111590004 張意昌 MV_HW4

Approach

> [!NOTE]
> In this homework, our goal is doing canny edge detection.
> There are five steps to complete in this homework.
> In this report. I will answer each question and put original images and result for each question.
> At the end of report. I will discuss some issue which I found in this homework.

Original Image

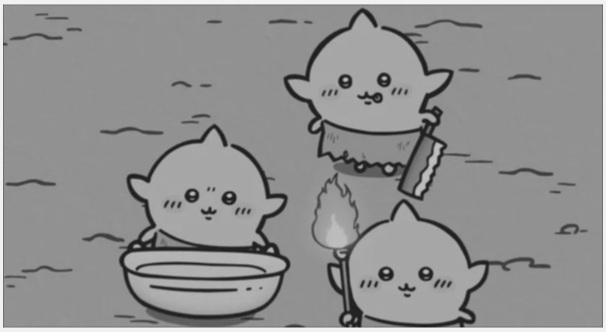
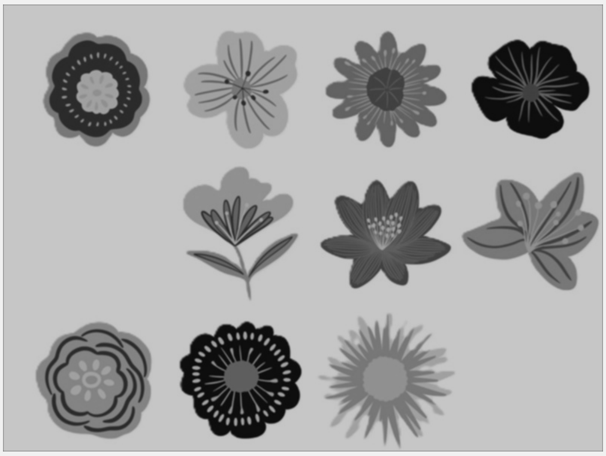
> [!TIP]
> Here is our original pictures.



Step 1 Mark the area you want to segment (output gaussian blur image)

> [!IMPORTANT]
> In the first step,we need to use gaussian filter.
> The formula is:
> $G(x, y)=1/(2\pi\sigma^2)\ e^{(-(x^2+y^2)/(2\sigma^2))}$
> σ is the standard deviation (controls the amount of blur).
> Where σ and kernel size, you need to choose by yourself.
> x and y is the distance between the middle point.
> I choose σ = 1.0 and kernel size is 3.

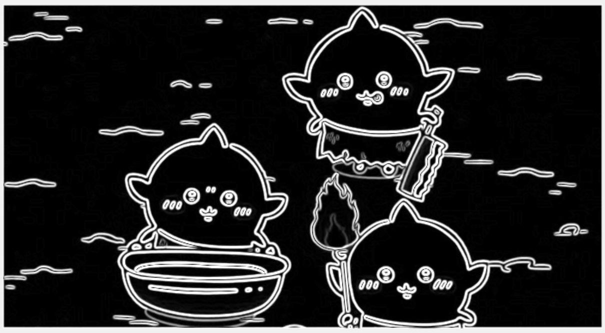
Gaussian Image

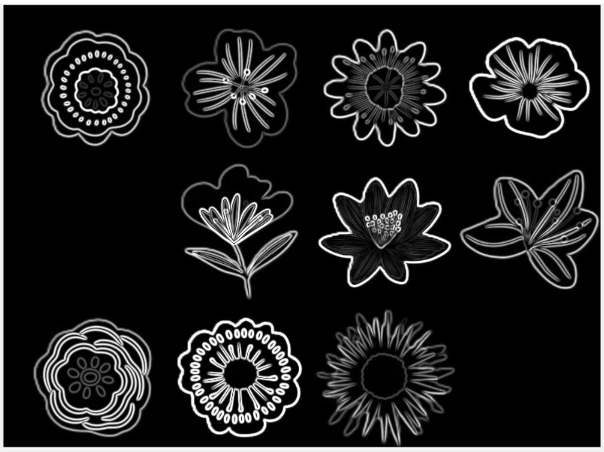
> [!TIP]
>
>  
>
> 

Step 2 Find the intensity gradient of the image (output magnitude G image)

> [!IMPORTANT]
>
> In this step,we need to use sobel operation separately x and y.
>
> Where kernel was defined in the homework announcement.
>
> And a θ graph for the slope of gradient.

Magnitude G Image

> [!TIP]
>
>  

> 

Step 3 Non-maximum suppression

> [!IMPORTANT]
> In this step we need to do non-maximum suppression by θ graph from step 2.
> First, we determine the gradient angle and classify it into one of the four nearest directions: 0°, 45°, 90°, or 135°.
> Then, if the pixel has a greater value than its neighbors in the gradient direction, it is retained.
> Otherwise set it to zero.

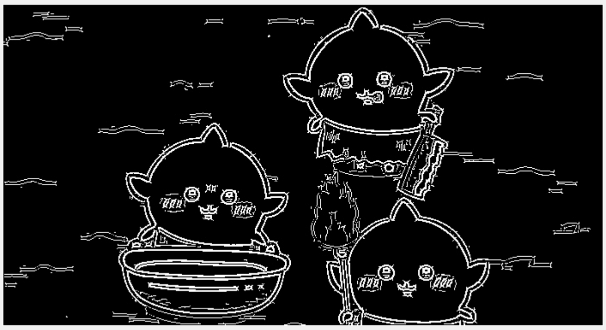
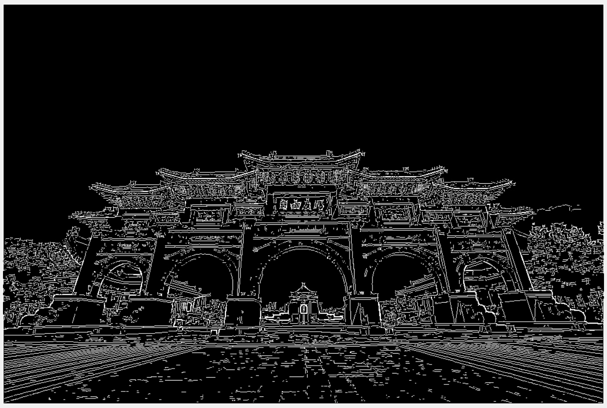
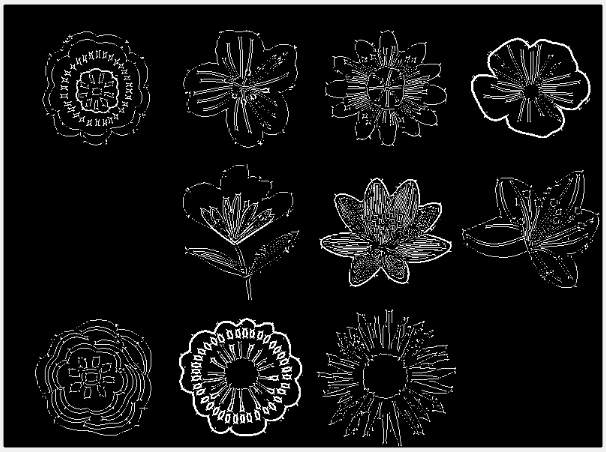
Step 4 Double threshold

> [!IMPORTANT]
> For these step, we need to choose two thresholds.
> One is low threshold and the other is high thresholds.
> First, calculate the gradient magnitude for all points.
> Next, remove zero values since they do not impact the result.
> Finally, manually select two values as the thresholds.

Step 5 Edge Tracking by Hysteresis (output edge detection result image)

> [!IMPORTANT]
> In step 4, we have already chosen two values as thresholds: low and high.
> If a pixel's value is lower than the low threshold, it will be ignored.
> If the value falls between the low and high thresholds, it will be labeled as a weak edge.
> If the value is greater than the high threshold, it will be marked as a strong edge.
> Next, we check each weak edge pixel.
> If it has at least one neighboring strong edge, it will be upgraded to a strong edge.
> Otherwise, it will be set to zero.

Result Image

> [!TIP]
>  
> 

My thought in hw4

> [!TIP]
> The key points of this homework are selecting the kernel size and σ in Step 1, and determining the thresholds in Step 4.
> And since the result is a binary image.
> I have convert the test images into grayscale image first and execute these five steps.
> One major issue in this homework is performance, as many steps involve nested loops.
> This results in longer computation time, since the program is designed to complete all steps before displaying the output.
> Therefore, it may take approximately 1 minute to finish running the entire code.