HW10 report

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1. 作業要求：

Zero Crossing Edge Detection

- You are to implement Laplacian, Minimum Variance Laplacian, Laplacian of Gaussian, and Difference of Gaussian(inhibitory sigma=1, excitatory sigma=3, kernel size 11x11 [1][1])
- Threshold Values listed below are for reference:

  (僅供參考，同學可自己找出 Edge Image 品質最佳的門檻值 threshold value)

  – Laplace Mask (0, 1, 0, 1, -4, 1, 0, 1, 0): 15

  – Minimum variance Laplacian: 20

  – Laplace of Gaussian: 3000

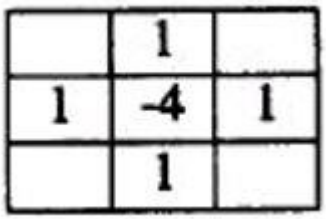
  程式語言：Java

  執行環境：Eclipse

2. 程式設計:

- Laplacian:

  Kernel 如下，threshold = 15:



- Minimum Variance Laplacian:

  Kernel 如下，threshold = 20:

$$\frac{1}{3}\begin{bmatrix} 2 & -1 & 2 \\ -1 & -4 & -1 \\ 2 & -1 & 2 \end{bmatrix}$$

- Laplacian of Gaussian:

  Kernel 如下，threshold = 3000:

$$\begin{bmatrix} 0 & 0 & 0 & -1 & -1 & -2 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & -2 & -4 & -8 & -9 & -8 & -4 & -2 & 0 & 0 \\ 0 & -2 & -7 & -15 & -22 & -23 & -22 & -15 & -7 & -2 & 0 \\ -1 & -4 & -15 & -24 & -14 & -1 & -14 & -24 & -15 & -4 & -1 \\ -1 & -8 & -22 & -14 & 52 & 103 & 52 & -14 & -22 & -8 & -1 \\ -2 & -9 & -23 & -1 & 103 & 178 & 103 & -1 & -23 & -9 & -2 \\ -1 & -8 & -22 & -14 & 52 & 103 & 52 & -14 & -22 & -8 & -1 \\ -1 & -4 & -15 & -24 & -14 & -1 & -14 & -24 & -15 & -4 & -1 \\ 0 & -2 & -7 & -15 & -22 & -23 & -22 & -15 & -7 & -2 & 0 \\ 0 & 0 & -2 & -4 & -8 & -9 & -8 & -4 & -2 & 0 & 0 \\ 0 & 0 & 0 & -1 & -1 & -2 & -1 & -1 & 0 & 0 & 0 \end{bmatrix}$$

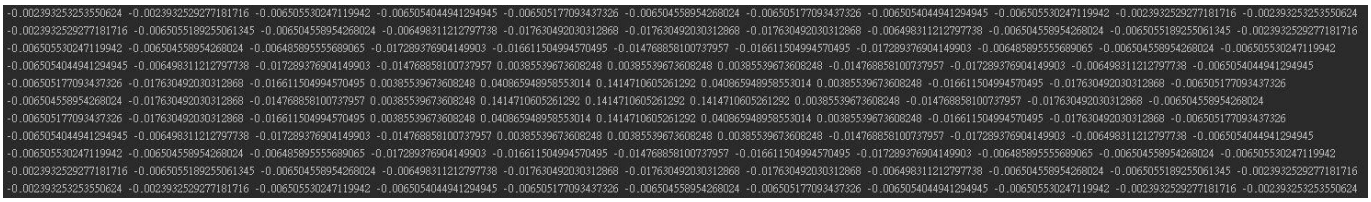
- Difference of Gaussian:

  利用下列公式建立出 kernel，分別計算出 G1(σ = 1), G2(σ = 3)，再算出 G1-G2 當作 mask，

$$Gaussian: \frac{1}{2\pi\sigma^2} e^{-\frac{1}{2}\left(\frac{r^2+c^2}{\sigma^2}\right)}$$

  其中，kernel size = 11。

Kernel 如下，threshold = 1:



3. 主要程式：

Main(./Source Code/src/hw10/MainZeroCrossing.java):

```
public class MainZeroCrossing {
    public static void main(String[] args) throws IOException {
        int[][] img = FileProcess.inputImg(new File("lena.bmp"));
        int[][] outputImg = null;
        List<Point> mask = new ArrayList<>();

        mask = Mask.getLaplacian();
        outputImg = ZeroCrossingEdgeDection.operator(img, mask);
        outputImg = ImageProcess.binaryImage(outputImg, 15);
        FileProcess.outputImg(outputImg, "laplacian_lena.bmp");

        mask = Mask.getMinimunVarianceLaplacian();
        outputImg = ZeroCrossingEdgeDection.operator(img, mask);
        outputImg = ImageProcess.binaryImage(outputImg, 20);
        FileProcess.outputImg(outputImg, "variance_lena.bmp");

        mask = Mask.getLOG();
        outputImg = ZeroCrossingEdgeDection.operator(img, mask);
        outputImg = ImageProcess.binaryImage(outputImg, 3000);
        FileProcess.outputImg(outputImg, "log_lena.bmp");

        mask = Mask.getDOG();
        outputImg = ZeroCrossingEdgeDection.operator(img, mask);
        outputImg = ImageProcess.binaryImage(outputImg, 1);
        FileProcess.outputImg(outputImg, "dog_lena.bmp");
    }
}
```

Zero crossing edge detection(./Source Code/src/hw10/ZeroCrossingEdgeDection.java):

```java
public class ZeroCrossingEdgeDection {
    public static int[][] operator(int[][] inputImg, List<Point> mask) {
        int height = inputImg.length;
        int width = inputImg[0].length;
        int[][] outputImg = new int[height][width];
        for (int i = 0; i < height; i++) {
            for (int j = 0; j < width; j++) {
                double newPixel = 0;
                for (Point point : mask) {
                    int x = point.getX();
                    int y = point.getY();
                    double value = point.getValue();
                    int pixel = i + x < height && j + y < width && i + x > 0 && j + y > 0 ? inputImg[i + x][j + y] : 0;
                    newPixel = newPixel + value * pixel;
                }
                outputImg[i][j] = (int) Math.round(newPixel);

            }
        }
        return outputImg;
    }
}
```

4. 執行結果：

Laplacian (Threshold: 15), Minimum Variance Laplacian (20), Laplacian of Gaussian (3000), Difference of Gaussian (1):

5. 如何執行

執行./Source Code/ hw10.jar 即可產生作業要求的兩種圖片(lena.bmp 需要和 hw10.jar 在同一個資料夾底下)

程式進入點為 ./Surce Code/src/hw10/ MainZeroCrossing.java