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Video processing – Ex 1

Part 2.1

1. Yes, the Harris corner detector is invariant to translation.
   Translation invariance means that the algorithm can successfully detect the same features in an image, regardless of its position. In the case of the Harris corner detector, this means that it can identify the same corners even if the image has been shifted, moved, or translated.
   The Harris corner detector works by computing the gradient of the image at each pixel and then forming a covariance matrix based on the gradient information. The resulting matrix is used to determine a score for each pixel, which is called the corner response function. The local maxima of this function correspond to the corner points in the image. Since the gradient computation and corner response function calculation are based on local information, the algorithm is naturally invariant to translation.

2. Yes, for the same reasons mentioned above, The Harris corner detector is invariant to rotation.
   Since the response matrix is based on the local gradient information, it captures the underlying structure of the image around each pixel.

3. The Harris corner detector is sensitive to changes in image intensity, and a constant illumination change ($I\_out = a * I\_in + b$) can affect the detected corners.
   When the illumination changes, the intensity values of the image pixels will also change. This can lead to different gradient values being computed, which may, in turn, affect the structure tensor and the corner response function.
   In practice, the Harris corner detector is somewhat robust to small changes in illumination, but its performance can degrade significantly under large illumination changes. One way to mitigate the effect of illumination changes is to preprocess the image using techniques like histogram equalization or adaptive histogram equalization, which can help normalize the intensity distribution in the image before applying the Harris corner detector.

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Part 3

The Sobel operator, also known as the Sobel filter or Sobel-Feldman operator, is a discrete differentiation operator used in image processing and computer vision for edge detection. It computes an approximation of the gradient of the image intensity function, emphasizing areas of the image with rapid intensity changes, which often correspond to edges.

The Sobel operator consists of two kernels, one for the horizontal gradient (Gx) and one for the vertical gradient (Gy). These kernels are convolved with the input image to produce two gradient images, one for the x-axis and one for the y-axis. The kernels are usually 3x3 and have the following form:

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 1 & 2 \\ -1 & 0 & 1 \end{bmatrix}, \qquad G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$