        ...,
        [217, 224, 221],
        [217, 224, 221],
        [217, 224, 221]],

       [[211, 208, 204],
        [211, 208, 204],
        [211, 208, 204],
        ...,
        [217, 224, 221],
        [217, 224, 221],
        [217, 224, 221]],

       ...,

       [[116, 111, 112],
        [115, 110, 111],
        [117, 112, 113],
        ...,
        [ 31,  34,  19],
        [ 37,  40,  25],
        [ 39,  42,  27]],

       [[113, 111, 111],
        [113, 111, 111],
        [115, 113, 113],
        ...,
        [ 31,  34,  19],
        [ 37,  40,  25],
        [ 39,  42,  27]],

       [[112, 110, 110],
        [112, 110, 110],
        [116, 114, 114],
        ...,
```

```
        [ 29,  32,  17],
        [ 34,  37,  22],
        [ 35,  38,  23]]], dtype=uint8)
```



In [10]:
```
cv2.imwrite("corner_image.jpg",image)
```

Out[10]:
```
True
```

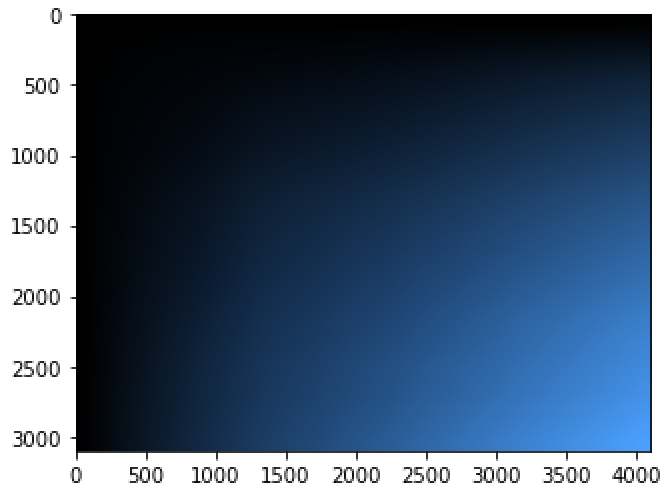
In [11]:
```
canny_img
```

Out[11]:
```
array([[ 0.       ,  0.       ,  0.       , ...,  0.       ,  0.       ,
         0.       ],
       [ 0.       ,  0.       ,  0.       , ...,  0.       ,  0.       ,
         0.       ],
       [ 0.       ,  0.       ,  0.       , ...,  0.       ,  0.       ,
         0.       ],
       ...,
       [ 0.       ,  0.       ,  0.       , ...,  0.       ,  0.       ,
         0.       ],
       [ 0.       ,  0.       ,  0.       , ..., 25.75889 ,  0.       ,
         0.       ],
       [ 0.       ,  0.       ,  0.       , ..., 35.721153,  0.       ,
         0.       ]], dtype=float32)
```

In [12]:
```
def integral_image(image, *, dtype=None):
    if dtype is None and image.real.dtype.kind == 'f':
        dtype = np.promote_types(image.dtype, np.float64)

    S = image
    for i in range(image.ndim):
        S = S.cumsum(axis=i, dtype=dtype)
    return S


def integrate(ii, start, end):
    start = np.atleast_2d(np.array(start))
    end = np.atleast_2d(np.array(end))
    rows = start.shape[0]

    total_shape = ii.shape
    total_shape = np.tile(total_shape, [rows, 1])

    start_negatives = start < 0
    end_negatives = end < 0
    start = (start + total_shape) * start_negatives + \
             start * ~(start_negatives)
    end = (end + total_shape) * end_negatives + \
           end * ~(end_negatives)

    if np.any((end - start) < 0):
        raise IndexError('end coordinates must be greater or equal to start')

    S = np.zeros(rows)
    bit_perm = 2 ** ii.ndim
    width = len(bin(bit_perm - 1)[2:])
    for i in range(bit_perm):
        binary = bin(i)[2:].zfill(width)
        bool_mask = [bit == '1' for bit in binary]

        sign = (-1)**sum(bool_mask)

        bad = [np.any(((start[r] - 1) * bool_mask) < 0)
               for r in range(rows)]

        corner_points = (end * (np.invert(bool_mask))) + \
                        ((start - 1) * bool_mask)

        S += [sign * ii[tuple(corner_points[r])] if(not bad[r]) else 0
              for r in range(rows)]
    return S
```

In [13]:
```
frame = cv2.imread('sample.jpg')
frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
frame= cv2.copyMakeBorder(frame, 50, 50, 50, 50, cv2.BORDER_CONSTANT, (0,0,0))
frame=integral_image(frame)
frame = frame/np.amax(frame)
frame = np.clip(frame, 0,255)
plt.imshow(frame)
```

Out[13]: <matplotlib.image.AxesImage at 0x2728dc6c4c0>



In [14]:
```
vid = cv2.VideoCapture(0)

while(True):
    ret, frame = vid.read()
    a=integral_image(frame)
    a = a/np.amax(a)
    a = np.clip(a, 0,255)
    cv2.imshow('frame',a )
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
vid.release()
cv2.destroyAllWindows()
```

Image Stitching

In [15]:
```
class Image_Stitching():
    def __init__(self) :
        self.ratio=0.85
        self.min_match=10
        self.sift=cv2.SIFT_create()
        self.smoothing_window_size=800

    def registration(self,img1,img2):
        kp1, des1 = self.sift.detectAndCompute(img1, None)
        kp2, des2 = self.sift.detectAndCompute(img2, None)
        matcher = cv2.BFMatcher()
        raw_matches = matcher.knnMatch(des1, des2, k=2)
        good_points = []
        good_matches=[]
        for m1, m2 in raw_matches:
            if m1.distance < self.ratio * m2.distance:
                good_points.append((m1.trainIdx, m1.queryIdx))
                good_matches.append([m1])
        img3 = cv2.drawMatchesKnn(img1, kp1, img2, kp2, good_matches, None, flags
        cv2.imwrite('matching.jpg', img3)
        if len(good_points) > self.min_match:
            image1_kp = np.float32(
                [kp1[i].pt for (_, i) in good_points])
            image2_kp = np.float32(
                [kp2[i].pt for (i, _) in good_points])
            H, status = cv2.findHomography(image2_kp, image1_kp, cv2.RANSAC,5.0)
        return H

    def create_mask(self,img1,img2,version):
        height_img1 = img1.shape[0]
        width_img1 = img1.shape[1]
        width_img2 = img2.shape[1]
        height_panorama = height_img1
        width_panorama = width_img1 +width_img2
        offset = int(self.smoothing_window_size / 2)
        barrier = img1.shape[1] - int(self.smoothing_window_size / 2)
        mask = np.zeros((height_panorama, width_panorama))
        if version== 'left_image':
            mask[:, barrier - offset:barrier + offset ] = np.tile(np.linspace(1,
            mask[:, :barrier - offset] = 1
        else:
            mask[:, barrier - offset :barrier + offset ] = np.tile(np.linspace(0,
            mask[:, barrier + offset:] = 1
        return cv2.merge([mask, mask, mask])

    def blending(self,img1,img2):
        H = self.registration(img1,img2)
        height_img1 = img1.shape[0]
        width_img1 = img1.shape[1]
        width_img2 = img2.shape[1]
        height_panorama = height_img1
        width_panorama = width_img1 +width_img2

        panorama1 = np.zeros((height_panorama, width_panorama, 3))
        mask1 = self.create_mask(img1,img2,version='left_image')
        panorama1[0:img1.shape[0], 0:img1.shape[1], :] = img1
```

```
        panorama1 *= mask1
        mask2 = self.create_mask(img1,img2,version='right_image')
        panorama2 = cv2.warpPerspective(img2, H, (width_panorama, height_panorama
        result=panorama1+panorama2

        rows, cols = np.where(result[:, :, 0] != 0)
        min_row, max_row = min(rows), max(rows) + 1
        min_col, max_col = min(cols), max(cols) + 1
        final_result = result[min_row:max_row, min_col:max_col, :]
        return final_result
```

In [16]:
```
d='building5'
img1=cv2.cvtColor(cv2.imread(d+'/1.jpg'), cv2.COLOR_BGR2RGB)
img2=cv2.cvtColor(cv2.imread(d+'/2.jpg'), cv2.COLOR_BGR2RGB)
img3=cv2.cvtColor(cv2.imread(d+'/3.jpg'), cv2.COLOR_BGR2RGB)
```

In [17]:
```
stitcher = cv2.Stitcher_create()
(status, stitched) = stitcher.stitch([img1,img2,img3])
print(status)
```

```
0
```

In [18]:
```
plt.imshow(stitched)
```

Out[18]: <matplotlib.image.AxesImage at 0x2728ef9f520>

In [19]:
```
cv2.imwrite(d+'/final.jpg',stitched)
```

Out[19]: True