Tracking medical 3D data with

a parametric deformable model

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References

- *A parametric deformable model to fit unstructured 3D data*, to appear in **Computer Vision and Image Understanding** (also INRIA Research report No. 2617).
- *Tracking and motion analysis of the left ventricle with deformable superquadrics*, to appear in **Medical Image Analysis** (also INRIA Research report No. 2797).

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Cardiac imagery

- cardiac muscle: **dynamic 3D** structure
- acquisition of **3D + T images of the left ventricle** with a good **spatio-temporal** resolution (X-ray scanner, nuclear medicine, MRI)

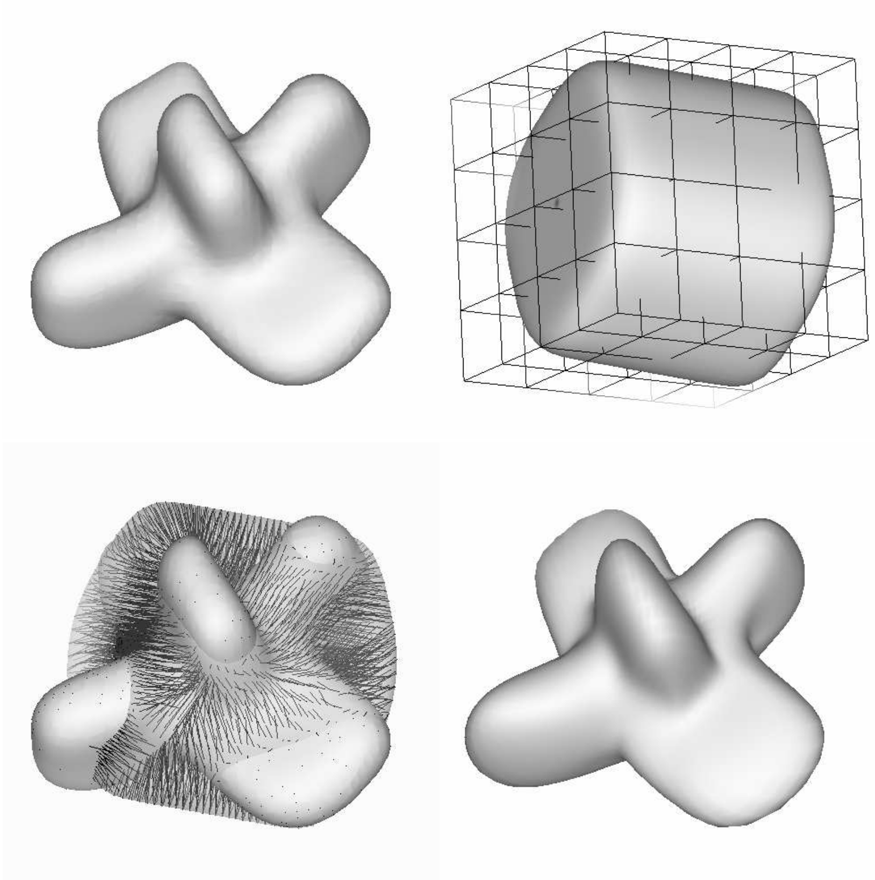
$-\gg$ **huge data volumes**

$-\gg$ a **parametric deformable model** provides a **compact representation** and the **extraction of quantitative parameters** which characterise the cardiac motion

The model

1. **superquadric approximation**
$-\gg$ **reduction** of the admissible solutions space

2. combine the superquadric model with a **volumetric free form deformation (FFD)**
$-\gg$ modelization of **complex shapes** with a **limited number of parameters**
$-\gg$ **simultaneous** deformation of several objects



Reconstruction algorithm. Top left: data. Top right: superquadric approximation and FFD control points box. Bottom left: displacement field between the superquadric and the data. Bottom right: model after energy minimisation. **Notice that the data are made of 6.000 3D points, whereas the model is defined by 130 3D points. Compression ratio: 46.**

Reconstruction algorithm

FFD definition: application from $\mathbb{R}^3$ to $\mathbb{R}^3$, defined by the tensor product of 3 Bernstein polynomials

$$M = \sum_{i,j,k=0}^{l,m,n} C_l^i C_m^j C_n^k (1-s)^{l-i} s^i (1-t)^{m-j} t^j (1-u)^{n-k} u^k P_{ijk}$$

$$\underline{M = B \cdot P}$$

FFD reconstruction:

$$\min_{\delta P} \| B(P + \delta P) - (X + \delta X) \|^2$$

Quantitative parameters

- **volume evolution** $- \gg$ ejection fraction
- decompostion of the **parametric points trajectories** into cylindrical coordinates (ρ, θ, z):

  $- \gg$ **myocardial thickness**: $\rho' - \rho$

  $- \gg$ **torsion component**: $\theta' - \theta$