MPEG-7 Visual shape descriptors

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Seminar on scientific soft skills

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Presentation Outline

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- 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-rigid 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 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 \((1,\ldots,N)\)
  - 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?