APPROXIMATION METHODS AND CALCULUS OF VARIATIONS IN DEFFORMABLE MODELS APPLIED IN IMAGE PROCESSING AND COMPUTER ASSISTED MEDICINE - RESEARCH LABORATORY

Contact details

Name	**Approximation methods and Calculus of Variations in Deformable Models applied in Image Processing and Computer Assisted Medicine – Research Laboratory**
Acronym	**IPPRRC**
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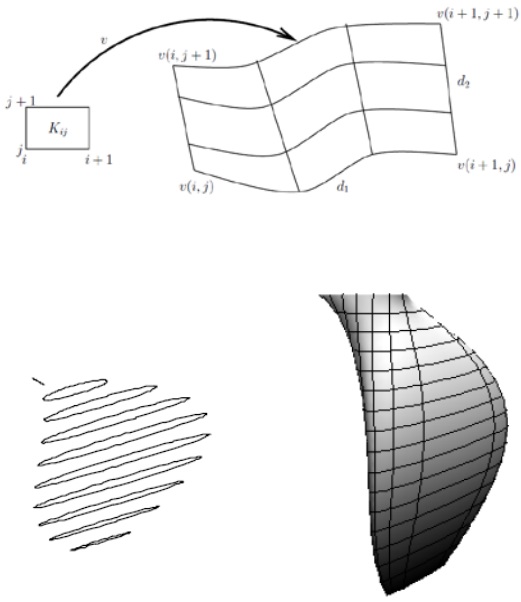

Areas of expertise

LC MoDef research laboratory is devoted to the development of the mathematical basis of the theory of deformable models and to the applications of this theory in image processing and medical imaging, involving the following areas of expertise:
- Differential Equations
- Calculus of Variations
- Geometry
- Numerical Analysis
- Probabilities
- Modelling & Simulation
- Medical Imaging (Ultrasonography, CT, MRI)

Team

Prof. Dr. Math. Alexandru I. Mitrea; Prof. Dr. Math. Dumitru Mircea Ivan; Assoc. Prof. Dr. Math. Daniela Inoan; Assoc. Prof. Dr. Math. Radu Peter, Senior Lect. Dr. Mircia Gurzau

Representative projects

MoDef, "Modelling using advanced methods and techniques based on the theory of deformable surfaces with applications in computer assisted surgery and other modelling procedures of anatomic structures", PN II 11018-Partenership, http://dicomge.utcluj.ro/modef (2007-2010)
Advanced Methods and Algorithms of Mathematics related to the Theory of Deformable Models, with applications in image processing and medicine, Grant CNCSIS 1255, 2006-2008

Significant results

The most representative publications of the past 5 years:

1. A.I. Mitrea, S. Nedevschi, D.M. Ivan, D. Mitrea, O.M.Gurzau, P. Mitrea, D. Inoan, N. Lungu, D. Cimpean, "3D Deformable Models. Applications", *UT Press*, 2010, 101pp
2. A. I. Mitrea, O. M. Gurzau and P. Mitrea, "On the Stability and Convergence Rate of Some Discretized Schemes for Parametric Deformable Models Used in Medical Image Analysis", *IFMBE Proceedings*, 2011, vol. 36, part 3, pp. 212-219

3. A. I. Mitrea, R. Badea, D. Mitrea , S.Nedevschi, P. Mitrea, D. M. Ivan, O. M.Gurzau, “Iterative methods for obtaining energy-minimizing parametric snakes, with application to medical imaging”*, Computational and Mathematical Methods in Medicine*, vol. 2012 (2012), Article ID 918510, pp. 48-59
4. A.I. Mitrea, P. Mitrea, O.M. Gurzau, “Finite Difference Based Methods for Obtaining Energy Minimizing Snakes used in Medical Diagnosis, Monitoring and Surgery”*, Proceedings of 2012 IEEE International Conference AQTR*, pp.491-496
5. P. Mitrea, O.M. Gurzau, A.I. Mitrea, “On the approximation error of some numerical methods for obtaining the optimal deformable model”*,* in *International Series of Numerical. Math., Birkhauser-Verlag -Basel Publ. (Springer)*, vol. 161, 2012, pp. 103-115
6. A.I. Mitrea*,* A. Prodan, P. Mitrea, O.M.Gurzau, F. Gavrilas, V. Oprea, R. Cimpean, M. Mesaros*,* “Computer Assisted Prosthetic Surgery, based on Deformable Surfaces and Statistical Modeling”, *Proceedings of 2010 IEEE International Conference AQTR*, Vol.2, pp.271-278
7. A.I. Mitrea, D.M. Ivan, D. Mitrea, D. Inoan, P. Mitrea, “Deformable Variational Models used in Medical Imaging”, *IFMBE Proc*., vol. 26, 2009, pp.273-278
8. A.I. Mitrea, S. Nedevschi, D.M. Ivan, D. Mitrea, O.M. Gurzau, N. Lungu, D. Cimpean, “2D Deformable Models. Applications”, *UT Press*, 2009, 106pp
9. A.I. Mitrea, “On the unbounded divergence in the best approximation on equidistant nodes”, in *Appl. Math. Lett., v*ol. 26, 2013, pp. 61-64
10. A.I. Mitrea, D. Mitrea, “Two sided estimates for projection operators with applications to deformable models”, in *Math.Ineq. Appl.*, Volume 12, no. 4, 2009, pp. 845-853

Significant solutions:
Considering until now parametric (variational) deformable models, we developed an iterative method based on finite difference schemes in order to solve numerically the ELP equation of Calculus of Variations, which provides the energy minimizing snake; we derived estimates concerning the approximation error related to the corresponding ELP algorithm and we established conditions for its convergence and stability; as future targets, we intend to consider probabilistic models which offer an alternative approach by using the Bayes technique, as well as geometric deformable models which provide an efficient alternative to address some limitation of parametric deformable models.

Products and technologies:
1. Mathematical study concerning the deformable model theory: energy functional, evolution equation, discretization methods
2. Stochastic Modelling and Simulation Platform/Implemented in Java/
3. 3D Deformable Surfaces Modelling Software Environment

The offer addressed to the economic environment

Research & development	Generating performing mathematical algorithms in order to obtain the minimizing-energy curves and surfaces. Finding approximation error, convergence rate and giving consistency and stability conditions concerning these algorithms **.**
Consulting	Consulting in finding suitable algorithms to obtain minimizing-energy curves and surfaces, which assist activities in medicine, industrial environments, modern traffic infrastructure, physics
Training	**Deformable models theory:** reveal of the interdisciplinary value of the domain**,** connections with practical problems of medicine, image processing, and physics**;** knowledge confluence from functional analysis, approximation theory, differential equations, differential geometry, calculus of variations, numerical analysis, linear algebra, and probability theory**.** **Model-based approach:** integrating computer-assisted medical image analysis, their applications at this level including image segmentation, shape representation and motion tracking.