Harris Corner Detection

Goal

In this chapter,

- We will understand the concepts behind Harris Corner Detection.
- We will see the following functions: **cv.cornerHarris()**, **cv.cornerSubPix()**

Theory

In the last chapter, we saw that corners are regions in the image with large variation in intensity in all the directions. One early attempt to find these corners was done by **Chris Harris & Mike Stephens** in their paper **A Combined Corner and Edge Detector** in 1988, so now it is called the Harris Corner Detector. He took this simple idea to a mathematical form. It basically finds the difference in intensity for a displacement of (u, v) in all directions. This is expressed as below:

$$E(u,v) = \sum_{x,y} \underbrace{w(x,y)}_{\text{window function}} \underbrace{[I(x+u,y+v)}_{\text{shifted intensity}} - \underbrace{I(x,y)}_{\text{intensity}}]^2$$

The window function is either a rectangular window or a Gaussian window which gives weights to pixels underneath.

We have to maximize this function $E(u, v)$ for corner detection. That means we have to maximize the second term. Applying Taylor Expansion to the above equation and using some mathematical steps (please refer to any standard text books you like for full derivation), we get the final equation as:

$$E(u,v) \approx \begin{bmatrix} u & v \end{bmatrix} M \begin{bmatrix} u \\ v \end{bmatrix}$$

where

$$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x I_x & I_x I_y \\ I_x I_y & I_y I_y \end{bmatrix}$$

Here, I_x and I_y are image derivatives in x and y directions respectively. (These can be easily found using **cv.Sobel()**).