Multimedia Databases Exercises
SS 2023

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Exercise 7

Aufgabe 1: Content-Based Retrieval

1. What does Content-Based Retrieval mean?
2. What are the components of a CBIR architecture? Explain the basic principle of each component using an example.
3. What is a feature vector?
4. Which problems occur when indexing feature vectors?

Aufgabe 2: Definitions related to CBR

Explain the following notions and give examples:

1. Dominant Color
2. Spatial Coherency
3. Distance Metrics
4. Curse of Dimensionality
5. Types of content-based queries

Aufgabe 3: CBIR System

Which are the necessary conditions must be fulfilled in order to able to issue the following query to a CBIR system:

- Give me all images which contain a red car!

What are the problems that can occur?

Aufgabe 4: Image indexing by colours

The starting points are the following two images (see figure 1). Supposing every image has a resolution of 4x4 pixels. Thus the left image contains exactly 8 red coloured and 8 white coloured pixels, the right one one big black and one big white block:

1. Apply an even colour quantification for 8 colours. Which quantification area (range) do the colours in the two images belong to?
2. Create a colour histogram for both images.
3. Apply an even bin quantification for 2 bit.

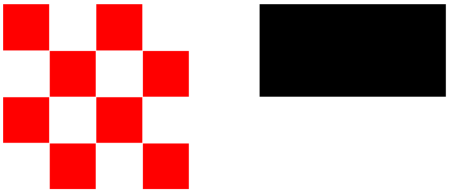

Abbildung 1:

Aufgabe 5: Similarity of images because of colour distribution

Minkowski Distances
Use the two images of exercise 4 and the results of exercise 4b (without bin quantification). Determine the similarity of the images with the help of Minkowski distances L_1, L_2 and $L\infty$.

Definition of the Minkowski Distance:
Starting with $P = (x_1, x_2, \ldots, x_n)$ and $Q = (y_1, y_2, \ldots, y_n) \in R^n$

$$L_p(P,Q) = \left(\sum_{i=1}^{n} |x_i - y_i|^p \right)^{1/p}$$

Which result would you obtain if the red colour in the left image was black? Which conclusions do you draw?
Statistical Distances
Starting with the following colour distribution: $H_1 = (4,4,4,4)$ and $H_2 = (8,3,4,5)$

Non-parametrical Distances:
Calculate the distances between H_1 and H_2 with the help of the following functions: Kolgomorov-Smirnov Distance, Chi-squared Distance.

Kolgomorov-Smirnov Distance:

$$KS(P,Q) = \max_i |F^r(i;P) - F^r(i;Q)|$$

$F^r(i;P)$ is equivalent to *kumulative histogram* of P in place i.

Chi-squared Distance:

$$D_\chi(P,Q) = \sum_i \frac{(x_i - f'(i))^2}{f'(i)}$$

Mit:

$$f'(i) = \frac{x_i + y_i}{2}$$

Parametrical Distance Function:
Calculate the distance between H_1 and H_2. Use *Weighted-mean-variance* and the following training data:

$$V_1(8,8,4,12), V_2(4,0,0,16), V_3(2,3,8,7), V_4(4,4,6,10)$$

Weighted-mean-variance:

$$WMV(P,Q) = \frac{|\mu(P) - \mu(Q)|}{|\sigma(\mu(Ref))|} + \frac{|\sigma(P) - \sigma(Q)|}{|\sigma(\sigma(Ref))|}$$

μ: average
σ: Standard deviation
$\mu(Ref)$: Average calculated from training data
$\sigma(Ref)$: Standard deviation calculated from training data