

Associate Professor in Computer Science at University of Toulouse
Research activities in IRIT UMR CNRS 5505 Laboratory, Toulouse, France

Adrian BASARAB

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Research Topics: Signal and image processing for computational biomedical imaging

- Medical imaging
- Ultrasound imaging
- Computational imaging
- Inverse problems
- Applications of machine learning in medical imaging
- Multidimensional signal processing
- Image formation and reconstruction
- Tissue motion estimation and image registration

Short Bio

Adrian Basarab received the M.S. and PhD degrees in signal and image processing from the National Institute for Applied Sciences of Lyon, France, in 2005 and 2008. Since 2009 (respectively 2016) he is assistant (respectively associate) professor at the **University Paul Sabatier Toulouse 3** and a member of IRIT laboratory (UMR CNRS 5505).

His research interests include medical imaging and more particularly inverse problems (deconvolution, super-resolution, compressive sampling, beamforming, image registration and fusion) applied to ultrasound image formation, ultrasound elastography, cardiac ultrasound, quantitative acoustic microscopy, computed tomography and magnetic resonance imaging.

Adrian Basarab has been elevated to the grade of **IEEE Senior Member** in 2019. He is currently **associate editor for Digital Signal Processing** (Elsevier) and was a member of the French National Council of Universities Section 61 - Computer sciences, Automatic Control and Signal Processing from 2010 to 2015. In 2017, he was **guest editor** (with Y. Eldar - Technion and H. Liebgott - University of Lyon) for the **IEEE TUFFC special issue** on "Sparsity driven methods in medical ultrasound". In 2020, he will give an **invited talk at IEEE Ultrasonics Symposium**, on inverse problems in computational ultrasound imaging.

Since 2018, Adrian Basarab is the **head of Computational Imaging and Vision research group** of IRIT laboratory. Since 2019, he is **member of the EURASIP Technical Area Committee Biomedical Image & Signal Analytics**. Since 2020, he is **member of the IEEE Ultrasonics Symposium TPC**.

Positions

2016 *Associate professor*, University of Toulouse, France
2009 *Assistant Professor*, University of Toulouse, France
2008 *Postdoctoral position*, Catholic University of Leuven, Belgium
2008 *Assistant Professor*, University of Lyon, France

Qualifications

2016 *Habilitation to conduct researches*, A few inverse problems in ultrasound imaging, University of Toulouse
2008 *PhD Thesis*, Motion estimation in ultrasound imaging, INSA-Lyon
2005 *Post-graduate degree* in computer science and signal and image processing, INSA-Lyon

Honors

2020 Elected member of the IEEE Ultrasonics Symposium TPC
2019 IEEE Senior Member
2019 Member of the EURASIP Technical Area Committee Biomedical Image & Signal Analytics
2016 Among the winners (joint work with T. Szasz) of "Plane wave imaging challenge in ultrasound imaging", IEEE Ultrasonics Symposium, Tours, 2016
2016 Paul Calas award (joint work with J. Michetti), French Society of Endodontics, 2016

- 2016** Best PhD thesis in biomedical imaging, research section, awarded by EMBS IEEE France Section, Z. Chen, compressed deconvolution in ultrasound imaging, 2016
- 2015** Best student paper finalist (joint work with Z. Chen and D. Kouamé), IEEE Ultrasonics Symposium, Taiwan, 2015

Scientific and administrative responsibility

- Since 2019 Member of the EURASIP Technical Area Committee Biomedical Image & Signal Analytics
- Since 2017 Head of the Computational Imaging and Vision research group of IRIT laboratory
- Since 2017 Member of the French committee awarding the best PhD thesis in signal and image processing
- 2016-2018 Co-head of the Computer Science in Health Activities team of IRIT laboratory
- Since 2015 Associate Editor for Digital Signal Processing journal
- 2012-2015 Member of the French National Council of Universities (signal and image processing division) of the French Minister of Higher Education and Research

Editorial experience

- Guest editor (with Y. Eldar - Technion and H. Liebgott - University of Lyon) for IEEE TUFFC special issue on "Sparsity driven methods in medical ultrasound", 2017
- Associate Editor of Digital Signal Processing (Elsevier)

Invited talks at international conferences

- 2020** *IEEE Ultrasonics Symposium, Las Vegas, USA*, Inverse problems in computational ultrasound imaging and related applications: from model-based to machine learning approaches
- 2019** *Symposium on Image, Signal Processing and Artificial Vision, Bucaramanga, Colombia*, Sparse Representations and Dictionary Learning: From Image Fusion to Motion Estimation
- 2019** *IEEE International Conferences on Advances in Biomedical Engineering, Tripoli, Lebanon*, Computational medical imaging: from model-based approaches to machine learning

Publications

- 44 journal publications with peer review
- 5 book chapters
- More than 100 communications at international conferences
- 1 French patent

Complete List of Published Work:

<https://www.irit.fr/~Adrian.Basarab/publicationsBibBase.html#>

Google scholar profile:

<https://scholar.google.fr/citations?hl=fr&user=I2CCHb0AAAAJ>

Organized events

- 2019** Co-organizer of IEEE CAMSAP 2019 special session on "Computational biomedical imaging"
- 2017** Co-organizer of IEEE ICASSP 2017 special session on "Inverse Problems in Ultrasound Imaging: Recent Advances and Opportunities"
- 2016** Co-organizer of EUSIPCO 2016 special session on "Recent advances in medical image restoration"
- 2015** Co-organizer of EUSIPCO 2015 special session on "Recent advances in biomedical signal and image processing"
- 2014** Co-organizer and chair of CFA 2014 special session on "Compressed acquisition in acoustics"
- 2013** Co-organizer and chair of IEEE ISBI 2013 special session on "Sparse Representations and Compressed Sensing in Medical Ultrasound Imaging"
- 2013** Member of the local committee of CIMI workshop "Optimization and Statistics in Image Processing", 24 - 28 June 2013, Toulouse.

Co-supervisor of junior researchers

- 8 **ongoing** PhD thesis, including 7 thesis in medical imaging
- 8 PhD thesis in signal and image processing **defended** (2013-2019)
- 25 Post-graduate students (image and signal processing)

Funding

PI

2020-2021	Cancéropôle Grand Sud-Ouest (13k€) - augmented reality for breast cancer surgery
2020	Toulouse Tech Transfer (15k€) - augmented reality for breast cancer surgery
2020-2022	1 Ecos Nord Colombia project (30k€) - medical and hyperspectral computational imaging
2019-2020	1 project funded by French government space agency (CNES) (50k€) - modeling and inverse problems for point spread function estimation
2018-2020	1 Stic AmSud grant with PUCP (Lima) and UIS (Bucaramanga) (20k€) - inverse problems in ultrasound imaging
2016-2017	1 national grant (30k€) - cardiac motion estimation in echocardiography
2011-2018	6 local grants (70k€), founded by the University of Toulouse

Partner

2018-2022	French national funding (257 kEuros), PI: H. Wendt, University of Toulouse - tissue characterization in ultrasound imaging using multifractals
2017-2018	1 industrial grant from Airbus (150k€)
2011-2014	1 national grant (205k€), PI: H. Liebgott, University of Lyon - transverse oscillations in ultrasound imaging
2011-2014	1 regional grant (110k€), PI: D. Kouamé, University of Toulouse - inverse problems in ultrasound imaging

Referee

Referee for IEEE Trans. on Ultrasonics, Ferroelectrics and Frequency Control, Ultrasound in Medicine and Biology, Ultrasonics, IEEE Trans. on Image Processing, IEEE Journal of Selected Topics in Signal Processing, IEEE Trans. on Biomedical Imaging, IEEE Trans. on Medical Imaging.

Teaching activities

In charge (with David Vanderhaeghe) of MSc Computer graphics and Image Analysis, University Paul Sabatier, Toulouse.

Medical Imaging (Graduate): ultrasound, MRI, tomographic reconstruction

Image Processing (Graduate): computational imaging, image restoration, image reconstruction

Signal Processing (Graduate): sampling, digital filtering, stochastic signal processing, beamforming

Contribution to Science

- 1. Quantum mechanics-inspired signal and image processing algorithms.**
 - a. S. Dutta, A. Basarab, B. Georgeot, D Kouamé, Quantum mechanics-based signal and image representation: application to denoising, IEEE Open Journal of Signal Processing, 2021.
- 2. Image fusion methods for magnetic resonance (MR) and ultrasound (US) images, aiming at combining the advantages of each modality, i.e., good contrast and signal to noise ratio for the MR image and good spatial resolution for the US image, with application to endometriosis detection.**
 - a. O. El Mansouri, F. Vidal, **A. Basarab**, P. Payoux, D. Kouamé, Jean-Yves Tournet, Fusion of Magnetic Resonance and Ultrasound Images for Endometriosis Detection, IEEE Transactions on Image Processing, Vol. 29 N. 1, p. 5324–5335, 2020.
- 3. Artifact quantification in lung ultrasound imaging.**
 - a. O. Karakus, N. Anantrasirichai, A. Aguersif, S. Silva, **A. Basarab**, A. Achim, Detection of Line Artefacts in Lung Ultrasound Images of COVID-19 Patients via Non-Convex Regularization, IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, Special Issue on Ultrasound in COVID-19 and Lung Diagnostics, Vol. 67 N. 11, p. 2218–2229, 2020.
- 4. The limited bandwidth of ultrasound transducers and the physical phenomena related to ultrasound wave propagation through human tissues affect the quality of ultrasound images in terms of spatial resolution and contrast. Under the first order Born approximation and the assumption of weak scattering classically assumed for soft tissues, these degradations can be expressed a linear image formation model relating the tissue reflectivity function to the RF acquired data. Recently, our group proposed several**

methods to invert this model and to successfully **recover high quality images better reflecting the tissues** than native ultrasound images.

- a. D. Pham, A. Basarab, I. Zemmoura, J.-P. Remenieras, D. Kouamé, Joint Blind Deconvolution and Robust Principal Component Analysis for Blood Flow Estimation in Medical Ultrasound Imaging, IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, 2020.
 - b. M. Hourani, **A. Basarab**, D. Kouamé, J.-Y. Tournet, Ultrasound Image Deconvolution Using Fundamental and Harmonic Images, IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, 2020.
 - c. M. I. Florea, **A. Basarab**, D. Kouamé, S. A. Vorobyov, "An axially-variant kernel imaging model applied to ultrasound image reconstruction", IEEE Signal Processing Letters, IEEE, Vol. 25 N. 7, p. 961-965, 2018.
 - d. N. Zhao, **A. Basarab**, D. Kouamé, J.-Y. Tournet, "Joint Segmentation and Deconvolution of Ultrasound Images Using a Hierarchical Bayesian Model based on Generalized Gaussian Priors", IEEE Transactions on Image Processing, Vol. 25, no. 8, p. 3736-3750, 2016.
 - e. N. Zhao, Q. Wei, **A. Basarab**, N. Dobigeon, D. Kouamé, J.-Y. Tournet, "Fast Single Image Super-resolution using a New Analytical Solution for 12-12Problems", IEEE Transactions on Image Processing, Vol. 25 N. 8, p. 3683-3697, 2016.
5. Recent developments in ultrasound technologies have led to novel acquisition modes such as ultrafast or 3D imaging. While the first, based on plane wave emissions, suffers from lower image quality than standard imaging using focused beams, the second leads to huge amounts of data to be collected and processed. In 2010, our group was among the first to use **compressed sensing** as an alternative to existing technologies to decrease the data volume in ultrasound imaging. These pioneer studies have been pursued by several research groups, imposing the concept of sparsity in ultrasound imaging as an important alternative to the well established Gaussian signal processing.
- a. J. Kim, J. Mamou, D. Kouamé, A. Achim, **A. Basarab**, Autoregressive model-based reconstruction of quantitative acoustic maps from RF signals sampled at innovation rate, IEEE Transactions on Computational Imaging, 2020.
 - b. N. Zhao, D. O'Connor, **A. Basarab**, D. Ruan, K. Sheng, Motion Compensated Dynamic MRI Reconstruction with Local Affine Optical Flow Estimation, IEEE Transactions on Biomedical Engineering, Vol. 66 N. 11, p. 3050-3059, 2019.
 - c. J. Kim, J. Mamou, P. Hill, N. Canagarajah, D. Kouamé, **A. Basarab**, A. Achim, "Approximate Message Passing Reconstruction of Quantitative Acoustic Microscopy Images", IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, Vol. 65 N. 3, p. 327-338, 2018.
 - d. Z. Chen, **A. Basarab**, D. Kouamé, "Reconstruction of Enhanced Ultrasound Images From Compressed Measurements Using Simultaneous Direction Method of Multipliers", IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, Vol. 63 N. 10, p. 1525-1534, 2016.
 - e. Z. Chen, **A. Basarab**, D. Kouamé, "Compressive deconvolution in medical ultrasound imaging", IEEE Transactions on Medical Imaging, Vol. 35, no. 3, p. 728-737, 2016.
 - f. A. Achim, **A. Basarab**, G. Tzagkarakis, P. Tsakalides and D. Kouamé, "Reconstruction of ultrasound RF echoes modelled as stable random variables", IEEE Transactions on Computational Imaging, Vol. 1, no. 2, p. 86-95, June 2015.
 - g. C. Quinsac, **A. Basarab**, D. Kouamé, "Frequency domain compressive sampling for ultrasound imaging", Advances in Acoustics and Vibration, Special issue on Advances in Acoustic Sensing, Imaging, and Signal Processing, Vol. 12, p. 1-16, 2012.
6. **Ultrasound beamforming** is the art of combining the RF raw signals acquired by multi-element transducers. While delay-ad-sum still remains the most used method due to its real-time capabilities, techniques aiming at improving the quality of beamformed images have received a considerable attention in the literature. During the last three years, I have contributed significantly to this field by introducing a novel beamforming framework in ultrasound imaging, based on solving regularized inverse problems.
- a. T. Szasz, **A. Basarab**, D. Kouamé, "Beamforming through regularized inverse problems in ultrasound medical imaging", IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, Vol. 63 N. 12, p. 2031-2044, 2016.

- b. T. Szasz, **A. Basarab**, D. Kouamé, "Strong reflector-based beamforming in ultrasound medical imaging", *Ultrasonics*, Vol. 66, p. 111-124, 2016.
7. **Tissue motion estimation** has several medical imaging applications, such as cardiac function assessment or elastography. Since my PhD thesis, I have developed several motion estimation methods. For many years, the main originality of the methods proposed by our group was the use of spatial phase images instead of native ultrasound images. More recently, I have contributed in showing the interest of dictionary learning methods in cardiac motion estimation.
- a. N. Ouzir, **A. Basarab**, O. Lairez, J.-Y. Tournier, "Robust Optical Flow Estimation in Cardiac Ultrasound images Using a Sparse Representation", *IEEE Transactions on Medical Imaging*, Vol. 38 N. 3, p. 741-752, 2018.
 - b. N. Ouzir, **A. Basarab**, H. Liebgott, B. Harbaoui, J.-Y. Tournier, "Motion Estimation in Echocardiography Using Sparse Representation and Dictionary Learning", *IEEE Transactions on Image Processing*, Vol. 27 N. 1, p. 64-77, 2018.
 - c. L. Wang, **A. Basarab**, P. Girard, P. Croisille, P. Clarysse, P. Delachartre, "Analytic signal phase-based myocardial motion estimation in tagged MRI sequences by a bilinear model and motion compensation", *Medical Image Analysis*, Vol. 24 N. 1, p. 149-162, 2015.
 - d. M. Alessandrini, **A. Basarab**, L. Boussel, X. Guo, A. Serusclat, D. Friboulet, D. Kouamé, O. Bernard, H. Liebgott, "A New Technique for the Estimation of Cardiac Motion in Echocardiography Based on Transverse Oscillations: a preliminary evaluation in silico and a feasibility demonstration in vivo", *IEEE Transactions on Medical Imaging*, Vol. 33 N. 5, p. 1148-1162, 2014.
 - e. M. Alessandrini, **A. Basarab**, H. Liebgott, O. Bernard, "Myocardial Motion Estimation from Medical Images Using the Monogenic Signal", *IEEE Transactions on Image Processing*, Vol. 22 N. 3, p. 1084-1095, 2013.
8. **Super-resolution** in 3D dental computed tomography using deep learning and 3D image segmentation for endodontology.
- a. J. Hatvani, **A. Basarab**, J.-Y. Tournier, M. Gyongy, D. Kouamé, "A Tensor Factorization Method for 3D Super-Resolution with Application to Dental CT", *IEEE Transactions on Medical Imaging*, 2019.
 - b. J. Hatvani, A. Horvath, J. Michetti, **A. Basarab**, D. Kouamé, M. Gyöngy, "Deep Learning-Based Super-Resolution Applied to Dental Computed Tomography", *IEEE Transactions on Radiation and Plasma Medical Sciences*, 2018.
 - c. J. Michetti, **A. Basarab**, F. Diemer, D. Kouamé, "Comparison of an adaptive local thresholding method on CBCT and μ CT endodontic images", *Physics in Medicine and Biology*, IOP Science, Bristol - UK, Vol. 63, p. 1-10, 2018.