

APPROXIMATION METHODS AND CALCULUS OF VARIATIONS IN DEFORMABLE 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	<p>The diagram illustrates the concept of deformable models. The top part shows a 2D grid with nodes labeled $v(i, j)$, $v(i, j+1)$, $v(i+1, j)$, and $v(i+1, j+1)$. A small square element K_{ij} is shown with its nodes i, $i+1$, j, and $j+1$. An arrow labeled v indicates a deformation from the flat grid to a curved surface. The bottom part shows a 3D perspective of a curved surface with a grid, and a scribbled-out area representing an image.</p>
Acronym	IPPRC	
Logo	<p>The logo for LC MoDef features the text "LC MoDef" next to a 3D visualization of a grid on a curved surface.</p>	
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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. Mircea 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-Partnership, <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. Mitrea, Alexandru I., On the dense unbounded divergence of interpolatory product integration on Jacobi nodes CALCOLO Volume: 55 Issue: 1 Article Number: UNSP 10 Published: MAR 2018
2. Peter, Ioan Radu, A Bound of the Finslerian Ricci Scalar MEDITERRANEAN JOURNAL OF MATHEMATICS Volume: 15 Issue: 3 Article Number: 143 Published: JUN 2018
3. Inoan, Daniela Ioana; Kolumban, Jzsef, Existence Theorems for Inequality Systems BULLETIN OF THE IRANIAN MATHEMATICAL SOCIETY Volume: 44 Issue: 5 Pages: 1329-1336 Published: OCT 2018
4. Inoan, D.; Kolumban, J., Existence theorems via duality for equilibrium problems with trifunctions OPTIMIZATION Volume: 67 Issue: 5 Pages: 537-547 Published: 2018
5. Inoan, D.; Kolumban, J., On Quasi-Equilibrium Problems with Trifunctions MINIMAX THEORY AND ITS

APPLICATIONS Volume: 3 Issue: 1 Pages: 161-172 Published: 2018

6. Inoan, Daniela, Variational relations problems via fixed points of contraction mappings JOURNAL OF FIXED POINT THEORY AND APPLICATIONS Volume: 19 Issue: 2 Pages: 1571-1580 Published: JUN 2017
7. Anastasiei, Mihai; Kozma, Laszlo; Peter, Ioan Radu, Some applications of index form in Finsler geometry PUBLICATIONES MATHEMATICAE-DEBRECEN Volume: 90 Issue: 3-4 Pages: 455-469 Published: 2017
8. Mitrea, Alexandru I., On the dense divergence of the product quadrature formulas of interpolatory type JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS Volume: 433 Issue: 2 Pages: 1409-1414 Published: JAN 15 2016
9. I. R. Peter and C. Pinte, "Necessary Conditions for Finite Critical Sets. Maps with Infinite Critical Sets", *Topological Methods in Nonlinear Analysis*, vol. 47, pp. 739-749, Jun 2016.
10. D. Marian, I. R. Peter, and C. Pinte, "Operations with monotone operators and the monotonicity of the resulting operators," *Monatshfte Fur Mathematik*, vol. 181, pp. 143-168, Sep 2016.
11. A.I Mitrea, S.Nedeveschi, D. Mitrea, P. Mitrea, R. Badea: "Diseased Tissue Area Detection and Delimitation, by Fusion between Finite Difference Methods and Textural Analysis", *IEEE International Conference on Automation, Quality and Testing, Robotics 2014*, pp.305-310.
12. Ioana Chifor, Alexandru I. Mitrea, Iulia Clara Badea, Radu Chifor, Mindra Eugenia Badea, Paulina Mitrea, Sever Popa, Maria Crisan, Ramona Avram, "Mathematical Methods for Assessing the Prognostic of Fixed Partial Dentures Resulting from Evaluating a Group of Dental Patients in Romania", *Computational and Mathematical Methods in Medicine*, Volume 2014 (2014), Article ID 984901, 11 pages
13. A. I. Mitrea: "On the dense unbounded divergence of the discrete best approximation", *Taiwanese Journal of Mathematics*, vol.18, no.4(2014), 1119-1127, DOI:10.11650/tjm.18.2014.3743

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.