18124011600
Vishwas Acharya

Computer Vision

Date:

Assignment - 3

1) What is morphology?

Ans - Morphological image processing (or morphology) describes a range of image processing techniques that deal with the shape (or morphology) of features in an image

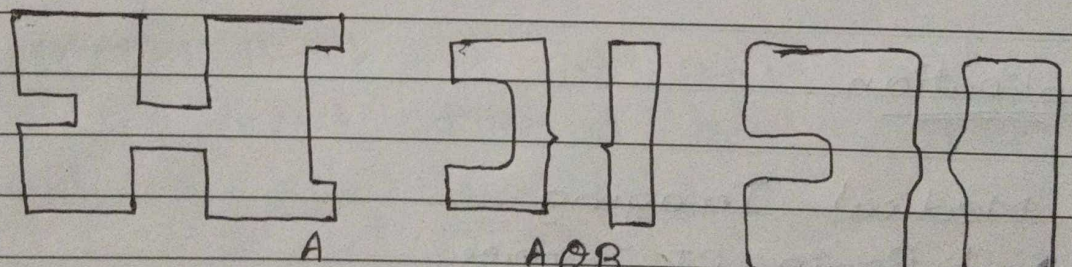
- Morphological operations are typically applied to remove imperfections introduced during segmentation and so typically operate on bi-level images.

2) What is Opening Compound Operations?

Ans - Opening Compound Operations is one types of this operations

- The opening of image i by structuring element s, denoted f∘s is simply an erosion followed by a dilation.

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



Original shap — After erosion — $A \cdot B = (A \ominus B) \oplus B$ After dilation (opening)

- Advantages

- Opening generally smoothing the contour of an object

- Breaks narrow isthmuses
- And eliminates thin protrusion

3) What is Active Contour?

Ans - Segmentation is a section of image processing for separation of information from the required target region of the image
- There are different techniques used for segmentation of pixels of interest from the image.
- Active contour is one of the active models in segmentation techniques, which makes use of the energy constraints and forces in the image for seperation of regions of interest.
- Active contour defines a separate boundary or curvature for the regions of target object for segmentation.

- Application

↳ Medical Imaging
  ↳ Brain CT Images
  ↳ Cardiac Image
  ↳ MRI Image
↳ Motion Tracking
↳ Stereo Tracking

- What is Active Contour?

Given: Approximate boundary (contour) around the object.

Task: Evolve (move) the contour to fit exact object boundary

Active Contour:

↳ Iteratively "deform" the initial contour so that:

↳ It is near pixels with high gradient (edges)

↳ It is smooth.

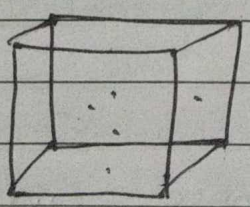
4) Define: Point Detection, Line Detection, Edge Detection.

Ans • Point Detection

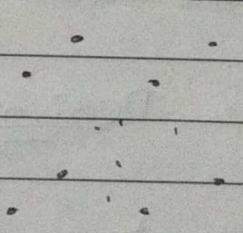
↳ It can be achieved simply using the mask below:

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

↳ Points are detected at those pixels in the subsequent filtered image that are above a set threshold.



original



Point detection

• Line Detection

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

-1	-1	-1
2	2	2
-1	-1	-1

Horizontal

-1	-1	2
-1	2	-1
2	-1	-1

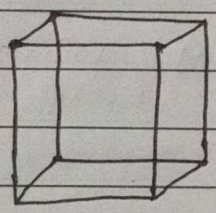
+45°

-1	2	-1
-1	2	-1
-1	2	-1

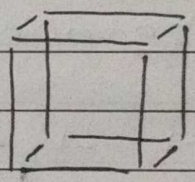
Vertical

-2	1	-1
-1	2	-1
-1	-1	2

-45°



Original



Line Detection

• Edge Detection

- An edge is a set of connected pixels that lie on the boundary between two regions.

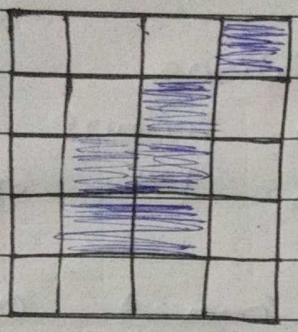
• Edges & Derivatives

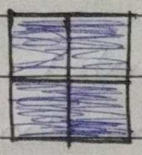
↳ 1st derivative tells us where an edge is.
↳ 2nd derivative can be used to show edge direction

- Derivative based edge detectors are extremely sensitive to noise
- We need to keep this in mind.

5) Explain, Hit, Miss and Fit structuring Elements.

Ans





Structuring Element

- Fit: All on pixels in the structuring element cover on pixels in the image.

- Hit: Any on pixel in the structuring element covers on on pixel in the images.

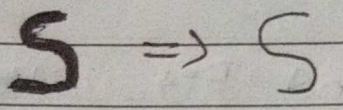
- All morphological processing are based on these simple ideas.

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

- What is use of Hit, Miss and Fit?

Hit and miss algorithm can be used to

thin and skeletonize a shape in a binary image.



Before After

6) Explain Fundamental Operations.

Ans- Fundamentally morphological image processing is very much like 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 in the operation performed.
- There are two basic morphological operations: erosion and dibtion.

• Erosion

↳ Erosion of image f by structuring element s is by $f \ominus s$

↳ The structuring element s is positioned with its origin at (x,y) and the pixel value is determined using the rule:

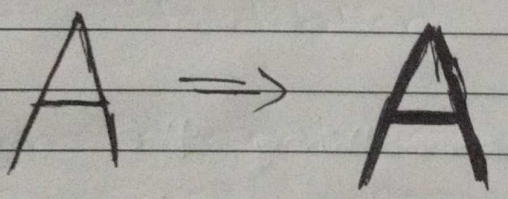
$$g(x,y) = \begin{cases} 1 & \text{if } s \text{ fits } f \\ 0 & \text{otherwise} \end{cases}$$

- ~~Erosion~~ What is Erosion for?
  - ↳ Erosion can split apart joined objects.
  - ↳ Erosion can strip away extrusions
  - ↳ Watch out: Erosion shrinks objects

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

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

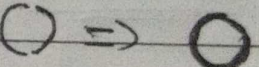
Ex: 1



original image

dilation by 3×3 square structing element.

Ex: 2



- What is Dilation For?
  - ↳ Dilation can repair breaks ~~and~~ bridges the gap
  - ↳ Dilation can repair intrusions
  - ↳ Watchout: Dilation enlarges objects

7) Explain Compound Operations

Ans- More interesting morphological operations can be performed by performing combinations of erosion and dilation.

- The most commonly used of these compound operations are:
  1) Opening
  2) Closing.

-> Opening

↳ The opening of image f by structuring element s, denoted $f \circ s$ is simply an erosion followed by a dilation

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

- Advantages

↳ Opening generally smoothing the contour of an object.
↳ Breaks narrow isthmuses
↳ And eliminates thin protrusion.

-> Closing

↳ The closing of image f by structuring element s, denoted $f \bullet s$ is simply a dilation followed by an erosion

$$f \bullet s = (f \ominus s) \oplus s$$

- Advantages

↳ Closing also tends to smooth sections of contours
↳ It generally fuses narrow breaks and long thin gulfs
↳ It eliminates small holes and fill gaps in the contour.

Q) List out the advantages of SIFT features.

Ans- SIFT stands for Scale-Invariant Feature Transform.

- Advantages:

↳ Locality: features are local, so robust to occlusion and clutter
↳ Distintiveness: Individual features can be matched to a large database of objects
↳ Quantity: many features can be generated for even small objects.
↳ Efficiency: close to real-time performance
↳ Extensibility: can easily be extended to a wide range of different fature types, with each adding robustness.

Date: 10

9) List out the five steps in the SIFT algorithm.

Ans - SIFT is quite an involved algorithm. There are mainly four steps involved in the SIFT algorithm.
- We will see them one-by-one.

- Scale-space peak selection: Potential location for finding features.

- Keypoint Localization: Accurately locating the feature keypoints.

- Orientation Assignment: Assigning orientation to keypoints.

- Keypoint descriptor: Describing the keypoints as a high dimensional vector.

10) Define Thresholding.

Ans - It is the usually first in any segmentation approach
- We have talked about simple single value thresholding already.
- Thresholding is used to produce region of uniformity within the given image based on some threshold criteria T.
- Single value thresholding can be given mathematically as follows:

$$g(x,y) = \begin{cases} 1 & \text{if } f(x,y) > T \\ 0 & \text{if } f(x,y) \leq T \end{cases}$$

- Examples:

↳ Imagine a poker playing robot that needs to visually interpret the cards in its hand.
↳ If you get the the threshold wrong, the results can be disastrous

- Basic Global Thresholding

↳ Based on the histogram of an image
↳ Partition the imag histogram using a single global threshold,
↳ The sucess of this technique very strongly depends on how well the histogram can be partitioned

- Types of thresholding:

1. Global thresholding
2. Local thresholding

- The basic global threshold, T, is calculated as follows

1. Select an initial estimate for T (typically the grey level in the image)
2. Segment the image using T to produce two group of pixels.

1. G_1 consisting of pixels with grey levels $> T$
2. G_2 consisting of pixels with grey levels $< T$

3. Compute the average grey levels of pixels in G_1 to give μ_1 and G_2 to give μ_2

4. Compute a new threshold value:

$$T = \frac{\mu_1 + \mu_2}{2}$$

5. Repeat steps 2-4 until the difference in T in successive iterations is less than a predefined limit T_∞.

- This algorithm works very well for finding thresholds when the histogram is suitable.