Computer Vision 2019 Fall

Final Notes

名詞解釋

1. Noise cleaning : based on neighborhood spatial coherence or pixel value homogeneity, replace values of the noisy pixels with some other values to make get better coherence or homogeneity.
2. Outlier (peak noise) : a pixel whose real value is greatly different from the predicted value
3. Center deleted: neighborhood pixel values in neighborhood except center
4. Edge: where brightness value appears to jump
5. Zero-crossing edge detector: a pixel is declared to have a zero crossing if it is less than $-t$ and one of its eight neighbors is greater than t or it is greater than t and one of its eight neighbors is less than $-t$ for some fixed threshold t.
6. Line segment: an elongated rectangular region having a homogeneous gray level bounded on both its longer sides by homogeneous regions of a different gray level.
7. Facet model: image can be thought of an underlying continuum or piecewise continuous gray level intensity surface
8. Bayesian approach to gradient edge detection: decide there is an edge when:

$$P(\text{edge}|G) < P(\text{nonedge}|G)$$

   - $P(\text{edge}|G)$: given gradient magnitude conditional probability of edge
   - $P(\text{nonedge}|G)$: given gradient magnitude conditional probability of nonedge
9. Polynomial basis set: discrete orthogonal polynomials
10. Corner: with two conditions
    - the occurence of an edge
    - significant changes in edge direction
11. Topographic primal sketch: labeling and grouping of the underlying image intensity surface patches according to the categories defined by monotonic, gray level, and invariant functions of directional derivatives
12. Peak: local maximum in all directions, curvature downward in all directions
13. Pit: local minimum in all direction
14. Ridge: local maximum in one direction
15. Ravine: local minimum in one direction
16. Saddle: local maximum in one direction and local minimum in perpendicular direction
17. Flat: zero gradient, no curvature
    - foot: flat begins to turn up into a hill
    - shoulder: flat begins to turn down into a hill
18. Inflection point: zero-crossing of second directional derivative
19. Pattern recognition: given textured region, determine the class the region belongs to

20. Generative model: give textured region, determine a description or model for it
21. Texture: an image obeying some statistical properties, similar structure repeated over and over again, some degree of randomness; repeating patterns of local variations in image intensity which are too fine to be distinguished as separated object at the observed resolution
22. Texture segmentation: given image having many textured areas, determine boundaries
23. Texel (texture element): basic textural unit of some defining spatial relationships
24. Texture primitive: connected set of pixels characterized by attribute set
25. Autocorrelation function: a feature that describes the size of gray level primitives
26. Vector dispersion: divide the texture into mutually exclusive neighborhoods
27. Granularity:

$$G(d) = 1 - \frac{\#(F \circ H_d)}{\#F}$$

    - F : a binary image
    - $\circ$: Opening operator
    - $\#$: number of elements
    - H_d : disk structuring element of diameter d
    - $G(d)$ measures the proportion of pixel participating in grains of size smaller than d
28. Fractal: natural phenomenon or a mathematical set that exhibits a repeating pattern that displays at every scale
29. Shape from texture: using image texture gradients to estimate surface orientation of the observation 3D object
30. Image segmentation: partition of image into set of non-overlapping regions
31. Clustering: partioning set of pattern vectors into clusters
32. Grouping: edge pixels participating in the same region boundary are grouped together into a sequence
33. Corner points (dominant points): the endpoints of the digital arc subsequences
34. Tangential angle deflection: to identify locations where two line segments meet and form an angle
35. Curvature:

$$\kappa(s) = \lim_{\Delta s \to 0} \frac{\Delta \theta}{\Delta s}$$

    - Δs : the change in arc length
    - $\Delta \theta$: the change in tangent angle

其他重點

Chapter 7

1. Order Statistics Neighborhood Operators

- median:
    - effective for impulsive noise (salt and pepper)
    - Disadvantage: distorts or lose fine detail such as thin lines

- running median:
    - effective for impulsive noise
- trimmed mean:
    - effective when noise distribution has fat tail
- midrange
    - not a good approach
- hysteresis smoothing
    - removes minor fluctations, preserve major transients

2. Types of noise:
    - Uniform: may occur at every pixel, with equal probability
    - Gaussian: noise values gather at tails of normal distribution
    - Salt and pepper: add noise to certain portion of pixels, noise value only 0 or 255
    - Varying: no certain pattern

Chapter 9

1. Statistical Texture Feature Approaches
    - Spatial gray-level co-occurence probabilities
    - Autocorrelation function
    - Edgeness per unit area
    - Relative extrema distributions
    - Mathematical morphology
    - Spectral power density function
    - Gray-level run-length distributions
2. Model Based Technique
    - Auto-regression
    - Markov random fields
    - Random Mosaic models
    - Moving-average
    - Time-series models
3. Texture Analysis Issues
    - Pattern recognition: given textured region, determine the class the region belongs to
    - Generative model: given textured region, determine a description or a model for it
    - Texture segmentation: given image having many textured areas, determine boundaries
4. Texture Analysis - Model Based Technique
    - Estimation: estimation values of model parameters based on observed sample examples of model-based technique
    - Verification: verify given image texture sample is consistent with or fits the model
5. Synthetic Texture Generation
    - Step 1: Choose a region from the original texture sample image as the initial region.
    - Step 2: Find the region with the similar edges in the original image
    - Step 3: Paste it on the result image

- Step 4: Back to Step 2 and repeat

Chapter 10

1. Methods:
    - Single-linkage region-growing
    - Hybrid single-linkage region-growing
    - Centroid-linkage region-growing
    - Hybrid-linkage combinations
    - Split and Merge
2. Single linkage region growing
    1. Strength: boundaries are spatially accurate
    2. Weakness: edge gaps result in excessive merging
3. Centroid linkage region growing
    1. Strength: to place boundaries in weak gradient area
    2. Scan in a predetermined manner, and a pixel's value is compared with the mean of an already existing neigboring segment. If the value and the mean is closed enough, the pixel is added to the segment and the mean of the segment is updated.
4. Split and Merge:
    1. Split: split each of its current segments into quarters if the segment is not homogeneous enough
    2. Merge: an initial segmentation and successively merge regions that are similar enough
    3. Weakness: large memory use, excessively blocky region boundaries

Chapter 11

1. Iterative Endpoint Fit and Split
    - To segment a digital arc sequence into subsequences that are sufficiently straight
    - connect the two endpoints of an arc, find the point that is farthest from this straight line and choose the point as the splitting point
2. Split and Merge
    - First: split arc into segments with the error sufficienlty small
    - Second: merge successive segments if resulting merged segment has sufficiently small error
    - Third: try to adjust breakpoints to obtain a better segmentation
3. Region-of-support Determination:
    - region of support too large: fine features smoothed out
    - region of support too small: many corner points or dominant points produced

Research

1. Introduction to SRGAN, deconvolution, point spread function, and inverse filtering
    - Method: SRGAN(Super-Resolution Generative Adversarial Network)
    - Step: low-resolution image $\rightarrow$ SRGAN $\rightarrow$ high-resolution image $\rightarrow$ compare with python method using PSNR, SSIM
    - Result: 2~5 times larger images
2. Hand Gesture Recognition:
    - Method: YOLOv3, YOLO, CNN, object detection

    - Step: recognized by CNN model, YOLO → CNN → Result
    - Result: WIP, can recognize gestures
3. Driver Drowsiness Detection:
    - Method: Mutli-task learning (machine learning, deep learning)
    - Step:
        - CNN - Spatial analysis
        - LSTM - Temporal analysis
    - Result: 1 means a driver is drowsy, 0 means a driver is not drowsy
4. Deep Convolutional Neural Network
    - Method: Filtered Back Projection, FPBCONV
    - Result: 3D image
5. Introduction to Pancreas Segmentation
    - Method: Attention U-net with VAE
    - Step: Preprocess image → image augmentation → Attention U-net with VAE → Result
    - Result: can handle cross-border dataset