Report

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1 Assignment -5 Optical Flow

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1.1 Optical Flow:

Optical flow or optic flow is the pattern of apparent motion of objects, surfaces, and edges in a visual scene caused by the relative motion between an observer and a scene. Optical flow can also be defined as the distribution of apparent velocities of movement of brightness pattern in an image. We assume that the Intensities of point doesn't change between respective frames.

$$I(x, y, t) = I(x + \Delta x, y + \Delta y, t + \Delta t)$$

$$I(x + \Delta x, y + \Delta y, t + \Delta t) = I(x, y, t) + \frac{\partial I}{\partial x}\Delta x + \frac{\partial I}{\partial y}\Delta y + \frac{\partial I}{\partial t}\Delta t + H.O.T. \tag{1}$$

From Equation 1 we have

$$\frac{\partial I}{\partial x}\Delta x + \frac{\partial I}{\partial y}\Delta y + \frac{\partial I}{\partial t}\Delta t = 0$$

$$\frac{\partial I}{\partial x}\frac{\Delta x}{\Delta t} + \frac{\partial I}{\partial y}\frac{\Delta y}{\Delta t} + \frac{\partial I}{\partial t}\frac{\Delta t}{\Delta t} = 0$$

$$\frac{\partial I}{\partial x}V_x + \frac{\partial I}{\partial y}V_y + \frac{\partial I}{\partial t} = 0$$

```
In [17]: import numpy as np
         import pandas as pd
         import matplotlib.pyplot as plt
         import cv2 as cv
```

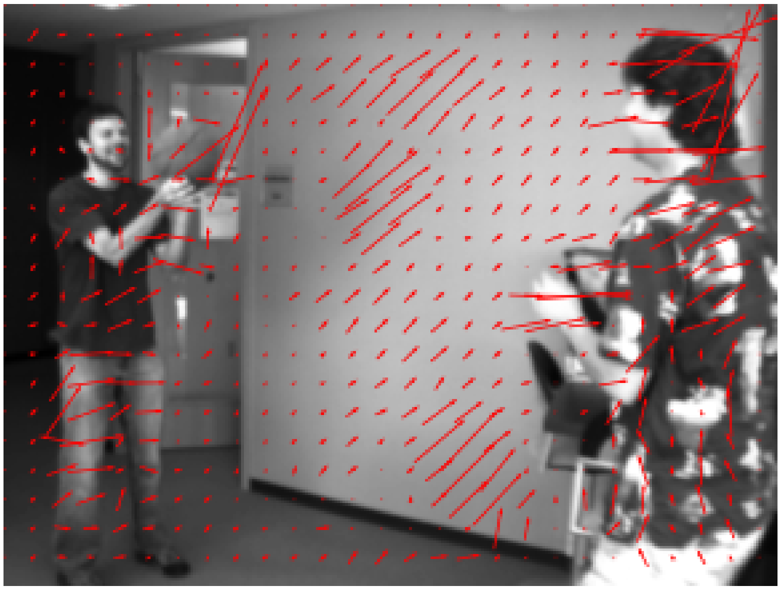
```
In [28]: def optical_flow(frame1, frame2, win=2):
             Ix = np.zeros(frame1.shape).astype(np.float32)
             Iy = np.zeros(frame1.shape).astype(np.float32)
             It = np.zeros(frame1.shape).astype(np.float32)

             Ix[1:-1, 1:-1] = cv.subtract(frame1[1:-1, 2:], frame1[1:-1, :-2]) / 2
```

```
    Iy[1:-1, 1:-1] = cv.subtract(frame1[2:, 1:-1], frame1[:-2, 1:-1]) / 2
    It[1:-1, 1:-1] = cv.subtract(frame1[1:-1, 1:-1], frame2[1:-1, 1:-1])

    params = np.zeros(frame1.shape + (5, ))
    params[..., 0] = Ix**2
    params[..., 1] = Iy**2
    params[..., 2] = Ix * Iy
    params[..., 3] = Ix * It
    params[..., 4] = Iy * It
    del It, Ix, Iy
    cum_params = np.cumsum(np.cumsum(params, axis=0), axis=1)
    del params
    win_params = (cum_params[2 * win + 1:, 2 * win + 1:] -
                  cum_params[2 * win + 1:, :-1 - 2 * win])
    win_params -= cum_params[:-1 - 2 * win, 2 * win + 1:]
    win_params += cum_params[:-1 - 2 * win, :-1 - 2 * win]
    del cum_params
    op_flow = np.zeros(frame1.shape + (2, ))
    det = win_params[..., 0] * win_params[..., 1] - win_params[..., 2]**2

    op_flow_x = np.where(det != 0,
                         (win_params[..., 1] * win_params[..., 3] -
                          win_params[..., 2] * win_params[..., 4]) / det, 0)
    op_flow_y = np.where(det != 0,
                         (win_params[..., 0] * win_params[..., 4] -
                          win_params[..., 2] * win_params[..., 3]) / det, 0)
    op_flow[win + 1:-1 - win, win + 1:-1 - win, 0] = op_flow_x[:-1, :-1]
    op_flow[win + 1:-1 - win, win + 1:-1 - win, 1] = op_flow_y[:-1, :-1]
    op_flow = op_flow.astype(np.float32)
    return op_flow
```

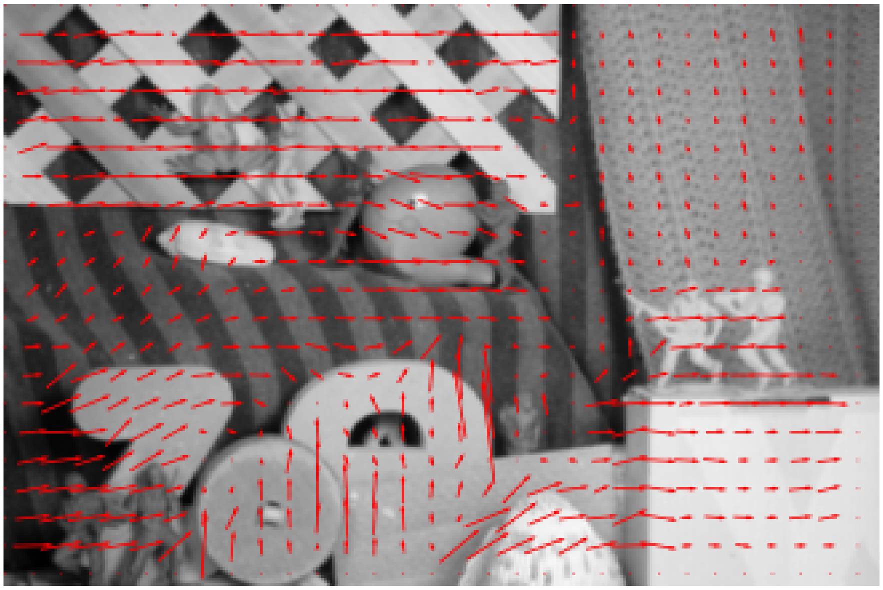
In [29]:

```
def draw_flow(img, flow):
    x = np.arange(0, img.shape[1], 1)
    y = np.arange(0, img.shape[0], 1)
    x, y = np.meshgrid(x, y)
    plt.figure()
    fig = plt.imshow(img, cmap='gray', interpolation='bicubic')
    plt.axis('off')
    fig.axes.get_xaxis().set_visible(False)
    fig.axes.get_yaxis().set_visible(False)
    step = img.shape[0] / 20
    step = int(step)
    plt.quiver(
        x[::step, ::step],
        y[::step, ::step],
        flow[::step, ::step, 0],
        flow[::step, ::step, 1],
        color='r',
                pivot='middle',
                headwidth=2,
                headlength=3)
            plt.axis('off')
            plt.show()
```

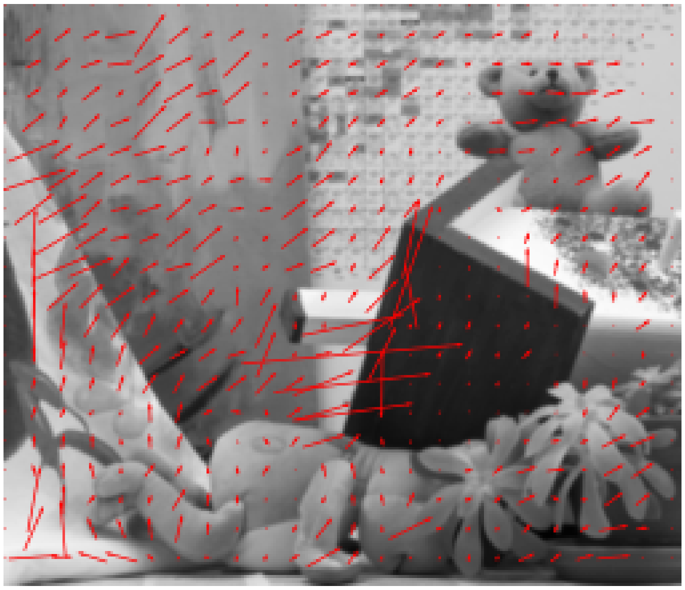
```
In [30]: image1 = cv.imread("eval-data-gray/Basketball/frame10.png", 0)
         image2 = cv.imread("eval-data-gray/Basketball/frame11.png", 0)
         flow = optical_flow(image1, image2, 15)
         draw_flow(image1, flow)
```



```
In [31]: image1 = cv.imread("eval-data-gray/Army/frame10.png", 0)
         image2 = cv.imread("eval-data-gray/Army/frame11.png", 0)
         flow = optical_flow(image1, image2, 15)
         draw_flow(image1, flow)
```

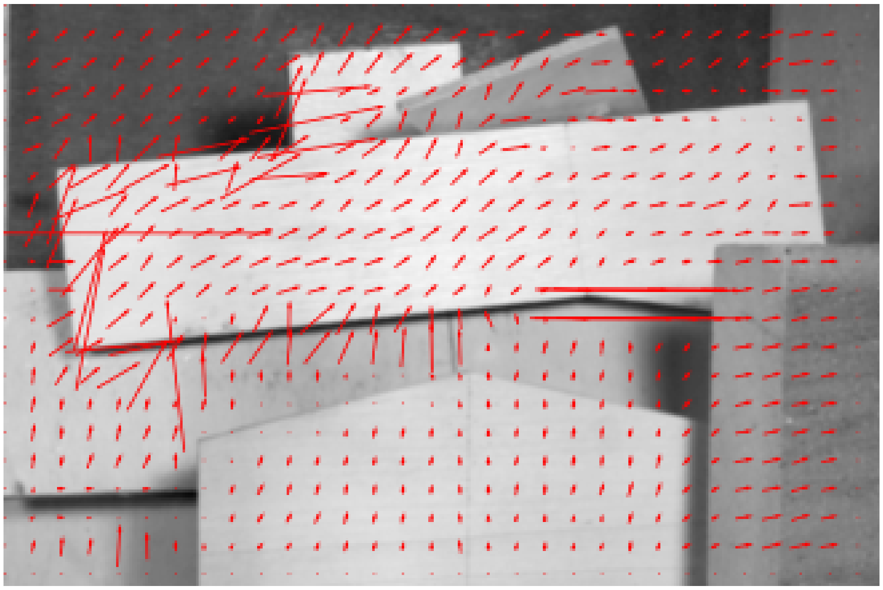


```
In [32]: image1 = cv.imread("eval-data-gray/Teddy/frame10.png", 0)
         image2 = cv.imread("eval-data-gray/Teddy/frame11.png", 0)
         flow = optical_flow(image1, image2, 15)
         draw_flow(image1, flow)
```

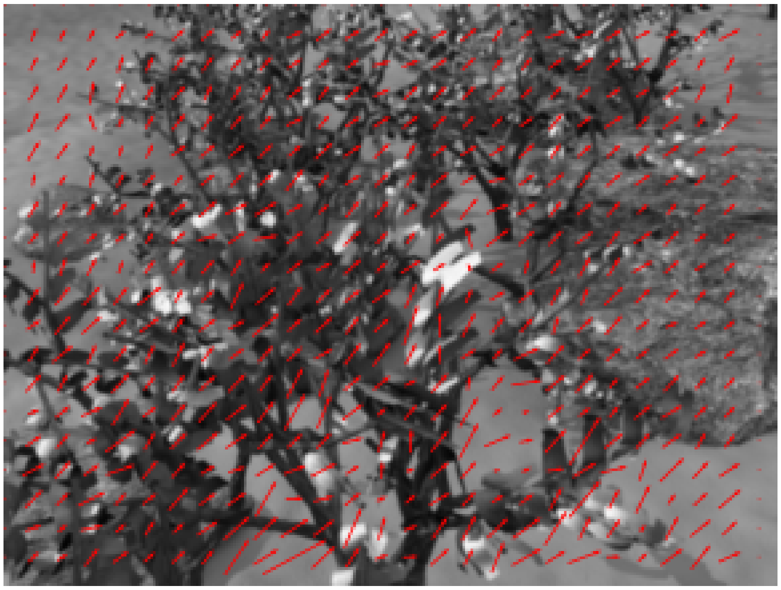


```
In [33]: image1 = cv.imread("eval-data-gray/Wooden/frame10.png", 0)
         image2 = cv.imread("eval-data-gray/Wooden/frame11.png", 0)
```

```
flow = optical_flow(image1, image2, 15)
draw_flow(image1, flow)
```



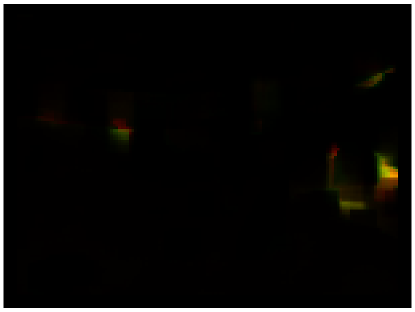
```
In [34]: image1 = cv.imread("eval-data-gray/Grove/frame10.png", 0)
         image2 = cv.imread("eval-data-gray/Grove/frame11.png", 0)
         flow = optical_flow(image1, image2, 15)
         draw_flow(image1, flow)
```

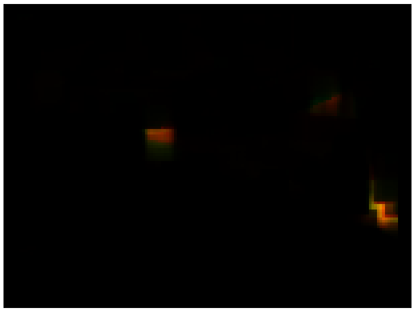


1.1.1 Detection and segmentation of moving objects in a video

Implementation Details: - Get the flow between consecutive frames of a video - Using cv2.cartToPolar() function get the magnitude of flow - Apply thresholds and convert the magnitude array to hsv for better visualization

```
In [35]: cap = cv.VideoCapture("vtest.avi")

         ret, frame1 = cap.read()
         prvs = cv.cvtColor(frame1, cv.COLOR_BGR2GRAY)
         hsv = np.zeros_like(frame1)
         hsv[..., 1] = 255
         count = -1
         while True:
             ret, frame2 = cap.read()
             count += 1
             if count % 200 != 0:
                 continue
             if ret is False:
                 break
             next = cv.cvtColor(frame2, cv.COLOR_BGR2GRAY)

             flow = optical_flow(prvs, next, 24)

             mag, ang = cv.cartToPolar(flow[..., 0], flow[..., 1])
             hsv[..., 0] = ang * 180 / np.pi / 2
             hsv[..., 2] = cv.normalize(mag, None, 0, 255, cv.NORM_MINMAX)
             rgb = cv.cvtColor(hsv, cv.COLOR_HSV2BGR)

             plt.subplot(1, 2, 1)
             plt.imshow(cv.cvtColor(frame2, cv.COLOR_BGR2RGB))
             plt.axis("off")
             plt.subplot(1, 2, 2)
             plt.imshow(cv.cvtColor(rgb, cv.COLOR_BGR2RGB))
             plt.axis("off")
             plt.show()
             prvs = next
         cap.release()
```





1.1.2 Tracking of objects in a video sequence

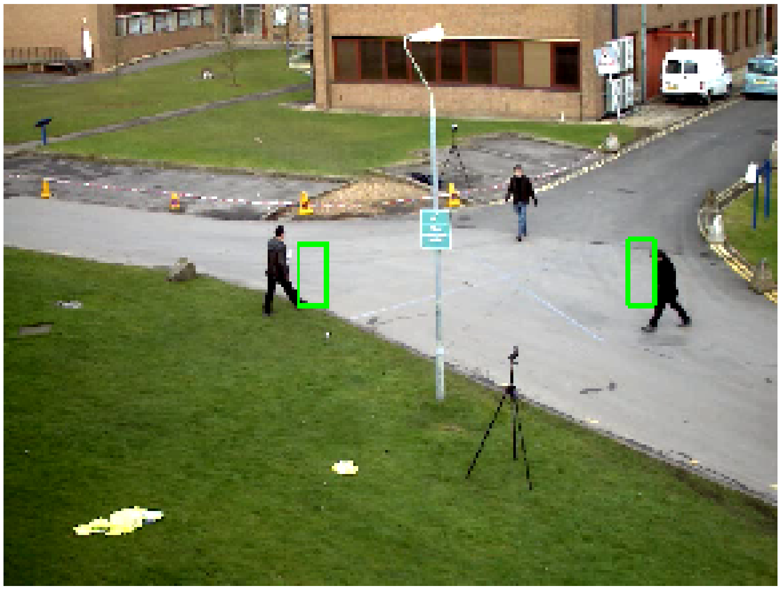
Implementation Details: - Get the flow between consecutive frames of a video - Using cv2.cartToPolar() function get the magnitude of flow - Convert the magnitude array to hsv and apply thresholds to get the dominant areas - Find the contours using cv2.findContours() method from the thresholded magnitude array - Draw bounded boxes for the different countours

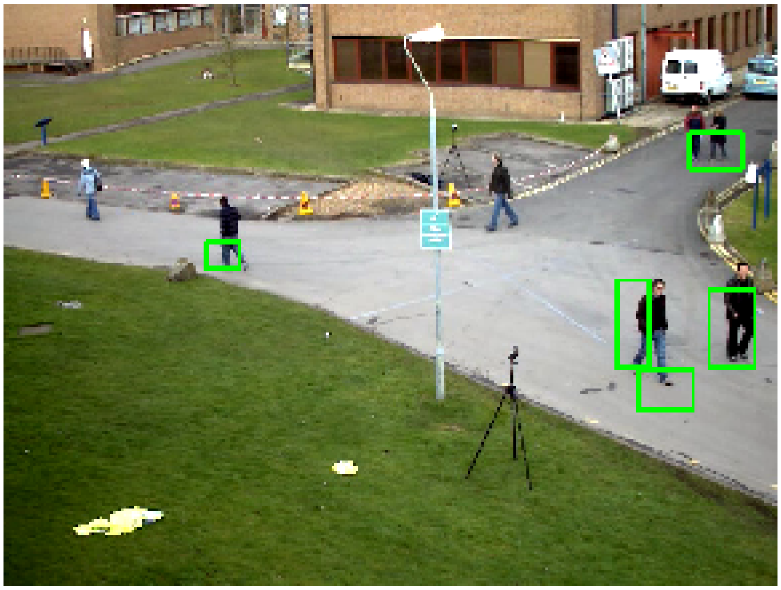
```
In [36]: def draw_hsv(flow, prev, change=True):
             hsv = np.zeros_like(prev)
             hsv[..., 1] = 255
             mag, ang = cv.cartToPolar(flow[..., 0], flow[..., 1])
             hsv[..., 0] = ang * 180 / np.pi / 2
             hsv[..., 2] = cv.normalize(mag, None, 0, 255, cv.NORM_MINMAX)
             if change:
                 hsv = cv.cvtColor(hsv, cv.COLOR_HSV2BGR)
             return hsv
```

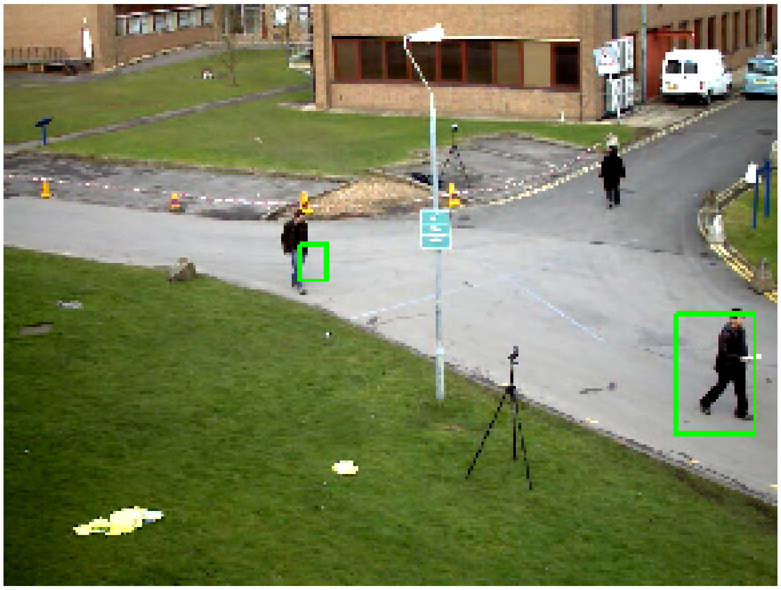
```
In [37]: def track_moving_objects(frame, prev):
             def gray(img):
                 return cv.cvtColor(img, cv.COLOR_BGR2GRAY)

             flow = optical_flow(gray(prev), gray(frame), 24)
             hsv1 = draw_hsv(flow, prev)
             gray1 = cv.cvtColor(hsv1, cv.COLOR_BGR2GRAY)
             thresh = cv.threshold(gray1, 25, 0xFF, cv.THRESH_BINARY)[1]
             thresh = cv.dilate(thresh, None, iterations=2)

             cnts, hierarchy = cv.findContours(thresh.copy(), cv.RETR_EXTERNAL,
                                                 cv.CHAIN_APPROX_SIMPLE)

             for c in cnts:
                 (x, y, w, h) = cv.boundingRect(c)
                 if w > 15 and h > 15 and w < 900 and h < 680:
```

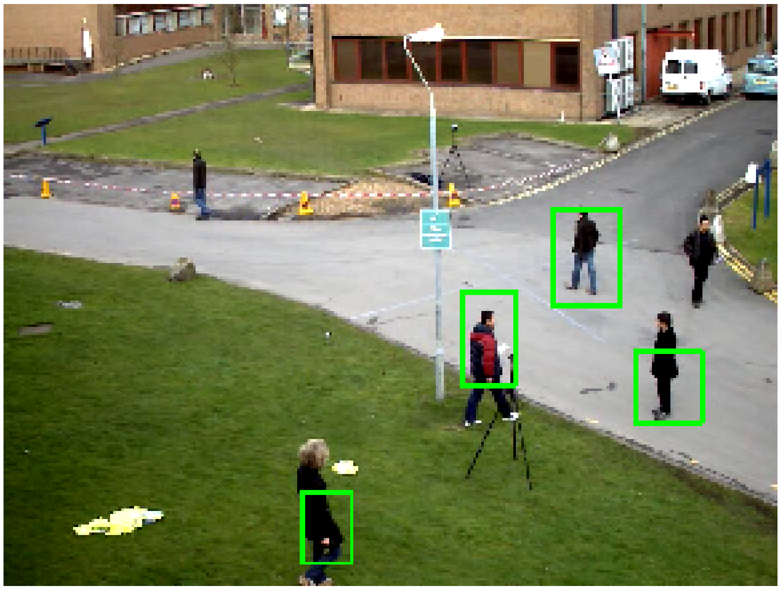
```
                cv.rectangle(frame, (x, y), (x + w, y + h), (0, 0xFF, 0), 4)
        return frame
```

```
In [38]: cap = cv.VideoCapture("vtest.avi")
         ret, frame1 = cap.read()
         count = -1
         while True:
             ret, frame2 = cap.read()
             count += 1
             if count % 200 != 0:
                 continue
             if ret is False:
                 break
             objected_frame = track_moving_objects(frame2, frame1)
             plt.imshow(cv.cvtColor(frame2, cv.COLOR_BGR2RGB))
             plt.axis("off")
             plt.show()
             prvs = next
         cap.release()
```









```
In [39]: cap = cv.VideoCapture("test.mp4")
         ret, frame1 = cap.read()
         count = -1
         while True:
             ret, frame2 = cap.read()
             count += 1
             if count % 200 != 0:
                 continue
             if ret is False:
                 break
             objected_frame = track_moving_objects(frame2, frame1)
             plt.imshow(cv.cvtColor(frame2, cv.COLOR_BGR2RGB))
             plt.axis("off")
             plt.show()
             prvs = next
         cap.release()
```

```
/home/aman/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:29: RuntimeWarning: divid
/home/aman/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:29: RuntimeWarning: inval
/home/aman/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:32: RuntimeWarning: divid
/home/aman/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:32: RuntimeWarning: inval
```