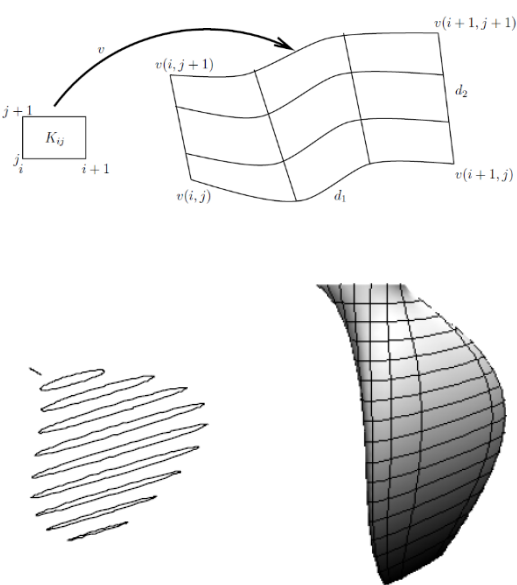# APPROXIMATION METHODS AND CALCULUS OF VARIATIONS IN DEFFORMABLE MODELS APPLIED IN IMAGE PROCESSING AND COMPUTER ASSISTED MEDICINE - RESEARCH LABORATORY

Contact details

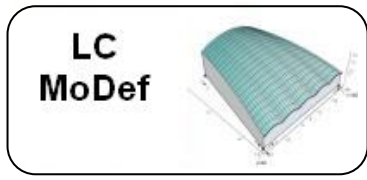|		
Name	**Approximation methods and Calculus of Variations in Deformable Models applied in Image Processing and Computer Assisted Medicine – Research Laboratory**	
Acronym	**LC MoDef**	
Logo		
Site	**http://dicomge.utcluj.ro/modef**	
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Areas of expertise

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)
- Digitization based on mathematical models applied in the medical field

Team

Prof. Dr. Math. Alexandru Mitrea; Prof. Dr. Math. Dumitru Mircea Ivan; Assoc. Prof. Dr. Math. Daniela Inoan   Prof. Dr. Math. Radu Peter; Assoc. Prof. Dr. Math. Daniela Marian;   Lect. Dr. Mircia Gurzau;   Lect. Dr. Delia Kerekes

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. Inoan, D., Marian, D. *Semi-Hyers–Ulam–Rassias Stability for an Integro-Differential equation of order n. Demonstratio Mathematica* (**2023**), *vol.56 (1), pp.2022019,* https://doi.org/10.1515/dema-2022-0198
2. Inoan, D**.**, Marian, D. *Semi-Hyers–Ulam–Rassias Stability of Some Volterra Integro-Differential Equations via Laplace Transform. Axioms* (**2023**), 12, 279. doi.org/10.3390/axioms12030279.
3. Mitrea, A.I. *On the condensation of singularities for some approximation procedures ,* The 17-th International Conference on Applied Mathematics and Computer Science, July 11-14, 2023
4. Ivan, M. Neagos, V. A representation of the interpolation polynomial, Numerical Algorithms 88 (2021), 1215—1231, https://doi.org/10.1007/s11075-021-01072-2}

5. Inoan, D., Marian, D. Semi-Hyers–Ulam–Rassias Stability via Laplace Transform, for an Integro-Differential Equation of the Second Order. Mathematics 2022, 10, 1893. https://doi.org/10.3390/math10111893
6. Inoan, D., Kolumbán, J. Calmness of the Solution Mapping of Navier-Stokes Problems Modeled by Hemivariational Inequalities. Set-Valued Var. Anal 30, 1089–1104 (2022). https://doi.org/10.1007/s11228-022-00636-1
7. Inoan, D. Calmness of the Solution Mapping of Parametric Variational Relation Problems, Filomat, Vol. 35 (2021), No. 10, 3541–3548, https://doi.org/10.2298/FIL2110541I
8. Inoan, D., Marian, D. Semi-Hyers–Ulam–Rassias Stability of a Volterra Integro-Differential Equation of Order I with a Convolution Type Kernel via Laplace Transform, Symmetry, Vol 13, Issue 11, 2181. https://doi.org/10.3390/sym13112181, 2021
9. Aral, A., Inoan, D. and Raşa, I. Approximation properties of Szász–Mirakyan operators preserving exponential functions, Positivity 2019, Volume 23, Issue 1, pp 233–246, doi.org/10.1007/s11117-018-0604-3
10. Mitrea, A. I. Remarks on using some Finite Difference Schemes to provide energy minimizing snakes, The 16-th International Conference on Applied Mathematics and Computer Science, July 3-6, 2019
11. Mitrea, A. 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
12. Peter, I. R. A Bound of the Finslerian Ricci Scalar MEDITERRANEAN JOURNAL OF MATHEMATICS   Volume: 15   Issue: 3   Article Number: 143   Published: JUN 2018
13. Inoan, D., Kolumban, J. Existence Theorems for Inequality Systems BULLETIN OF THE IRANIAN MATHEMATICAL SOCIETY   Volume: 44   Issue: 5   Pages: 1329-1336 Published: OCT 2018
14. Inoan, D., Kolumban, J. Existence theorems via duality for equilibrium problems with trifunctions OPTIMIZATION   Volume: 67   Issue: 5   Pages: 537-547   Published: 2018
15. Inoan, D., Kolumban, J. On Quasi-Equilibrium Problems with Trifunctions MINIMAX THEORY AND ITS APPLICATIONS   Volume: 3   Issue: 1   Pages: 161-172   Published: 2018

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.

Last update on January 2024