

1. Canny has two thresholds that control the edge thresholding process. What is their purpose?

The canny filter has two thresholds: The threshold upper bound above which points are assumed to be edges and the lower bound below which points are assumed to be non-edges. For points that fall between these values are edges if they are connected to some points above the max threshold.

2. What is the purpose of the aperture parameter? What is the result of changing it from 3 to 5, 7, 9 or greater?

This parameter specifies the dimension of the Sobel operator used after Gaussian smoothing. To detect the edges, this operator is convolved with the image. When making canny filtered photos, adjusting the value of the aperture parameter from 3 to 7 works effectively, and raising the value of the aperture parameter generates more lines and detect more smoother edges. If it increased by more than 7, it aborted. In operation, the aperture size should be an odd number between 3 and 7. As the aperture value increases, more edge-detected lines appear.

3. The Hough transform has two parameters that specify the resolution of the accumulator. Their default values are 1 and $\pi/180$. What is the effect of increasing the first and reducing the second?

The first parameter in the hough transform is rho, and the second one is theta. The accumulator's distance resolution is measured in pixels, while its angle resolution is measured in radians. Increasing the first one means the larger the pixel interval used for processing, the sparser the processed points, and the lower the continuity of the extracted straight line. In other words, I can see that increasing rho splits the horizon into small lines, making it appear scattered. The smaller the second parameter, the better the continuity of the extracted straight line, which means decreasing theta grows the connecting horizon, making it appear longer.

4. The Hough transform has a pair of parameters that determine the minimum length of a line that can be accepted, and the maximum gap between two segments if they are to be considered part of the same line. What is the effect of changing these values?

The minimum length parameter of the line constrains the minimum length of the proposed straight line, the larger the line, the fewer straight lines can be extracted. Increasing this parameter will allow longer lines to be detected. In contrast, decreasing this will let more shorter lines to be considered. However, it might cause noises and false lines.

The second parameter allows the maximum distance to connect points in the same line, the larger the line, the longer and messier the proposed line will be. Decreasing this could result in more fragmented lines but better separation between distinct lines with lower tolerance lines.

5. How close are the computed horizons to where you think the horizon should be? What might cause any discrepancy?

Clouds make calculating the curve a little bit difficult for Horizons 1 and 2, as Canny detects many edges even when all of my parameters are changed. It probably leads to false edge detection. However, the overall performance is quite good, so I can say that the computed one is the true horizon. On the one hand, there are a small amount of mis-extracted straight lines in the image that affect the accuracy of curve fitting. On the other hand, the real horizontal line is not a perfect quadratic curve, and there is a difference between it and the fitted quadratic curve.