MPEG-7 Visual shape descriptors

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Seminar on scientific soft skills

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Presentation Outline

- **Presentation Outline**
- **Introduction to problem**
- Shape spectrum - 3D shape descriptor
- ART – Region-based shape descriptor
- 2D/3D descriptor
- Contour-based shape descriptor

Introduction to problem

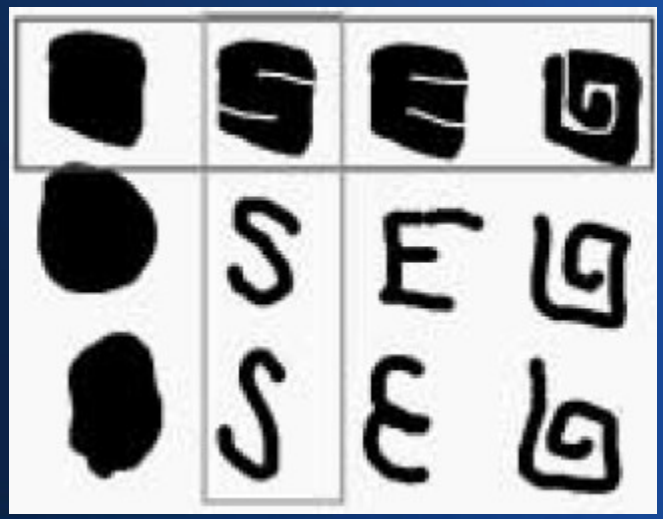
- MPEG-7
  - multimedia content description standard
- Shape representation & matching
  - techniques & tools

Introduction to problem (cont.)

- Shape
  - powerful clue to the object identity and functionality
  - object recognition
  - semantic information (color,texture,motion,...)
- Real world 3D
  - 3D shape descriptor
  - tools also for 2D projections

Introduction to problem (cont. 2)

- 2D case
  - Region-based similarity (row) – pixel spatial distribution
  - Contour-based similarity (column) - outline



Introduction to problem (cont. 3)

- 2D/3D shape descriptor
  - 3D information from set of 2D views
- Extensive tests of descriptors
  - Fast search and browsing
  - Invariant to scaling, rotation, translation and non-ridig deformations

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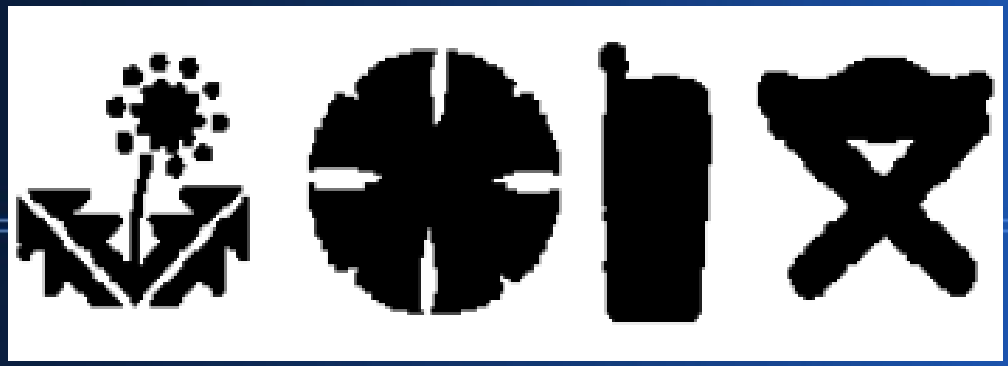
Shape spectrum - 3D shape descriptor

- extension of shape index concept (information about local convexity of 3D surface) to 3D meshes
- Histogram of shape index of each 3D vertex
- Invariant to scaling and Euclidean transformations

ART – Region-based shape descriptor

- Complex 2D Angular Radial Transformation (ART) defined on unit disk in polar coordinates
- Some important features
  - describe multiple disjoint regions simultaneously or simple objects with or without holes
  - robust to object splitting during segmentation
  - robust to segmentation noise



2D/3D descriptor

- 3D representation as set of 2D views
- Any 2D descriptor can be used
  - region-based, contour-based, color or texture
- 2D/3D and contour-based descriptor
  - good performance in multiview description of 3D shapes

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- **Contour-based shape descriptor**

Contour-based shape descriptor Properties

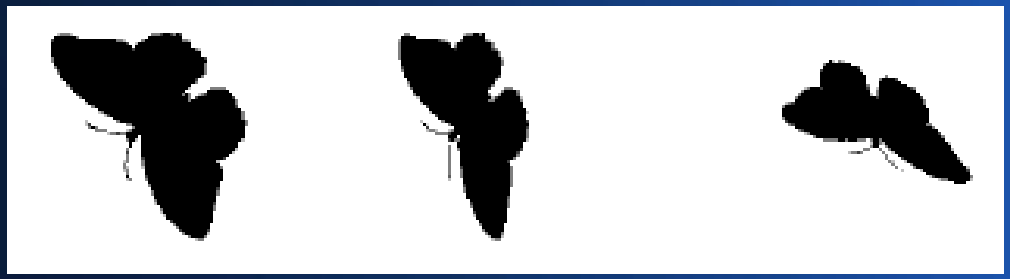
- Distinguish between shapes with similar region-shape and different contour-shape properties

- Support search for shapes semantically similar for humans with significant intra-class variability

Contour-based shape descriptor Properties (cont.)

- Robust to significant non-rigid deformations

- Robust to distortions in the contour due to perspective transformations (images, video)



Contour-based shape descriptor Properties (cont. 2)

- Based on Curvature Scale-Space(CSS)
- Key modifications
  - Addition of global shape parameters
  - Transformation of the feature vector in the parameter space
    - Improving performance
  - New quantisation scheme
    - Supporting a compact representation of the descriptor

Contour-based shape descriptor Syntax

- Eccentricity and circularity of original and filtered contour (12bits)
- Number of peaks in CSS image (6bits)
- Height of the highest peak (7bits)
- x and y positions of the remaining peaks (each 9bits)
- Average size = 112bits per contour

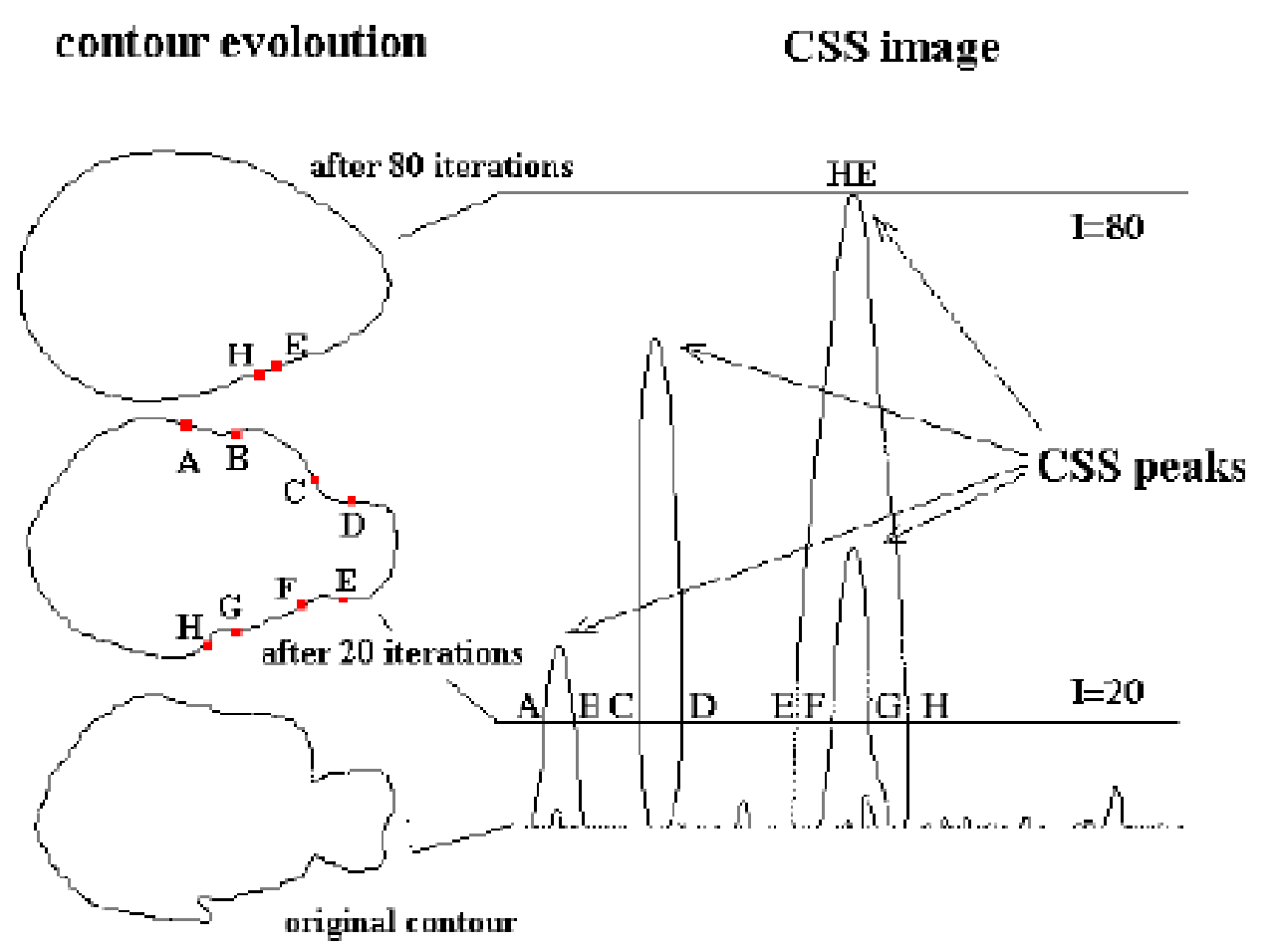
Contour-based shape descriptor Extraction

- Procedure
  - N equidistant points on the contour
  - Group x(y) coordinates together => series X(Y)
  - Low-pass filter to X(Y)
    - kernel (0.25, 0.5, 0.25)
- Many iterations => Contour Smoothing
  - concave parts flatten-out
  - contour becomes convex

Contour-based shape descriptor Extraction (cont.)

- CSS image
  - Contour evolution process
  - Horizontal coords – indices of contour points (1,..,N)
  - Vertical coords– number of passes of the filter
  - Each horizontal line
    - smoothed contour after k-passes
    - mark curvature zero-crossing (inflection) points

Contour-based shape descriptor Extraction (cont. 2)



Contour-based shape descriptor Extraction (cont. 3)

- Extraction from CSS image
  - Prominent peaks
    - extraction, ordering (decreasing y_css), non-linear transformation, quantization
  - Eccentricity and circularity of contour

Contour-based shape descriptor Example application

- Video browsing
  - Contour-based and dominant color descriptor

Conclusions

- Shape representation and matching
  - MPEG-7 techniques and tools
- Set of versatile shape descriptors
  - Shape spectrum - 3D shape descriptor
  - ART – Region-based shape descriptor
  - 2D/3D descriptor
  - Contour-based shape descriptor
  - Tested -> efficient, concise and easy to extract and match descriptors

THANK YOU

ANY QUESTIONS?