School of Computing
National University of Singapore
CS4243 Computer Vision and Pattern Recognition
Semester 1, AY 2016/17

Lab 4 Harris Corner Detector

Objective:

To understand and implement a popular corner detector called Harris Corner Detector using python codes

Preparation:

- Download the file HarrisCornerPictures.zip from IVLE into your working directory. Uncompress the file and you should find the following files: `checker.jpg, flower.jpg, test1.jpg, test2.jpg, test3.jpg`

Introduction: Harris Corner Detector

The following shows the detailed steps of a Harris Corner Detector that you will implement in this lab:

- Get the horizontal edge strength of every point in image and store in *gx*.
  - Please use a Sobel kernel for this step.
- Get the vertical edge strength of every point in image and store in *gy*.
  - Please use a Sobel kernel for this step.
- Compute the product of derivatives
  - *I_xx = gx * gx*
  - *I_xy = gx * gy*
  - *I_yy = gy * gy*
- Define a Gaussian kernel
  - The following is a block of python codes that generates a Gaussian kernel:

```
def gauss_kernels(size,sigma=1.0):
        ## returns a 2d gaussian kernel
        if size<3:
                size = 3
        m = size/2
        x, y = np.mgrid[-m:m+1, -m:m+1]
        kernel = np.exp(-(x*x + y*y)/(2*sigma*sigma))
        kernel_sum = kernel.sum()
        if not sum==0:
                kernel = kernel/kernel_sum

        return kernel
```

- Convolve *I_xx, I_xy, I_yy* using the Gaussian kernel of window size=3 and sigma=1. Place the results in *W_xx, W_xy, W_yy* respectively.

- Consider the pixel positions in *W_xx, W_xy, W_yy* at intervals of 10, both horizontally and vertically. For example, if size of *W_xx* is 512 by 512, consider only pixels at

  (10,10), (10, 20), …., (10, 510)
  (20,10), (20, 20), …., (20, 510)
  :
  (510,10), (510,20), …, (510, 510)

  For each of these pixels, perform the following:

  - Obtain the W matrix as follows:

$$W = \begin{pmatrix} W_{xx} & W_{xy} \\ W_{xy} & W_{yy} \end{pmatrix}$$

  - Compute the determinant of *W* and store in *detW*.

  - Compute the trace of W and store in *traceW*.

  - Compute the Harris Corner response given by the following equation:

    *response = detW – k * traceW * traceW*

    where *k = 0.06*

    Store the *response* in a matrix

- Find the maximum response value.

- Select all response values that are within 10% of the maximum response value. In the original color image, mark the location of these selected response values using a square box of 9 x 9 pixels. Save this image.

Instructions

- Please perform Harris Corner detection on all the pictures in this package (i.e. checker.jpg, flower.jpg, test1.jpg, test2.jpg, test3.jpg). Remember to read the color images into gray scale. Perform Harris Corner detection on these gray scale images. Mark the location of

strong corners and save the images using file names checker_corners.jpg, flower_corners.jpg, test1_corners.jpg, test2_corners.jpg and test3_corners.jpg.

- Please note that you can only use OpenCV for the following, and only for the following:
  - Read an image using cv2.imread
  - Write an image using cv2.imwrite
  - You are not allowed to use the other methods in OpenCV and any other packages other than python and its following import:
    - Numpy
    - Matplotlib.pyplot
  - You must implement the Harris Corner detector by writing the python codes all by yourself (i.e. you cannot get the codes from elsewhere).

Submission Instruction

At the end of your lab session, submit the softcopy of your Python codes and images to IVLE.

Note:

- Please mark the images with good features using the following codes:

```
plt.figure()
plt.imshow(image, cmap='gray')
plt.hold(True)
plt.scatter(rows,cols,color='blue')
plt.show()
```

- Please put your files in a folder and submit the folder. Use the following convention to name your folder:
  StudentNumber_yourName_Lab#. For example, if your student number is A1234567B, and your name is Chow Yuen Fatt, for this lab, your file name should be A1234567B_ChowYuenFatt_Lab4.

- There is no need to submit any hardcopy printouts.