First meeting of the Shape Working Group

17/02/2010

Program of the Day

- The Participants
- Shapes and related topics
- Talk & discussion 1, by Guillaume Charpiat (Pulsar)
- Coffee break
- Talk & discussion 2, by Stanley Durrleman (Asclepios)
- Conclusion, schedule next meeting, etc.

This Shape WorkINg Group could become :

- **a Shape PResentatIoN Group**
  (where each one makes a presentation about his own works)
- **a Regular Shape Seminar**
  (series of talks by various speakers, to know the latest works)
- **a SHApe ReadINg Group**
  (reading articles, books, to know precisely the state of the art)
- **a ShapE WorkINg Group**
  (where we think and work together to go beyond the state of the art)

Shapes and related topics

- **Why study shapes ?**
- **What is a shape ?**
  - what do we mean by *shape* ?
  - representation
  - families, shape spaces
- **Pairwise shape comparison**
  - distances
  - warpings
- **Where do shapes come from ?**
- **Shape statistics**
  - global variations
  - local scale
- **Using information about shapes**

Why study shapes ?

- **because they contain information**
  - patch-based detection (bounding box) vs. segmentation (contour)
  - image/video interpretation : posture/gesture recognition
  - diagnostic (medical imaging)
  - ... (application-dependent)
- **to use them as priors**
  - image segmentation with shape prior
  - etc.
- **to optimize a given property**
  - aerodynamics (shape of a plane), fluid mechanics
  - material constraints : shape of a bridge, soap bubbles
  - acoustics
  - aesthetics ?

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- weak notion : "shape" of the **graph of a function** (Fourier, cf Gabor/wavelet for image texture), of an histogram (they "look the same" : distance ? correlation ?)

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  - shapes as **metric spaces** : pairwise distance matrix (with Euclidean norm: invertible! [Boutin]), n-uplets distance matrices ($\forall n \Longrightarrow$ invertible [Gromov])

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- **topology**: genus only (pb: handling topological noise; lack of details)

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- families of nice shapes (curvature bounds, distance to the skeleton)

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- transformation groups : translation/rotation/scaling/affine : $\inf_{g \in G} d(A, gB)$
  - shapes as metric spaces $\Longrightarrow$ Gromov-Hausdorff [Memoli]

Pairwise shape comparison
Part II : warping, deformation, and embedding

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- optimization methods
  - gradient descent (of the warping cost) + multiscale
  - dynamic time warping
  - graph-cuts

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- $\Longrightarrow$ few shapes available, or no good-quality guaranteed
  - high intrinsic dimension of shape spaces
  - no dense training set
  - introduce priors when defining statistics

Shape statistics

Global variations

- mean shape, e.g. defined by $\inf_M \sum_i d(M, S_i)^2$
  - may be several means + computation issues + does not always make sense
- second order statistics : which variables ?
  - pb : correspondences between variables/shapes (transport?)
  - find a variable whose space if fixed, e.g. $\nabla_M d(M, S_i)$ or $m_{M \to S_i}$
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- manifold learning techniques
  - statistics on the high-dimensional manifold of shapes ?
  - neighborhood : dimension estimation, k-nearest neighbors
  - spectral techniques : graph Laplacian, Hessian eigenmaps, Isomap
  - tangent space of shapes : LLE (locally linear embedding)...
  - using transport & learning the metrics (cf my next talk)

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- $\Longrightarrow$ pattern recognition/classification

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- the issue of **occultation**
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