Eric BARDINET

Nationality: French
Date of birth: June 6, 1966.
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Current position

- **Visiting scientist** at the *Max Planck Institute of Cognitive Neuroscience*, Leipzig.

Thesis

- **1995** PhD thesis: constrained deformable models - applications to cardiac imagery. **Supervisor**: Laurent D. Cohen (CNRS). Defended on December 19, 1995 at Université Paris IX-Dauphine. **Jury**: Jean-Michel MOREL, *Isabelle MAGNIN, Mike BRADY (reviewers)*, Nicholas AYACHE, Laurent COHEN, Jean-Marie ROCCHISANI. **Mention**: *très honorable avec félicitations du jury.*

University studies and diplomas

- **1992** Master of Applied Mathematics (*D.E.A.*), with Image Processing option, at Université Paris IX-Dauphine (Ceremade U.R.A. CNRS 749).
- **1991** Degree in Applied Mathematics (*Maitrise de Mathématiques Appliquées*) at Université Paris VI-Pierre et Marie Curie.

Professionnal experience

- **1992 - 1995** Applied Mathematics thesis at INRIA - Sophia Antipolis (*Institut National de Recherche en Informatique et Automatique*) in the Epidaure group (director: Nicholas Ayache). University: Paris IX-Dauphine, Dept. of Applied Mathematics (Ceremade).
- **1992** 6-month of full training (D.E.A. research project) at INRIA - Rocquencourt in the Epidaure group. Subject: "Surface reconstruction constrained by active contours".

Relevant scientific techniques and skills acquired

- **Computer Vision**: segmentation, surface reconstruction, 3D object representation, non-rigid motion analysis, tracking, data compression.
- **Deformable Models**: active contours, active surfaces, 3D parametric models, deformable templates, superquadrics, volumetric splines, modal analysis, wavelets.
- **Medical Image Understanding**: understanding of cardiac images, representation and tracking of cardiac left ventricle, quantitative analysis of cardiac motion, parametric representation of brain structures, inter-patient variability of brain structures.
- **Applied Mathematics**: variational problems, partial differential equations, spline functions, numerical analysis.
- **Programming Languages**: C, C++, Fortran, Pascal, Vista, OSF/Motif.
- **Systems and Workstations**: Sun OS, DEC ULTRIX, DEC OSF, SPARC Stations, ALPHA DEC Stations.
- **Software**: AVS, Vista, Maple, Netscape, X Window Managers.

Languages

- French: native language.
- English: bilingual.
- Spanish: fluent.
- German: fluent.

Publications

- **Journals:**

  1. *A parametric deformable model to fit unstructured 3D data*, accepted for publication in **Computer Vision and Image Understanding** (with L.D. Cohen and N. Ayache).
  2. *Tracking and motion analysis of the left ventricle with deformable superquadrics*, accepted for publication in **Medical Image Analysis** (with L.D. Cohen and N. Ayache).
  3. *Suivi de données médicales 3D avec un modèle paramétrique déformable*, accepted for publication in **Technique et Science Informatique**, special issue **Reconnaissance et localisation d'objets par vision artificielle** (with L.D. Cohen and N. Ayache).
  4. *Surface reconstruction constrained by active contours*, submitted to **International Journal of Computer Vision** (with L.D. Cohen).

- **International conferences with review:**

  1. *Tracking medical 3D data with a parametric deformable model.* **European Conference on Computer Vision, Cambridge, England, April 1996**. (with L.D. Cohen and N. Ayache).
  2. *Tracking medical 3D data with a parametric deformable model.* **IEEE Computer Vision Symposium, Coral Gables, Florida, November 1995**. (with L.D. Cohen and N. Ayache).
  3. *Superquadrics and free-form deformations : a global model to fit and track 3D medical data.* **1st International Conference on Computer Vision, Virtual Reality and Robotics in Medicine, Nice, April 1995**. (with L.D. Cohen and N. Ayache).
  4. *Fitting 3-D Data Using Superquadrics and Free-Form Deformations.* **IEEE International Conference on Pattern Recognition, Jerusalem, October 1994**. (with L.D. Cohen and N. Ayache).
  5. *Fitting of Iso-Surfaces Using Superquadrics and Free-Form Deformations.* **IEEE Workshop on Biomedical Images Analysis, Seattle, June 1994**. (with L.D. Cohen and N. Ayache).
  6. *Surface Reconstruction Using Active Contour Models.* **SPIE Conference on Geometric Methods in Computer Vision, San Diego, July 1993** . (with L.D. Cohen and N. Ayache).

- **Research reports:**

  1. *Analyzing the deformation of the left ventricle of the heart with a parametric deformable model*, INRIA Research report No. 2797. (with L.D. Cohen and N. Ayache).
  2. *A parametric deformable model to fit unstructured 3D data*, INRIA Research report No. 2617. (with L.D. Cohen and N. Ayache).
  3. *Surface Reconstruction using Active Contour Models*, INRIA Research report No. 1824. (with L.D. Cohen and N. Ayache).

- **Lectures given to French seminars:**

  1. GDR Traitement du Signal et des Images - GT 3 (CNRS) Seminar on dynamic deformable models, Paris, January 1996.
  2. GDR Traitement du Signal et des Images - GT 3 (CNRS) Seminar on volumetric deformations, Paris, November 1994.

Abstracts of most relevant publications

- **Thesis**

  Modelling of a shape is one of the main problems encountered when analyzing images in computer vision. In particular, for the understanding of medical images, it is often necessary to model anatomical structures and also their deformations over time. A priori knowledge of the shape that has to be modelled leads to the use of specific models. For this reason, we have been interested in this thesis in the incorporation of constraints into deformable models.

  Initially, we studied two types of constrained models. Firstly, the explicit modelling of discontinuities in a surface reconstruction problem has led us to define a surface model constrained by an active contour. Secondly, the use of parametric models, which can define only a subset of the shapes obtainable with classical deformable models, has led us to define an original 3D parametric model, combining superquadrics and free form deformations. This model was found to be well suited for the representation of the left ventricle of the heart. We applied this model to the reconstruction and the tracking of the left ventricle in different imaging modalities. The use of a parametric model also permitted us to make a quantitative analysis of the cardiac muscle deformation.

- *A parametric deformable model to fit unstructured 3D data*, to appear in **Computer Vision and Image Understanding**

  Recovery of unstructured 3D data with deformable models has been the subject of many studies over the last ten years. In particular, in medical image understanding, deformable models are useful to get a precise representation of anatomical structures.

  However, general deformable models involve large linear systems to solve when dealing with high resolution 3D images. The advantage of parametric deformable models like superquadrics is their small number of parameters to describe a shape combined with a better robustness in the presence of noise or sparse data. Also, at the expense of a reasonable number of additional parameters, free form deformations provide a much closer fit and a volumetric deformation field.

  This article introduces such a model to fit unstructured 3D points with a parametric deformable surface based on a superquadric fit followed by a free form deformation to describe the cardiac left ventricle. We present the mathematical and algorithmic details of the method, as well as three experimental studies in a various number of 3D medical images.

- *Tracking and motion analysis of the left ventricle with deformable superquadrics*, to appear in **Medical Image Analysis**

  We present a new approach to analyse the deformation of the left ventricle of the heart, based on a parametric model that gives a compact representation of a set of points in a 3D image.

  We present a strategy to tracking surfaces in a sequence of 3D cardiac images. Following tracking, we then infer quantitative parameters which characterise left ventricle motion: volume of myocardium, ejection fraction, amplitude and twist component of cardiac motion and evolution over time of myocardium wall thickness. We explain the computation of these parameters using our model. Experimental results are shown in time sequences of two kinds of medical images, Nuclear Medicine and X-Ray Computed Tomography (CT).

  In brief, we both propose a robust surface estimation in 3D time-series which provides a compression of surface data, and extraction of key diagnosis parameters.