Computer Vision 2019 Fall

Midterm Notes

名詞解釋

1. grouping: identifies the events by collecting together or identifying maximal connected sets of pixels participating in the same kind of event.

   e.g. segmentation, edge linking

2. labeling: based on a model that suggests that the informative pattern has structure as a spatial arrangement of events, each spatial event being a set of. connected pixels.

   e.g. thresholding, edge detection, corner finding

3. shape: a certain closed area in an image, which is bounded by edges or curves. prime carrier of information in machine vision

   e.g. circle, rectangle

4. perserve order: a set A is included by a set B. If after some operation f, $f(A) \subseteq f(B)$, then we can say f preserves order.

   e.g. dilation

5. hexagonal grid: it is a situation for binary morphology in Euclidean N-space when N=2.
6. corner: the points at which the edges change directions rapidly
7. edge: a set of points describing the boundary of two regions in an image.
8. linear shift-invariant operator: given input image f, output image g,

$$g(r,c) = \sum_{(r',c') \in W (r+r', c+c') \in F} f(r+r', c+c') w(r', c')$$

9. mathematical morphology: a theory and technique for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology, and random function.

   e.g. dilation, erosion, opening, closing, hit-and-miss transformation

10. conditioning: out of scope
11. convolution: the convolution of an image f with kernel w is defined by

$$(f * u)(r,c) = \sum_{(r',c') \in W (r-r', c-c') \in F} f(r-r', c-c') w(r', c')$$

12. cross-correlation: the cross-correlation of f with w is defined by

$$(f \otimes w)(r,c) = \sum_{(a,b) \in W (r+a, c+b) \in F} f(r+a, c+b) w(a,b)$$

    used to measure the correlation between f and w.

13. weighted mask: it is a mask whose each grid is given different weight, often used in noise cleaning, cross-correlation, and convolution

14. histogram equailization: a method in image processing of contrast adjustment using the image's histogram

$$S = T(r), s_k = 255 \sum_{j=1}^{k} \frac{n_j}{n}$$

15. duality: negation of one equals to the other on negated variables

    e.g. erosion dilation duality: $(A \ominus B)^c = A^c \oplus \check{B}$

簡答

1. dilation: union of translates, extensive, preserves order (increasing)

   erosion: intersection of negative translates, antiextensive, perserves order (increasing)

   opening: antiextensive, increasing, idempotent

   closing: extensive, increasing, idempotent

2. 請用dilation和erosion定義opening和closing。

   $\text{opening}(I, K) = \text{dilation}(\text{erosion}(I, K), K)$

   $\text{closing}(I, K) = \text{erosion}(\text{dilation}(I, K), K)$

3. Explain "connected component labeling" and "signature segmentation".
   - connected component labeling: a group operation, all pixels that have value binary-1 and are connected to each other by path of pixels all with value binary-1 are given the same identifying label.
   - signature segmentation:
     - signature: histogram of the nonzero pixels of the resulting masked image
     - signature segmentation: segment a image into regions based on some form of signature
4. Explain "statistical pattern recognition".

   unit: image regions or projected segments, each unit has a associated measurement vector

   measurement vector: a vector consisting of the several features extracted from the unit

   decision rule: a rule used to determine the class of an unit based on the measurement vector

   Assignment: assign each unit to a class (classification). Our goal is try to optimally assign the each unit to a class such that the classification error is minimized.

5. Given

$$E = P(g,g)e(g,g) + P(g,b)e(g,b) + P(b,g)e(b,g) + P(b,b)e(b,b)$$

   Derive that

$$E = \{[1 - P(b|g)]e(g,g) + P(b|g)e(g,b)\}P(g) + \{P(g|b)e(b,g) + [1 - P(g|b)]e(b,b)\}[1 - P(g)]$$

$$\begin{aligned} E &= P(g,g)e(g,g) + P(g,b)e(g,b) + P(b,g)e(b,g) + P(b,b)e(b,b) \\ &= P(g|g)P(g)e(g,g) + P(b|g)P(g)e(g,b) + P(g \mid b)P(b)e(b,g) + P(b|b)P(b)e(b,b) \\ &= \{[1 - P(b|g)]e(g,g) + P(b|g)e(g,b)\}P(h) + \{P(g|b)e(b,g) + [1 - P(g|b)]e(b,b)\}[1 - P(g)] \end{aligned}$$

6. Under Fair Game Assumption, we have $P(a|t,d) = P(a|d)$. Show that

$$P(t, a|d) = P(a|d)P(t|d)$$

$$\begin{aligned} P(t, a|d) &= \frac{P(t, a, d)}{P(d)} \\ &= \frac{P(a|t, d)P(t, d)}{P(d)} \\ &= \frac{P(a|d)P(t, d)}{P(d)} \\ &= P(a|d)P(t|d) \end{aligned}$$