Computer Vision and Imaging [06 30213] Assignment 1 Report

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**Task1: Laplacian of Gaussian**

In this task, we aim to create a filter that does both smoothing and edge detecting. We first use the convolution of a Gaussian filter and a Laplacian kernel to create a combined filter which is capable to smooth the image and detect the edges when convolving it with the image. However, the resulted image does not clearly show the edges, as shown in Figure 1. We now need to threshold it to determine which pixels should be retained as edges and which should be discarded as noise. We first manually threshold to find an appropriate value. Then we perform **Hysteresis thresholding** which *1.* Sets two thresholds: th as the high threshold and tl as the low threshold *2.* Scans the whole image to identify possible edges for pixels above th and label them as true edges. *3.* Traverses along the true edges. Continue to label the edges with gradient magnitudes above th as true edge and stop if the gradient magnitude is below than tl. Figure 2 is of manually threshold and Figure 3 is the result of performing Hysteresis thresholding in which there is less noise and more clear edges.

形状

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Figure 1 Figure 2 Figure 3

LoG no threshold LoG manually threshold Log Hys threshold

**Task 2: Edge Detection**

**First order Gaussian** only smooths the image to improve the performance of potentially accompanied edge detector, not detecting edges. It has the worst performance. **Laplacian** kernel approximates the actual implementation of Laplacian which is the sum of second derivatives of pixel intensity on x and y. The problem with Laplacian is that its kernel is sensitive to noise as the central value is much bigger than the surroundings. So again, this edge detector does not work quite well on its own. **Laplacian of Gaussian** can remove the background noise on the image and detect the edges. It has better efficacy on images with much noise than the other edge detectors that has no smoothing. However, we need to carefully choose the value of standard deviation that is used for characterising the Gaussian filter. Thus, if the Gaussian filter over-smoothed the image, it removes details from the image and can broaden the zero-crossings which is vital for edge detecting. **Conclusions:** All three images of cells are mainly composed of circular shapes (explains why Hysteresis thresholding works well as it traverse along true edges to locate other edges, so once it has found true edges, it is highly likely to identify the whole circular shape), meaning gradient changes at most pixels are on both horizontal and vertical directions. Hence, **Roberts** and **Sobel** operators are more sensitive to changes in gradient magnitudes in this case as they detect edges in an image by finding the gradient magnitudes at each pixel using two convolution kernels, one detects horizontal changes, namely Gx, and one detects the vertical changes, namely Gy. Then we combine Gx and Gy to obtain the gradient magnitudes by the formula ,. Also, there is not much noise in the images, meaning there is less chance of false edges being detected, so Roberts and Sobel have the best performance in terms of edge detection (minimal false positive rates and maximal true positive rates) and localisation (location of detected edges are close to their real positions) in the five edge detection algorithms, although they have very thick edges. Figure 4 – Figure 6 show the three cells after filtered by the five edge detection algorithms with Hysteresis thresholding.

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Figure 4: Cell 9343 Hysteresis thresholding

图片包含 照片, 游戏机, 地毯, 草

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Figure 5: Cell 10905 Hysteresis thresholding

一棵树

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Figure 6: Cell 43590 Hysteresis thresholding

**Task 3: Advanced Edge Detection**

**Canny** operator requires careful choice on sigma value. As can be seen in the following figures, when we have sigma value being 3, many details are lost than sigma being 1. However, it has the fastest response, since it is only approximation with the first derivatives. **Scharr** has the best accuracy and localisation.

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Figure 7: Cell 9343 Hysteresis thresholding

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Figure 8: Cell 10905 Hysteresis thresholding

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**Task 4: Result evaluation**

filters like Scharr and Sobel that tend to produce thicker edges might closely align with the true edges, thereby increasing their true positive rate.

图表

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Aim, Method, Results and Conclusions