**CSC420 Assignment 1**

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**Q1**

(a) If it is not separable, it costs O(m2n2) since we need to do m2 times operation to each pixel.

(b) if it is separable, it costs O(2mn2) = O(mn2) we only do the 1-d horizontal convolution and 1-d vertical convolution FOR each pixel in instead.

**Q2**

Canny edge detection steps are following:

1. **Removing noise**, in this step we apply horizontal and vertical direction derivative of Gaussian into the image to remove the influence by the noise.
2. **Finding magnitude and orientation of gradient,** in this step we will compute the magnitude and orientation on each pixel, so that we can determine the strength of each pixel and its direction.
3. **Non-max suppression,** in this step, for each pixel, we check if it is local maximum along gradient direction. If it is the local maximum, it will remain. So that we can locate the edge more accurately by removing the non max pixel.
4. **Hysteresis Thresholding,** in this step, we “link” the edges by setting two threshold, high threshold and low threshold. If one pixel’s magnitude is larger than the high threshold, it is marked as strong edge pixel. If it is between high threshold and low threshold and it is neighbor of a strong edge pixel, it is marked as weak edge pixel. Otherwise it is suppressed.

**Q3**

**The Laplacian of Gaussian approach find edges by detecting zero-crossing.**

The zero-crossing is the place where second derivative changes sign, indicating that in this point, the first derivative is **local maximum or local minimum**. In other words, **the pixel magnitude changes significantly** which tells that this pixel is the edge pixel.

**Q4**

**(a)**

**A screenshot of a cell phone

Description automatically generated**

**A picture containing screenshot

Description automatically generated**

**(b)**