Thematic line Inverse Problems in Health Sciences - Lt PICS

Coordinator: Paula Cerejeiras

SHORT DESCRIPTION

The thematic line in Inverse Problems in Health Sciences was create in 2015. The line coordinates the common efforts of researchers on problems related to the field of health sciences.

http://sweet.ua.pt/pceres/LtPICS

AIMS AND GOALS

The thematic line in Inverse Problems in Health Sciences coordinates the common efforts of researchers from different groups problems related to the field of health sciences. Currently, its projects fall broadly into two topics.

Project 1. Diagnostic of Thyroide Cancer

The work is focused on the detection and classification of nodules in medical images by means of monogenic curvelets and their replacement by quasi-monogenic shearlets. Currently, we study the possibility to use scattering theory and deep neural networks for the classification of radiological images.

• Principal researchers: Ana Breda (GAG), Paula Cerejeiras (GACH), Uwe Kähler (GACH), Evgeny Lakshtanov (former OGTC).

• Main results: Preliminary software for nodule detection using monogenic curvelets and the Hough transform.

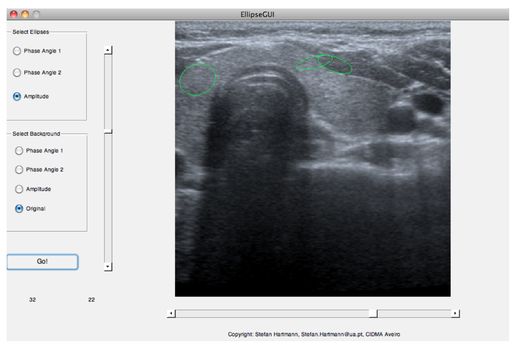

Figure 1: Nodule detection.

• Collaborations: MAMEBIA - Mathematical Methods in Biological Image Analysis (TU München, Universität Passau, Helmholtz-Zentrum München, Germany); members of *Instituto Português de Oncologia de Coimbra Francisco Gentil EPE*.

Project 2. Modelation of Ophthalmic Surfaces

This project studies the modelation of ophthalmic surfaces by special orthogonal polynomials. Emphasis is given to description of abnormalities of the cornea by fractional Zernike polynomials and special Chebyshev polynomials.

• Principal researchers: Manuela Rodrigues (GAFA), Nelson Vieira (GACH).

• Main results: New models for abnormalities of the cornea based on fractional Zernike, Bessel and Chebyshev type functions.

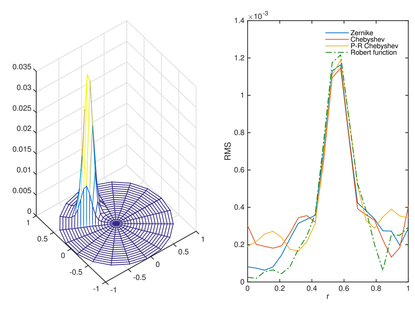

Figure 2: Model of abnormality of the cornea.

• Collaborations: J.N. Murta and A. Rosa - members of *Centro Hospitalar e Universitário de Coimbra*.

DISSEMINATION AND FURTHER COLLABORATION

• In parallel to Research Seminars, the line hosts a Working Seminar where current topics and methodologies are presented and discussed.

• Additionally to seminar and conference talks, members presented their work at invitation-only conferences such as MOIMA - Schloss Herrenhausen 2016.

• Members published their results in mathematical journals, such as SIAM J. Math. Anal., Trans./Proc. AMS, Math. Methods Appl. Sci., J. Complexity, to name a few.

• Close collaboration with MAMEBIA (Mathematical Methods in Biological Image Analysis (TU München, Universität Passau, Helmholtz-Zentrum München, Germany)): Common supervision of PhD students, projects, long term visits, publications, etc.

Figure 3: Meeting with the *Inverse Problems Group* at the University of Helsinki.

• The group has close collaborations with many well-known researchers in either the field itself or in closely related fields, among them N. Ford (Chester), R. Novikov (École Polytechnique), M. Ruzhansky (Imperial College/Ghent University), S. Siltanen (Helsinki), G. Teschke (Zuse Institute, Neubrandenburg), and J. Wirth (Stuttgart).

• The line contributes to the scientific training of under-graduates / researchers through regular supervisions of research grants at bachelor / master / post-doc - level [e.g. André Martins, now a graduate student at UC Santa Barbara, US)].

RESEARCH TOPICS

(a non-exhaustive list)

• Study of monogenic curvelets and quasi-monogenic shearlets in the context of hypercomplex analysis;
• Estimation of curvature in images;
• Study of special functions and their applications to modelation of ophthalmic surfaces;
• Inverse scattering theory;
• Convolutional neural networks with sparsity constrains and deep learning;

† This poster was supported through CIDMA and the Portuguese Foundation for Science and Technology (FCT-Fundação para a Ciência e a Tecnologia), within project UID/MAT/04106/2019.