Detection of Discontinuities

- There are three basic types of grey level discontinuities which we are interested in digital images
  - Points
  - Lines
  - Edges
- We typically find discontinuities using masks and correlation

Computer Vision and Image Processing (CSEL-393)

Lecture 13

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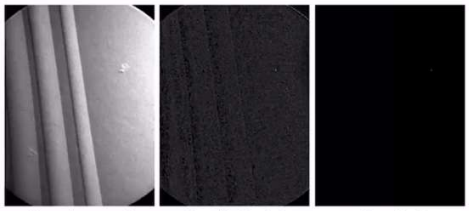
Points Detection

- Point detection can be achieved simply using the mask below:

−1	−1	−1
−1	8	−1
−1	−1	−1

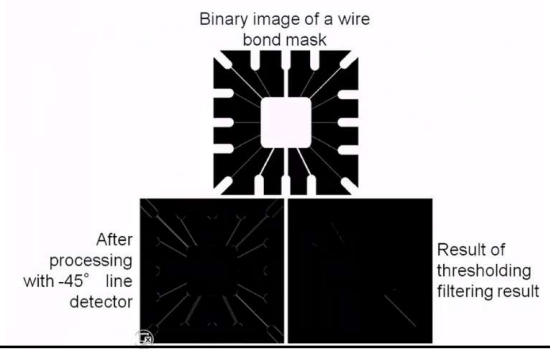
- This mask gives high weight to the center pixel and nullify the neighboring pixels. That means we will find the points in the image

Point Detection Example



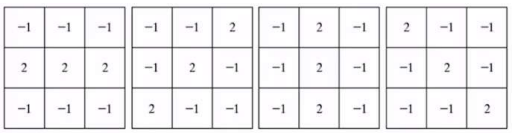
X-ray image of a turbine blade | Result of point detection | Result of thresholding

Line Detection-Example



Line Detection

- The next level of complexity is to detect lines
- The masks given below extract lines that are **one pixel thick** and running in a particular direction



−1	−1	−1	−1	−1	2	−1	2	−1	2	−1	−1
2	2	2	−1	2	−1	−1	2	−1	−1	2	−1
−1	−1	−1	2	−1	−1	−1	2	−1	−1	−1	2

Horizontal | +45° | Vertical | −45°

Morphology and Morphological Image Processing

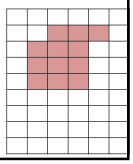
- For the extraction of feature we will focus on the following terminologies
- **Foreground**: white color → (region of interest), moving object
- **Background:** black color, not in interest for the development of specific application, non-moving objects are background

Morphology

- **Morph**: forms or shapes
- **Ology**: to study something
- **Morphology**: is a branch of biology that deals with the form and structure of animals and plants
- **Image Morphology**: is a branch that deals with the form and structure of images
- Morphological Image processing is used to extract the image components for the representation and description of regions shape such as **boundaries**, **skeletons** and the **convex hull**

Dilation and Erosion Structuring Elements

- Morphology deals with structuring elements
- Structuring Elements: Structuring elements are same as spatial filters (i.e. may have any shape, and size)
- **Fit**: All pixels in the structuring elements cover on pixels in the image
- **Hit**: Any pixel in the structuring element covers pixels in the image
- **Miss**: All are missed
- All morphological image processing operations are based on these simple ideas

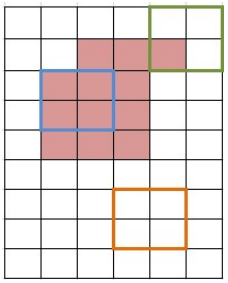


Morphology

- **Morphological image processing** (or morphology) describes a range of image processing techniques that deal with the shape (or morphology) of features in an image
- Morphological operations are typically applied to remove imperfections introduced during segmentation, and so typically operate on bi-level(binary) images

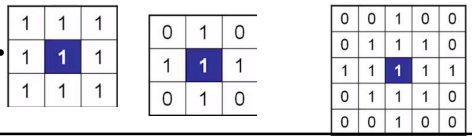
Dilation and Erosion Structuring Elements

- **FIT**: All pixels in the structuring elements cover on pixels in the image
- **HIT**: Any pixel in the structuring element covers pixels in the image
- MISS: All are missed
- All morphological image processing operations are based on these simple ideas

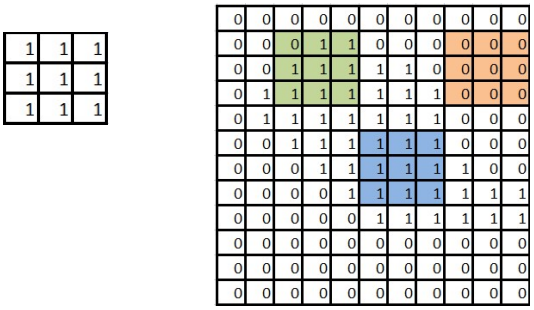


Dilation and Erosion Structuring Elements

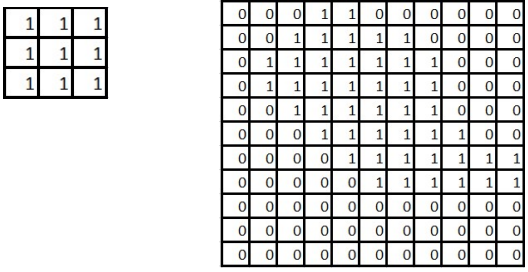
- Structuring elements can be any size and make any shape. Can have varied values of coefficients
- However, for simplicity we will use rectangular structuring elements with their origin at the middle pixel



Example of Structuring Elements Application



Example of Structuring Elements Application



Erosion and Dilation

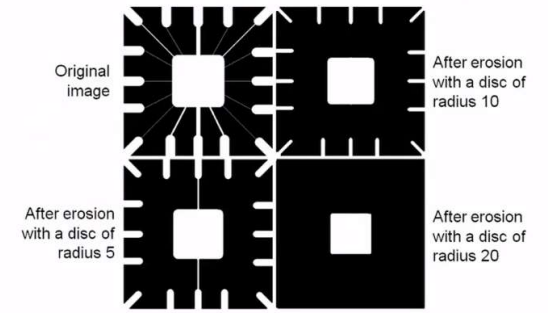
- Fundamentally morphological image processing is same as spatial filtering
- The structuring element is moved across every pixel in the original image to give a pixel in a new processed image.
- The value of this new pixel depends on the operation performed.
- There are two basic morphological operations: **erosion** and **dilation** which are done using structuring elements process i.e. FIT, HIT, MISS
- Erode: If structuring element FITs then it is ERODE
- Dilate: if Structuring Element HIT then it is DILATE

Erosion

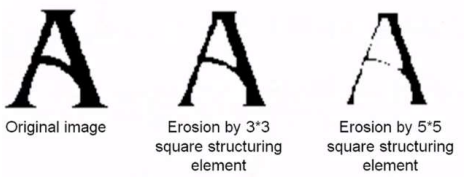
- Erosion of image ***t*** by structuring element ***s*** is given by $t \ominus s$
- The structuring element ***s*** is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ fits } f \\ 0 \text{ otherwise} \end{cases}$$

Erosion-Example



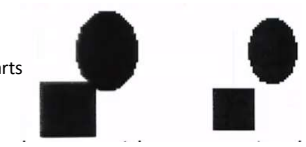
Erosion-Example



Input image → negative→ morphological operations → Negative

Erosion

Erosion can Split apart joined parts



Erosion can strip away extrusions

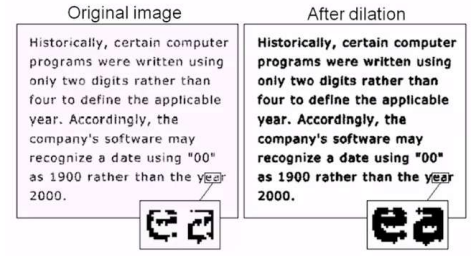
Erosion Shrinks objects: Definitely, when it removes extrusions, the object becomes shrinks

Dilation

- Dilation of image ***t*** by structuring element ***s*** is given by $t \oplus s$
- The structuring element ***s*** is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ hits } f \\ 0 \text{ otherwise} \end{cases}$$

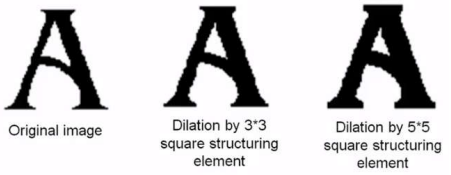
Dilation-Example



Broken characters are joined

Structuring element

Dilation-Example



Input image → negative→ morphological operations → Negative

Dilation-Example

Dilation can repair breaks

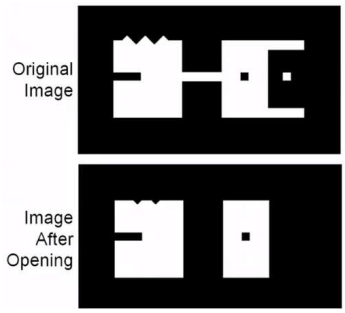
Dilation can repair intrusions

Dilation Enlarge objects

Compound Operations

- More interesting morphological operations can be performed by performing combinations of erosions and dilations.
- The most widely used of these compound operations are:
  1. Opening
  2. Closing

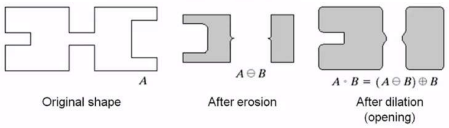
Opening- Example



Opening

- Opening of image ***t*** by structuring element ***s*** denoted by
- **t ∘ s** is simply an erosion followed by a dilation

$$t \circ s = (t \ominus s) \oplus s$$



- Note a disc shaped structuring element is used

Code of boundary Extraction

THANK YOU