COMPUTER VISION

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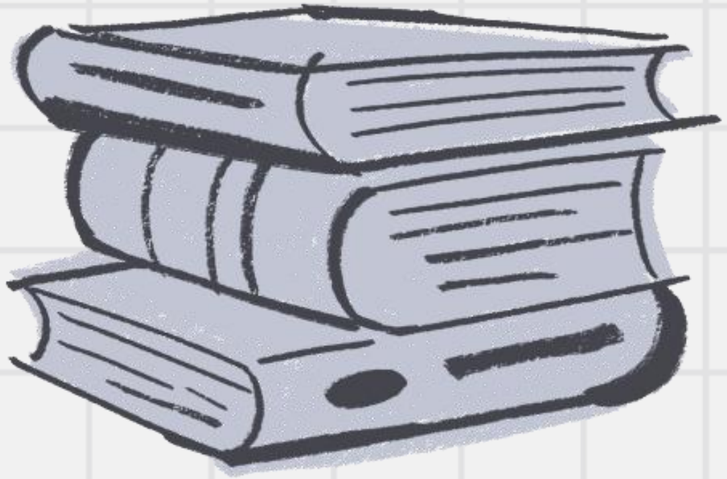
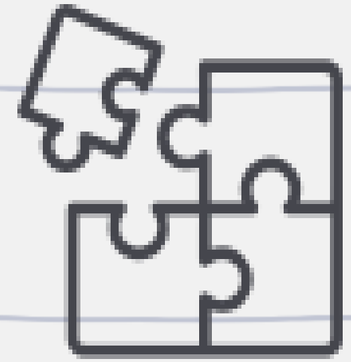


01



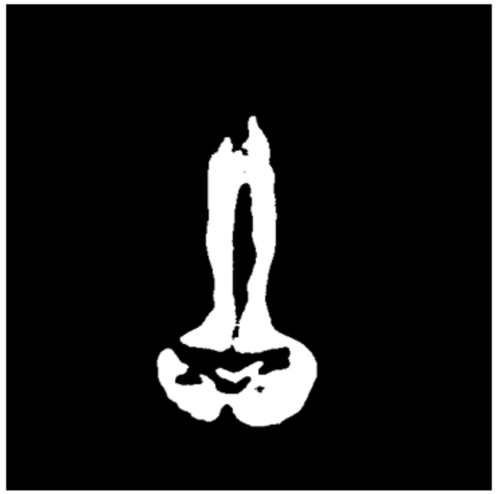
Introduction

Introduction

Last time, we finished our talk with a question. How would we fill the gaps of nose? 🤔💭
Because after we used applied blurring filters, we still had huge gaps in the chimpanzee's nose.

HSV Threshold

Mean Blur

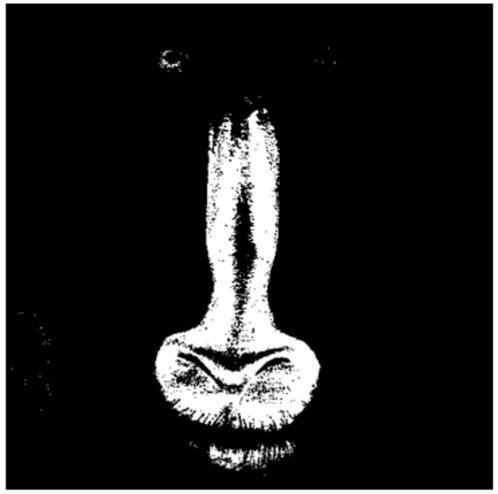


Gaussian Blur

Introduction

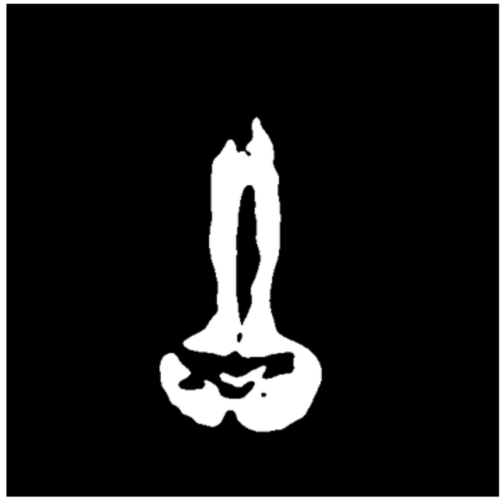
The answer is that we need to apply an image processing technique called morphological operations. Its job is to fill gaps outside the detected shape by operation called dilation and fill gaps inside the detected shape by operation called erosion.🔎

HSV Threshold



Mean Blur

Gaussian Blur

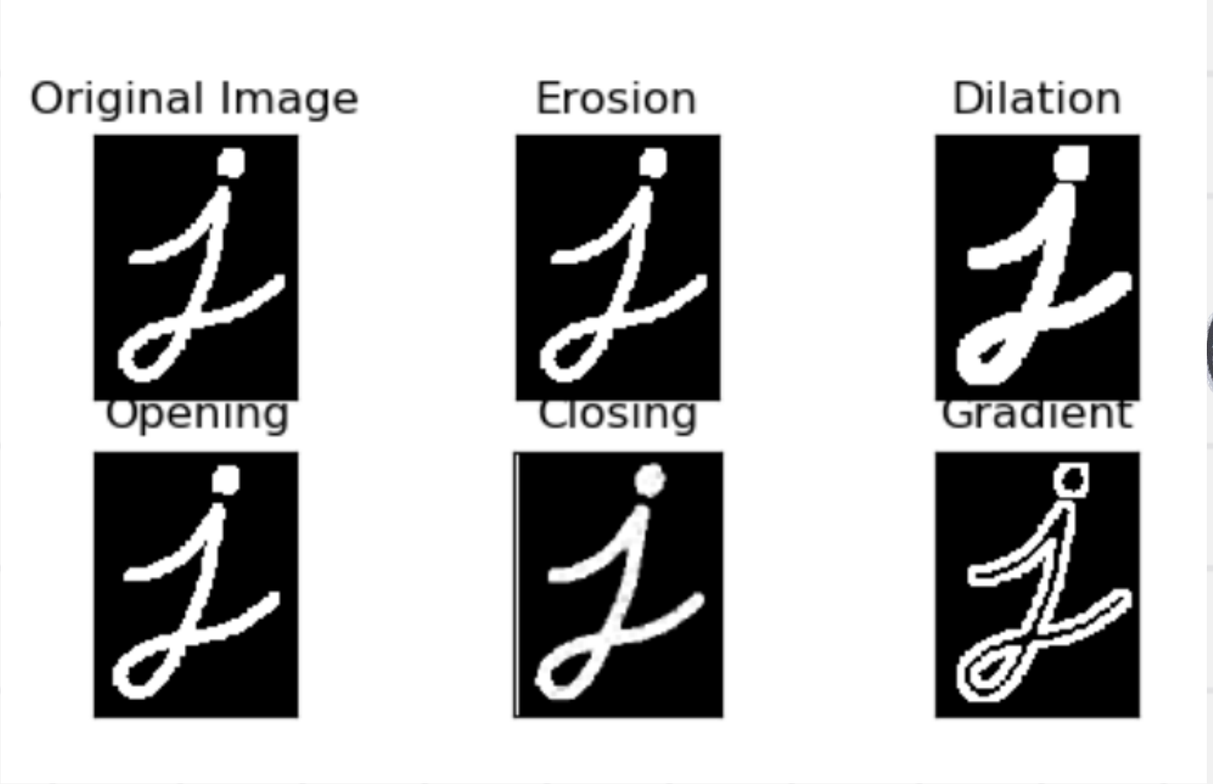


02

Morphological operations

Morphological operations

Morphological operations are fundamental image processing techniques used to analyze and manipulate the structure of objects in binary and grayscale images. These operations rely on a structuring element (a small shape or kernel) to modify the image based on the shapes present. They are widely used for noise removal, shape enhancement, object detection, and segmentation.

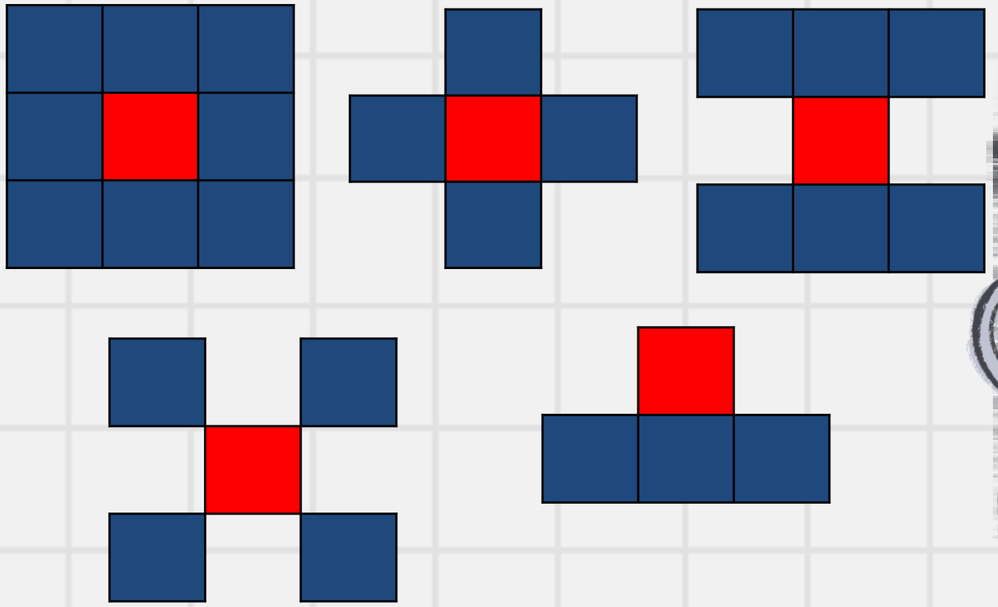


Morphological operations

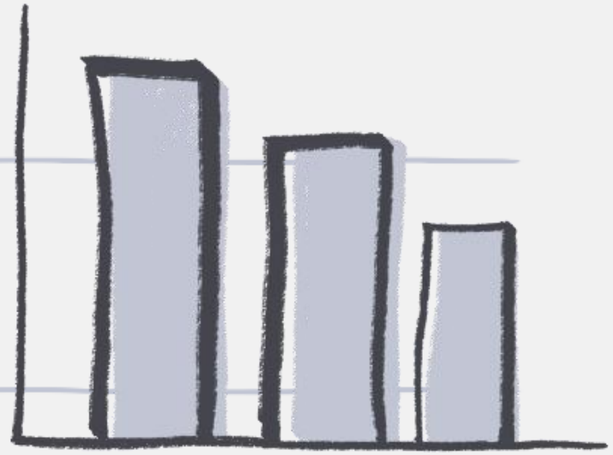
Before we start to talk about Structuring Element (Kernel).

A structuring element is a small shape or matrix used in morphological operations to probe and interact with an image. It defines how and where the image will be changed.

- Think of it like a stamp that moves over the image.
- It has a specific shape (like a square, circle, or cross) and a size (like 3×3 or 5×5).
- The center of the structuring element is its reference point. It decides which pixels in the image should be added or removed during operations like dilation or erosion.



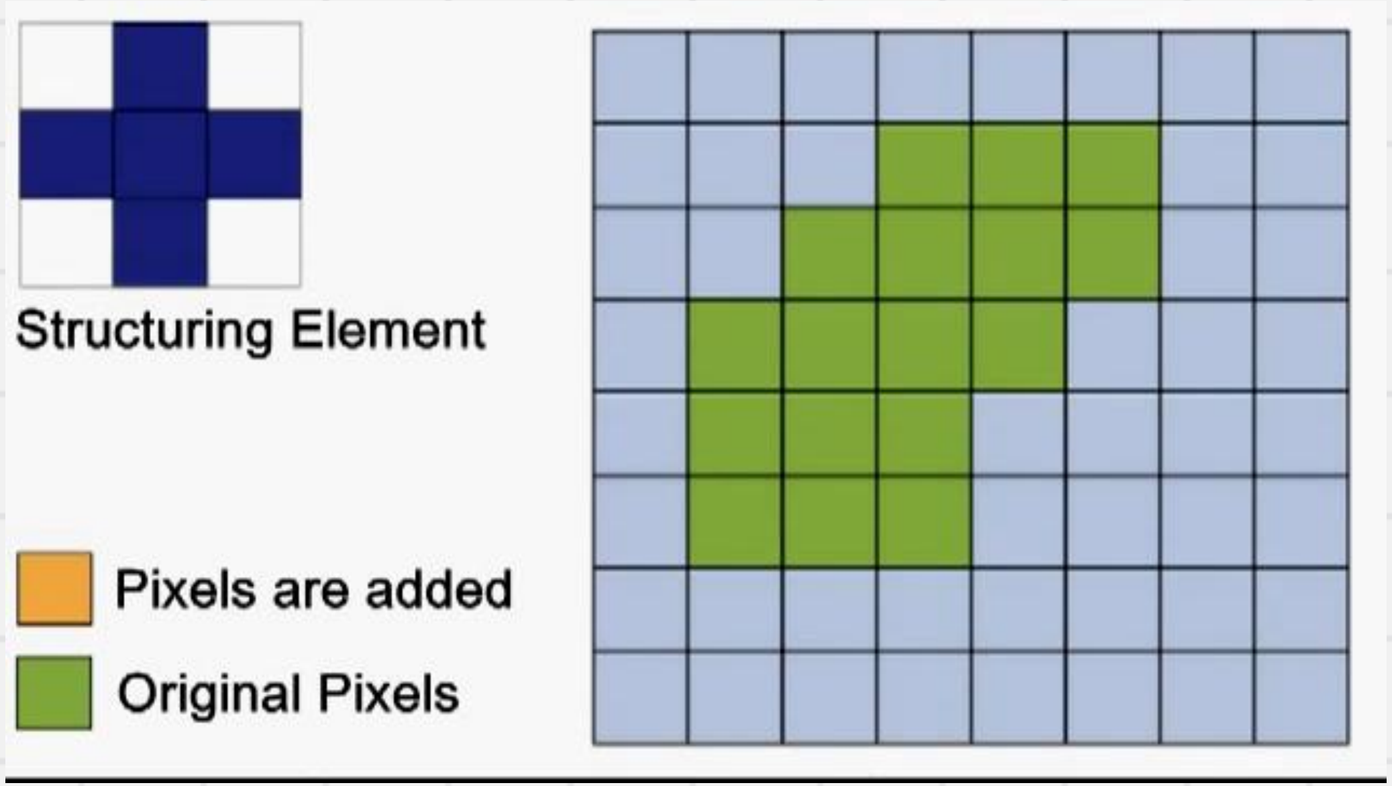
03



Dilation & Erosion

Dilation Operation

Dilation is a morphological operation used to enhance binary or grayscale images by expanding the boundaries of bright regions. It helps to fill small gaps, connect nearby objects, and recover missing edge pixels in detected shapes.



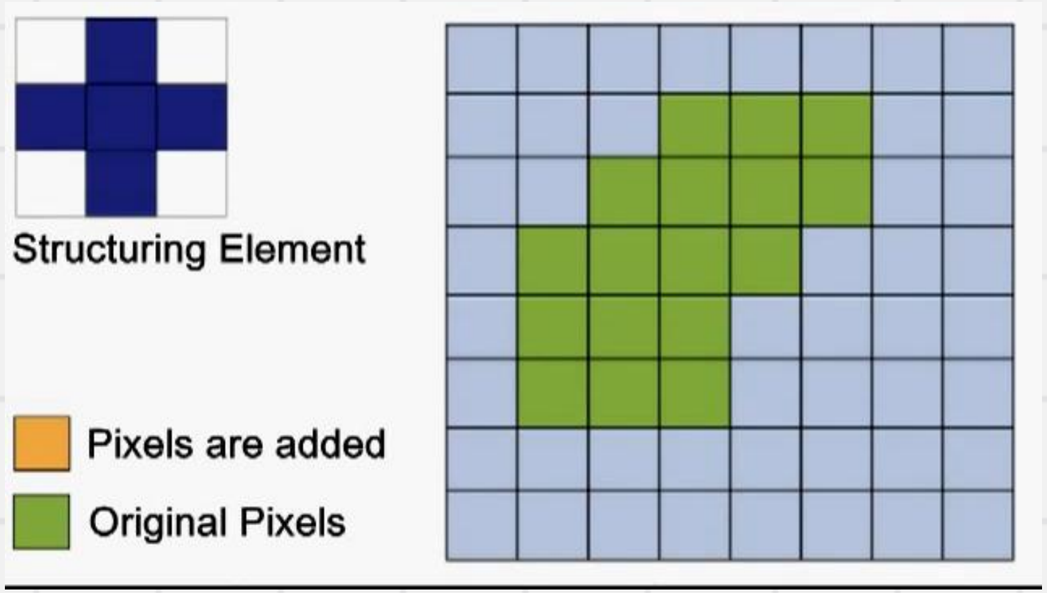
Dilation Operation

It is mathematically represented using set notation and structuring elements.

Mathematical Representation

Given:

- I as the binary input image (a set of foreground pixels)
- S as the structuring element (a set of pixels defining the shape and size of dilation)

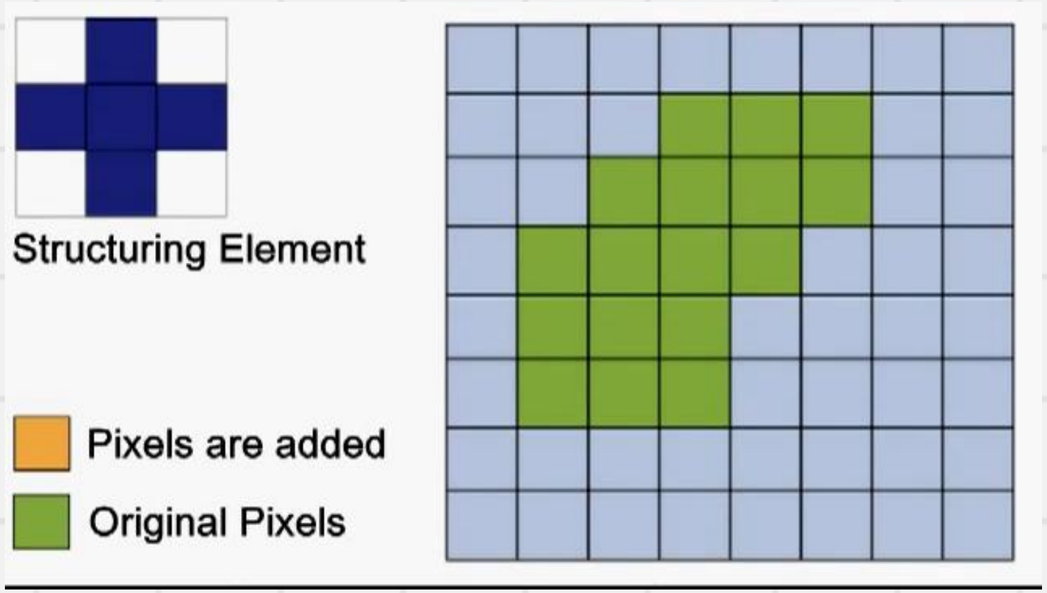


Dilation Operation

The dilation of I by S is defined as:

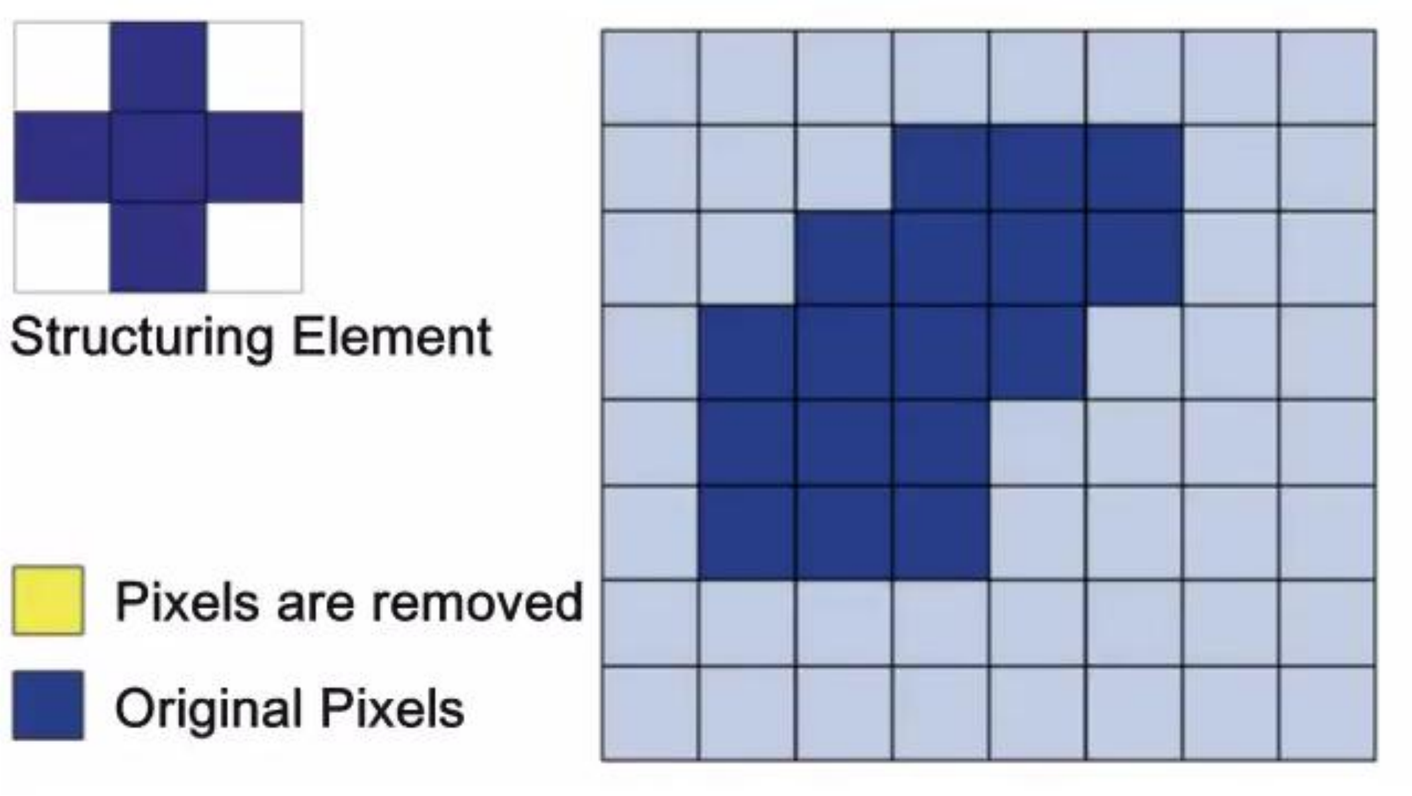
$$I \oplus S = \{p | S_p \cap I \neq \emptyset\}$$

- S_p is the structuring element S translated to the position p.
- $\oplus$ denotes the dilation operation.
- The dilation operation places the structuring element at every pixel in I and adds all pixels that overlap with at least one foreground pixel.



Erosion Operation

Erosion is a morphological operation used to process binary or grayscale images by shrinking the boundaries of bright regions. It helps to remove small noise, detach connected objects, and eliminate thin protrusions or irregularities along the edges of



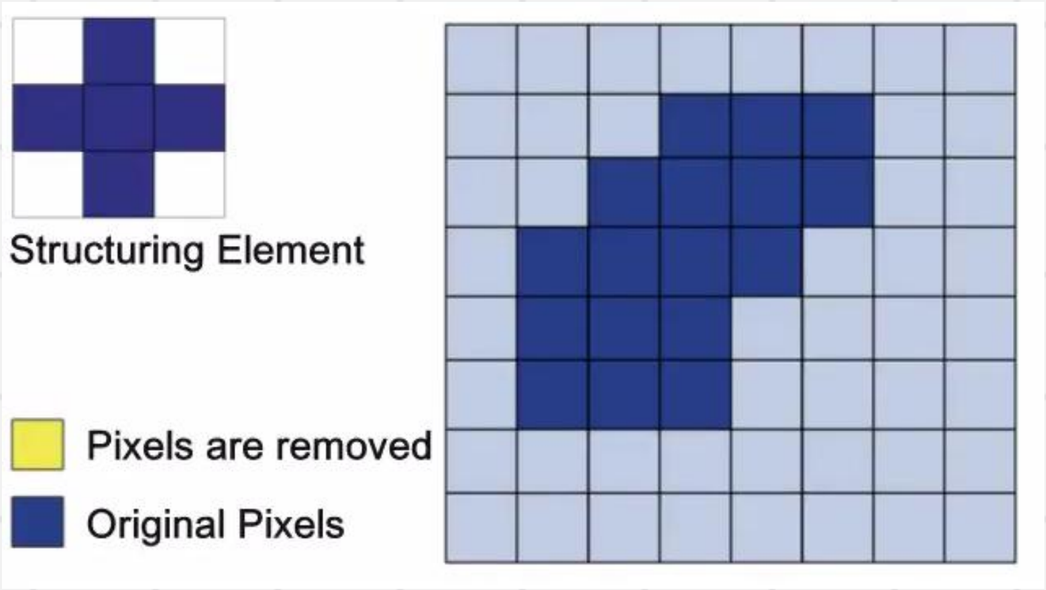
Erosion Operation

It is mathematically represented using set notation and structuring elements.

Mathematical Representation

Given:

- I as the binary input image (a set of foreground pixels)
- S as the structuring element (a set of pixels defining the shape and size of dilation)

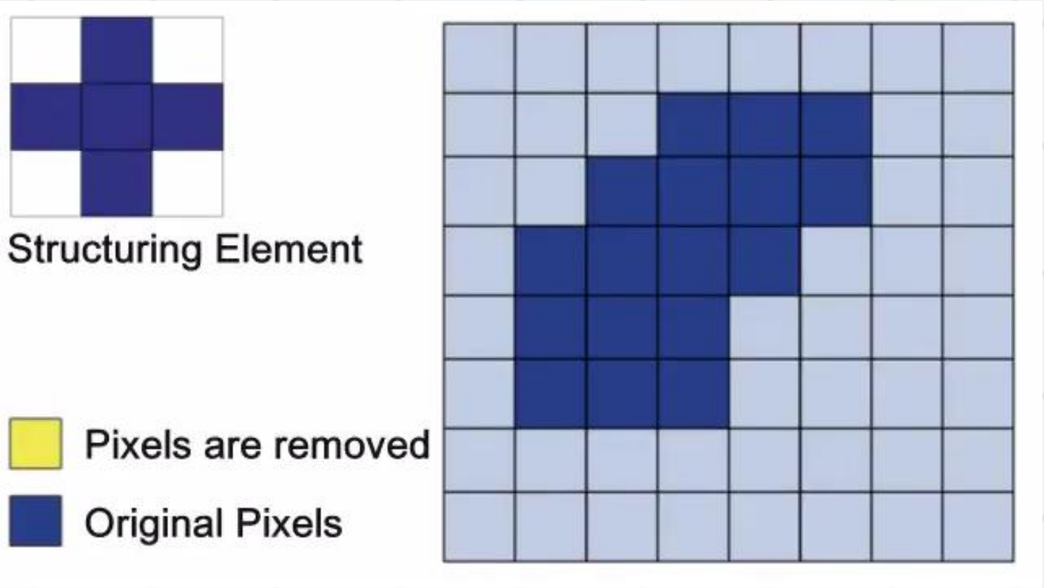


Erosion Operation

The erosion of by S is defined as:

$$I \ominus S = \{p | S_p \subseteq I\}$$

- S_p is the structuring element S translated to the position p.
  - $\ominus$ denotes the erosion operation.
- The erosion operation places the structuring element at every pixel in I and removes pixels, where S is not completely contained within the foreground region. This results in shrinking objects, removing noise, and separating connected components.



Dilation & Erosion

📌 Source & References

The animation in the previous section is directly taken from:

🔹 Youtube - SmarT E-learning

Author: Kamilia Jaber – Muna Abu-Zaghleh

Published on: Jul 7, 2012

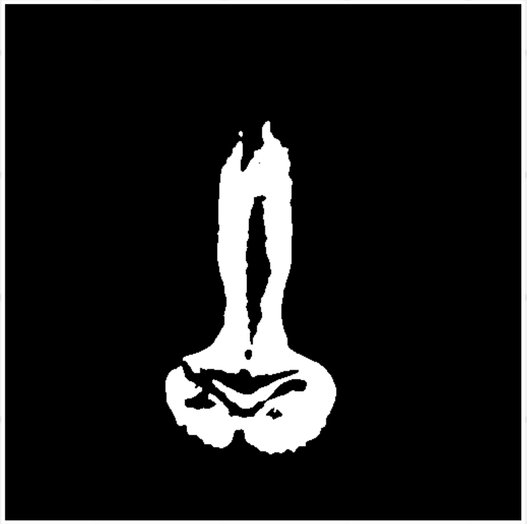
Dilation & Erosion

Now let's see how would dilation and erosion affect our chimpanzee's nose. 🔎

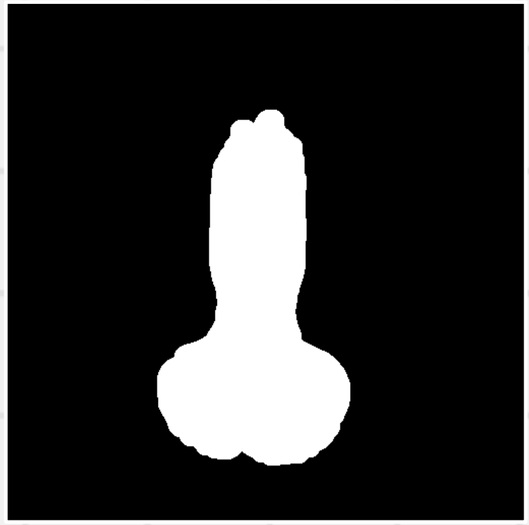
As we see here after applying dilation the gaps inside nose disappeared, but the nose got much bigger.

So, we applied erosion to resize it and solve this problem.

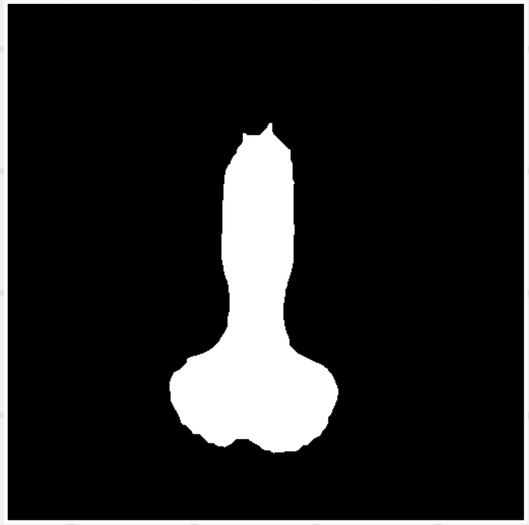
Gaussian Blur



Dilation



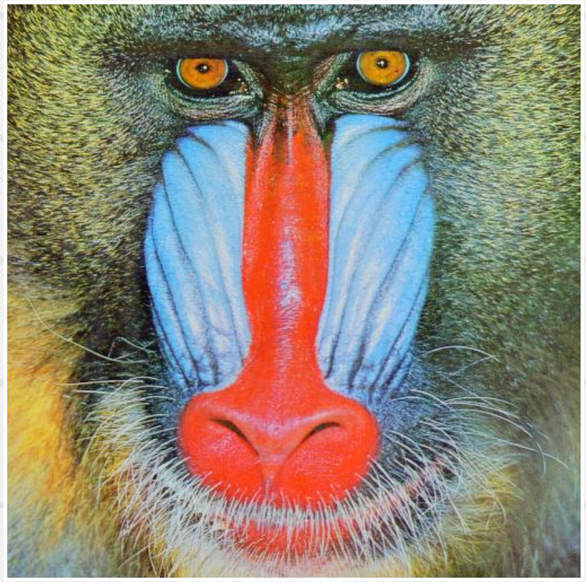
Erosion



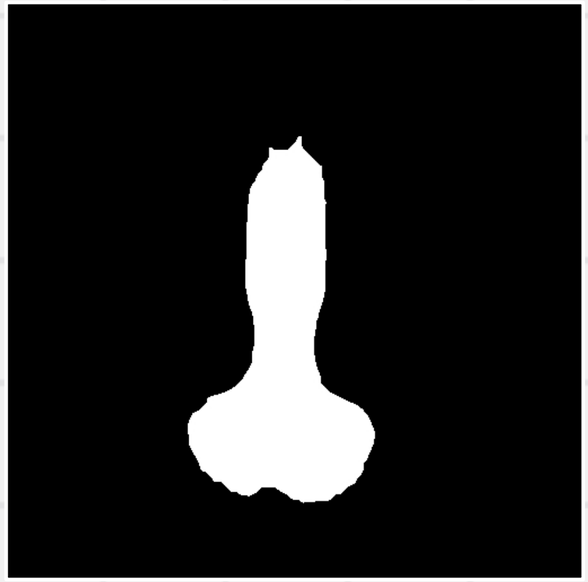
Dilation & Erosion

As you can see, we have successfully detected the object in the binary image, where all objects appear as white pixels and the background as black. This result is achieved after the final stage of processing—dilation and erosion—which helped enhance the shape and connectivity of the detected regions. Using this representation, we can easily determine the object's position along the X-axis and Y-axis.

Original Image



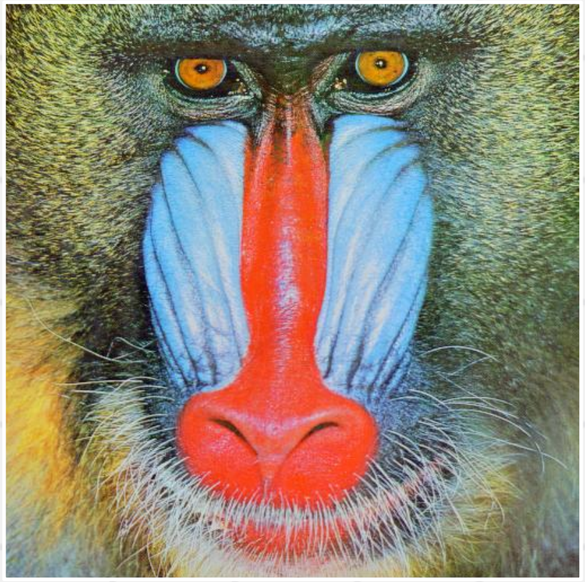
Final Image



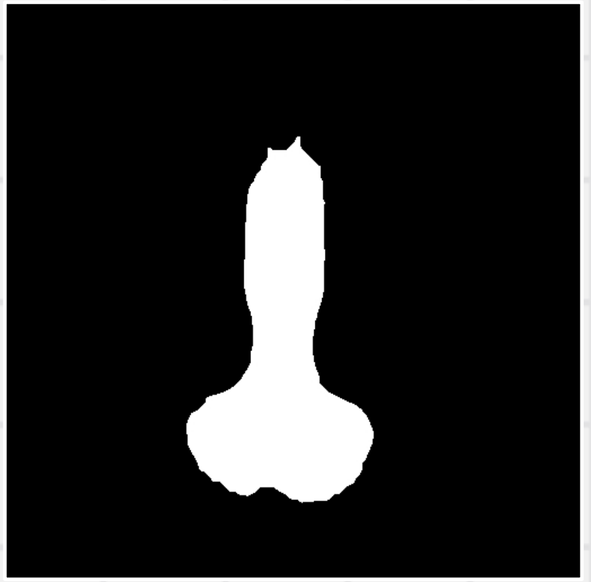
Dilation & Erosion

Are there more effective alternatives to Gaussian blurring for noise reduction in object detection? Similarly, can you think of alternative methods to dilation and erosion for enhancing object boundaries and removing noise in binary images?

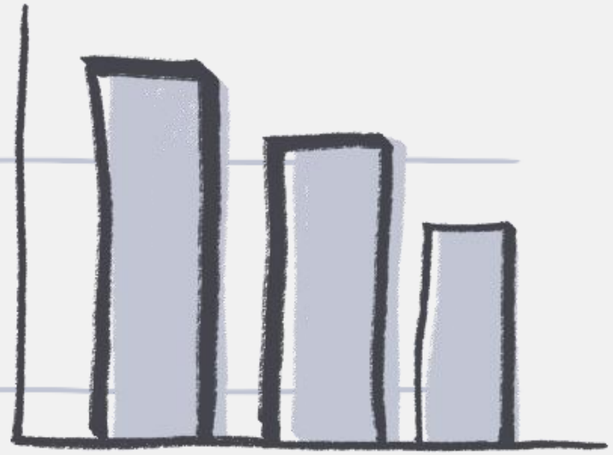
Original Image



Final Image



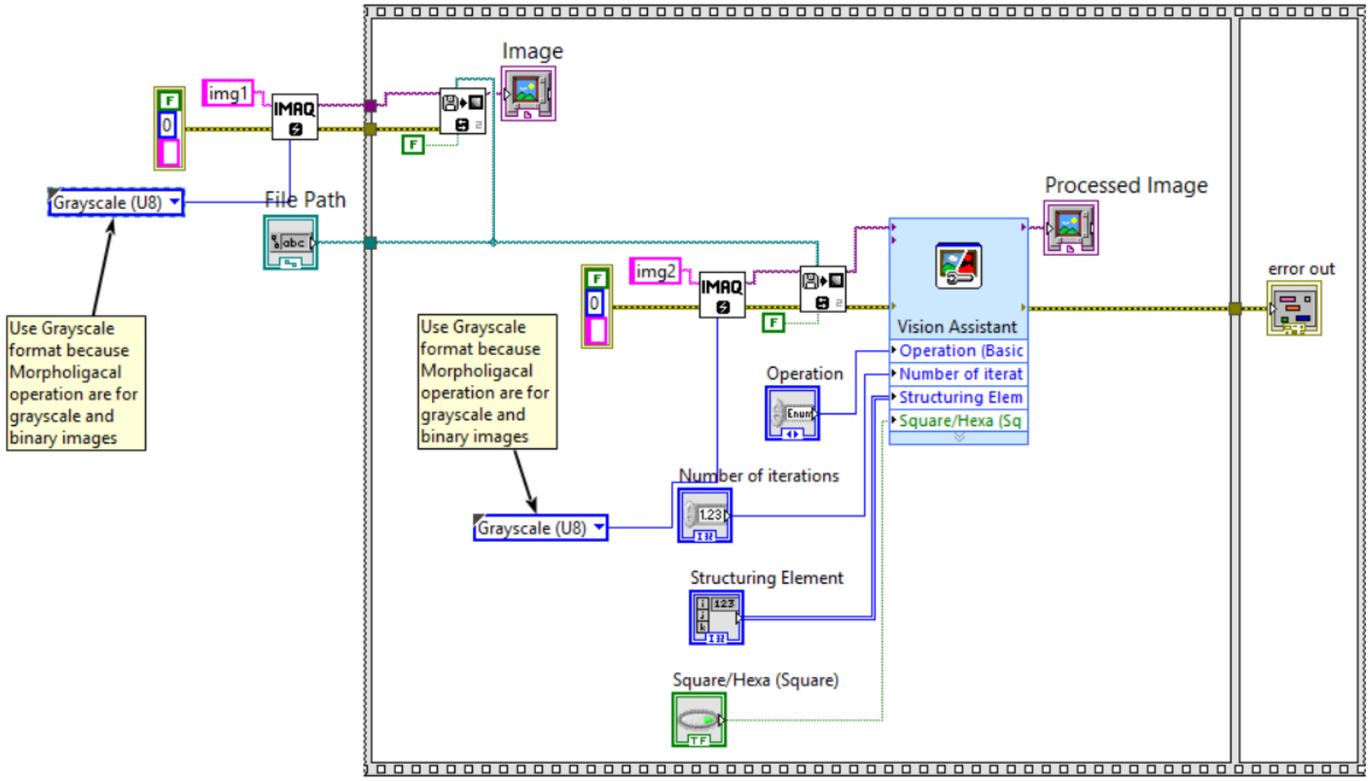
04



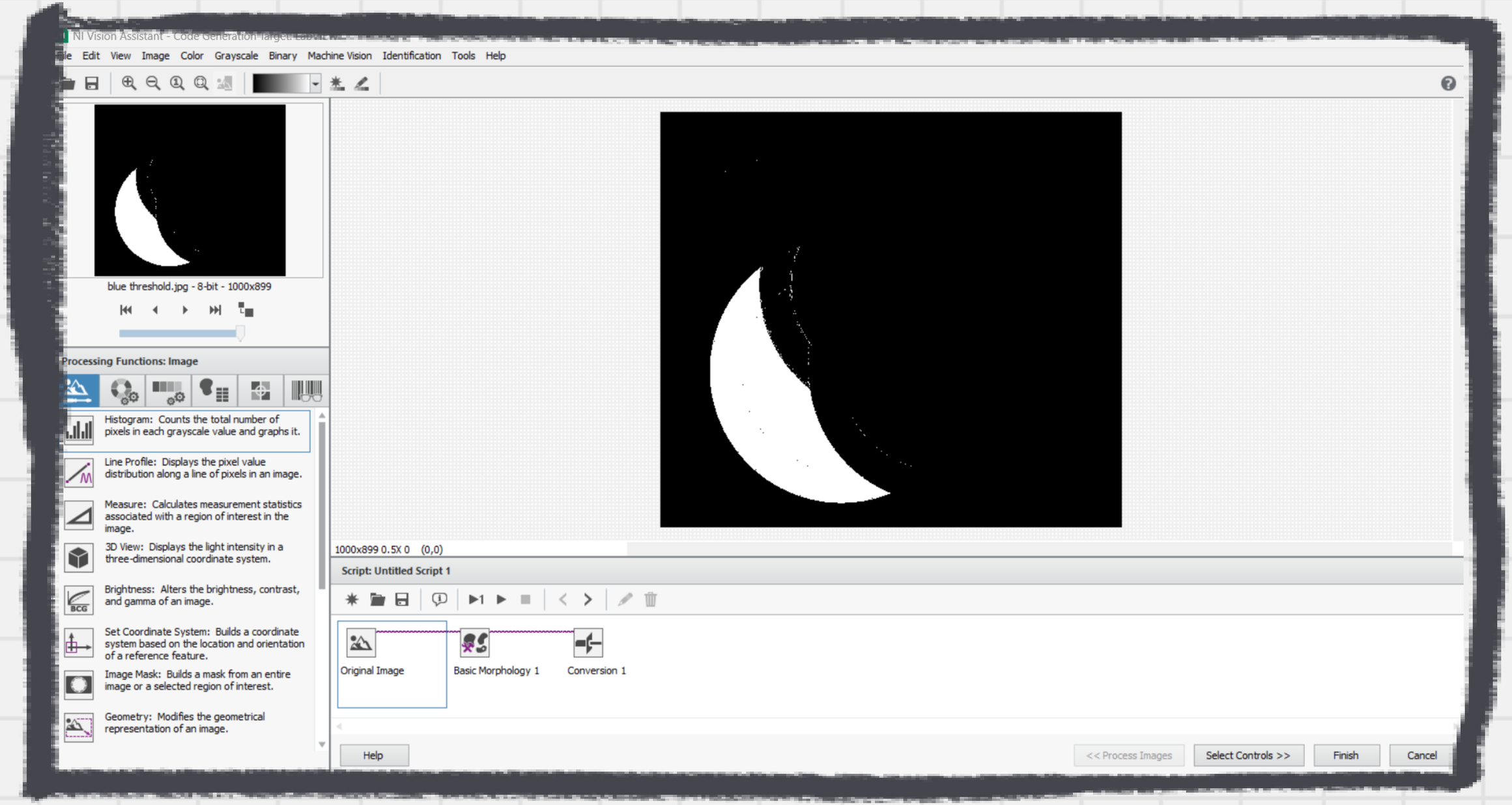
LabVIEW

EX8. Morphological Operations

EX8. Morphological Operations



EX8. Morphological Operations




THANK
YOU