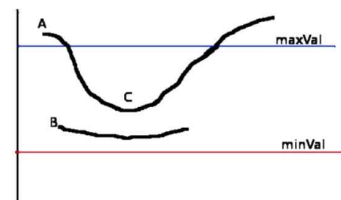


- How can we improve the edge detection performance? Explain it by using the parameters given in the provided program, 'OpenCV-Canny-Edge-Detection.'

To use canny-edge detection, first we have to reduce noise by gaussian filter size of 5x5. Secondly, we have to find part with high gradient. To do this, we use sobel kernel for vertical direction and horizontal direction. We define horizontal direction as G_x , vertical direction as G_y . Gradient of edge is calculated by $\sqrt{G_x^2 + G_y^2}$ and the angle will be calculated by $\tan^{-1}(\frac{G_x}{G_y})$. Next, we have to erase non-maximum. For

4 7 5 7 6
 8 8 4

example, 3 3 4 1 left one becomes maximum, and right one becomes



non-maximum. Lastly, we set two thresholds,

and if value is larger than maxVal, then it is edge. If it is smaller than minVal, then it is not an edge. So, we have to increase both maxVal and minVal, which is 'hi' and 'lo' in function 'double_thresholding'.

- How can we improve the keypoint matching performance? Explain it by using the parameters given in the provided program, 'Harris-Corner-Detector.'

To detect edge, we use 'Canny-Edge-detection'. If we define $I_x = \frac{\partial I}{\partial x}$, $I_y = \frac{\partial I}{\partial y}$

then we can define $M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$. By matrix M, we can determine

corners, edges, and flat regions. In other words, the eigenvalues (λ_1, λ_2) of the 2x2 matrix X can be obtained to compare the magnitudes of the eigenvalues. For example if both are small, it is flat. If only one is large, it is edge and if both are large it is corner. There are other way to determine it. We can use R, which is $\det(M) - \alpha \text{tr}ace(M)^2 = \lambda_1 \lambda_2 - \alpha (\lambda_1 + \lambda_2)^2$. If R is less than 0, it is edge. If R is larger than 0, then it is corner and if |R| is very small, it is flat surface.

To improve the edge detection performance, we have to decrease ' α ' value. which is parameter 'k' in function create_corner_response_matrix in the provided program. Also, we have to decrease 'thresh' value in function create_corner_response_matrix. But both of these two values should be bigger than 0.