Pablo Arias

Post-doctoral researcher

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Personal Data

Birth:	March 27th, 1980 in Montevideo, Uruguay
Nationality:	Uruguayan, Spanish

Biosketch

I graduated as a Telecommunications Engineer from the Universidad de la República (UdelaR) in Uruguay in 2006. I did a Masters degree supervised by Gregory Randall (UdelaR) and Guillermo Sapiro (Duke University) in topics of manifold learning. I did my Ph.D. at the University Pompeu Fabra (UPF) in Barcelona, Spain, under the supervision of Vicent Caselles on the subjects of image inpainting and video editing.

From September 2012 until January 2015 I worked part-time as a researcher in "Fundació Barcelona Media" (now called Eurecat), a private non-profit research center. There I conducted research in video processing for visual effects in movie post-production, within the FP7 European Project SCENE. From April 2015 to May 2016, I continued working with Fundació Barcelona Media, as a consulting researcher.

From October 2013 until September 2014 I worked part-time as a post-doc at UPF, in Vicent Caselles'"Inpainting" ERC project, conducting research in image inpainting and video editing.

Since January 2015 until April 2020 I worked as a post-doc researcher at Centre Borelli (ex CMLA), at ENS Paris-Saclay (ex ENS Cachan), in Jean-Michel Morel's group, where I am conducting research in image and video restoration. Currently I work as a researcher for the Centre Borelli.

I participated and coordinated several research projects in collaboration with industrial partners. I co-supervised one Ph.D. thesis and I am co-supervising another three at the moment.

I have been involved in teaching in mathematics and signal processing courses since 2001.

Professional Experience

- Since May 2021: post-doctoral researcher at Centre Boreli, ENS Paris-Saclay.
- May 2020 – May 2021: contracted researcher (*chercheur sous contrat*) at Centre Boreli, ENS Paris-Saclay.
- January 2015 – April 2020: post-doctoral researcher at CMLA (now Centre Borelli), ENS Paris-Saclay.
- April 2015 – May 2016: consulting researcher at Fundació Barcelona Media.

- September 2012 – January 2015: part-time senior researcher at Fundació Barcelona Media.
- October 2013 – September 2014: part-time post-doc at University Pompeu Fabra.
- September 2011 – August 2014: Part-time lecturer at the Dept. of Information and Communication Technologies (DTIC), University Pompeu Fabra.
- August 2004 – December 2006: Teaching assistant at the Institute of Electrical Engineering, Universidad de la República, Uruguay.
- September 2001 – December 2004: Teaching assistant at the Institute of Mathematics and Statistics "Prof. Rafael Laguardia", Universidad de la República, Uruguay.

Academic Background

Ph.D. in Information and Communication Technologies. University Pompeu Fabra (Spain). September 2008 until October 2013. Ph.D. thesis title: *"Variational methods for exemplar-based image inpainting and gradient-domain video editing"*. Supervised by Vicent Caselles. Examining board: Simon Masnou (chair), Patric Pérez, Eulalia Nualart.

M.S. in Information, Communication and Audiovisual Media Technologies (TICMA). University Pompeu Fabra (Spain). September 2007 to September 2008. Master thesis: *"Iterative non-local methods for image inpainting"*. Supervised by Vicent Caselles.

M.S. in Electrical Engineering. Universidad de la República (Uruguay). February 2006 to March 2009. Title of master thesis: *"Constrained Pre-Image for Kernel PCA"*. Supervised by Gregory Randall and Guillermo Sapiro.

B.S. in Electrical Engineering. Universidad de la República (Uruguay), Facultad de Ingeniería. Finished December 2006. Final project: *"Segmentation with shape priors applied in meat quality assessment system"* (only in spanish). With A. Pini, G. Sanguinetti, P. Sprechmann. Advisors P. Cancela, A. Fernández, Á. Gómez, G. Randall.

Research Internships

- February 2006 to August 2006 and from January 2007 to August 2007 : visiting graduate student at the University of Minnesota in the group of Guillermo Sapiro. The research focused on kernel methods for manifold learning.

Public Research Projects and Collaborations with the Industry

- Since January 2022: coordinator of a research collaboration between Centre Borelli (ENS Paris-Saclay) and LERITY. The aim of the project is the development of an efficient video processing pipeline including denoising, deblurring and super-resolution.
- Since January 2022: coordinator of a research collaboration between Centre Borelli (ENS Paris-Saclay) and THALES. The aim of the project is the development of an efficient video denoising methods for infrared camerasa.

- From September 2020 until December 2021: principal investigator of a research collaboration between Centre Borelli (ENS Paris-Saclay) and Huawei Technologies. The aim of the project is the development of an efficient video denoising method to be implemented on mobile phones.
- From August 2018 until November 2019: coordinator of a research collaboration between CMLA (ENS Cachan) and the company MBDA. The aim of the project was the development of efficient infrared video processing pipeline.
- From February 2017 until Februery 2018: coordinator of a research collaboration bettween CMLA (ENS Cachan) and the company L'Heritier-Alcen. The aim of the project was the development of efficient video denoising methods for night vision cameras.
- From January 2015 until December 2017: as a post-doctoral researcher at CMLA - ENS Cachan, I worked in video denoising in the context of the project "Plein-Phare", financed by the french bussiness cluster "CAP Digital - Paris Region".
- From April 2015 until May 2016: consulting researcher at Fundació Barcelona Media, supervising work in the H2020 European project "Autopost" developing natural video matting methods for post-production tools.
- September 2014 to January 2015: part-time researcher at Fundació Barcelona Media, working in the H2020 European project "3FLEX" developing depth-based post-production tools.
- September 2012 to September 2014: part-time researcher at Fundació Barcelona Media, working in the FP7 European project "SCENE" on video matting and real-time ToF depth super-resolution using a high resolution RGB image.
- October 2013 to September 2014: part-time post-doc at UPF, working in Vicent Caselles' "Inpainting" ERC Project on image inpainting and video editing.
- August 2004 to December 2005: Developer and research assistant in the project "VAP" (Video Analysis Platform) in UdelaR, Uruguay. The aim of the object was to develop a framework video processing focusing on the extraction of MPEG-7 descriptors from a video sequence.

Supervised theses

- From September 2020: co-supervisor of the PhD Thesis of Adrien Courtois (co-advising 60-40 with Jean-Michel Morel). The thesis is on non-locality in neural networks: understand the different mechanisms allowing long range connections in existing architectures and propose ways to evaluate their effectiveness.
- From September 2020: co-supervisor of the PhD Thesis of Ngoc Long Nguyen (co-advising 60-40 with Gabriele Facciolo). The thesis is on developping self-supervised training strategies for super-resolution of bursts of satellite images.
- From September 2019: co-supervisor of the PhD Thesis of Valery Dewil (co-advising 50-50 with Gabriele Facciolo). The thesis is on self-supervised and on-line learning strategies for model-blind video restoration tasks.

- From September 2016 until June 2020: co-supervisor of the PhD Thesis of Thibaud Ehret (co-advising 40-40-20 with Jean-Michel Morel and Gabriele Facciolo). The thesis covers several aspects of image and video denoising. It starts with a study of differen elements pach-based methods (such as a the patch model, and the patch search). It then follows with data-driven approaches, introducing the self-supervised on-line learning strategies for model blind video denoising and joint denoising and demosaicking tasks (that is: when even the noise distribution is unknown). Finally, it focuses on anomaly and forgery detection by applying some of the same ideas and tools used for patch-based denoising. The outcomes of the thesis were published in 5 journal publications and 7 conferences papers.

Publications in journals

1. Thibaud Ehret and **Pablo Arias**. *Implementation of VBM3D and some variants.* Image Processing On Line 11, 2021.
2. Axel Davy, Thibaud Ehret, Jean-Michel Morel, **Pablo Arias**, Gabriele Facciolo *Video Denoising by Combining Patch Search and CNNs.* Journal of Mathematical Imaging and Vision, 63:7388, 2021.
3. **Pablo Arias** and Jean-Michel Morel. Video denoising via Empirical Bayesian Estimation of Space-Time Patches. Journal of Mathematical Imaging and Vision, 60(1):70-93, 2017.
4. Thomas Hach, **Pablo Arias**, Carles Bosch, Javier Montesa and Pablo Gascó, *Seamless 3D Interaction of Virtual and Real Objects in Professional Virtual Studios,* in SMPTE Motion Imaging Journal, 126(1), pp. 43-56, Jan.-Feb. 2017.
5. Vadim Fedorov, Gabriele Facciolo and **Pablo Arias**. *Variational framework for non-local inpainting.* Image Processing On Line 5:362-386, 2015.
6. Vadim Fedorov, **Pablo Arias**, Rida Sadek, Gabriele Facciolo, Coloma Ballester. *Linear multiscale analysis of similarities between images on Riemannian manifolds: Practical formula and affine covariant metrics.* SIAM Journal on Imaging Sciences 8(3):2021-2069, 2015.
7. Rida Sadek, Gabriele Facciolo, **Pablo Arias** and Vicent Caselles. *A Variational Model for Gradient-Based Video Editing.* International Journal of Computer Vision, 103(1):127-162, 2012.
8. **Pablo Arias**, Vicent Caselles, Gabriele Facciolo, Vanel Lazcano and Rida Sadek (authors in alphabetical order). *Nonlocal variational models for inpainting and interpolation.* Mathematical Models & Methods in Applied Sciences, 22, 2012.
9. **Pablo Arias**, Vicent Caselles and Gabriele Facciolo (authors in alphabetical order). *Analysis of a Variational Framework for Exemplar-Based Image Inpainting.* Multiscale Modeling & Simulation, 10(2), 2012.
10. **Pablo Arias**, Gabriele Facciolo, Vicent Caselles and Guillermo Sapiro. *A Variational Framework for Exemplar-Based Image Inpainting.* International Journal of Computer Vision, 93(3):319-347, 2011.
11. **Pablo Arias**, Alejandro Pini, Pablo Sprechmann, Gonzalo Sanguinetti, Pablo Cancela, Alicia Fernández, Álvaro Gómez and Gregory Randall. *Ultrasound Image Segmentation with Shape Priors: Application to Automatic Cattle Rib-Eye Area Estimation.* IEEE Transactions on Image Processing, 16(6):1637-1645, 2007.

Publications in conferences

1. Ngoc Long Nguyen, Jérémy Anger, Axel Davy, **Pablo Arias**, Gabriele Facciolo, *Self-supervised multi-image super-resolution for push-frame satellite images.* Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW). Earth Vision Workshop, 2021.

2. Ngoc Long Nguyen, Jérémy Anger, Axel Davy, **Pablo Arias**, Gabriele Facciolo, *Proba-V-ref: Repurposing the Proba-V challenge for reference-aware super resolution.* 2021 IEEE International Geoscience and Remote Sensing Symposium (IGARSS).

3. Valery Dewil, Jeremy Anger, Axel Davy, Thibaud Ehret, Gabriele Facciolo, **Pablo Arias**. *Self-Supervised Training for Blind Multi-Frame Video Denoising.* Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV), 2021, pp. 2724-2734.

4. Charles Hessel, Rafael Grompone von Gioi, Jean-Michel Morel, Gabriele Facciolo, **Pablo Arias** and Carlo de Franchis. *Relative Radiometric Normalization Using Several Automatically Chosen Reference Images for Multi-Sensor, Multi-Temporal Series.* ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences. (The Annals act as the proceedings of the 2020 edition of the XXIVth ISPRS Congress).

5. Axel Davy, Thibaud Ehret, Jean-Michel Morel, **Pablo Arias**, and Gabriele Facciolo. *A Non-Local CNN for Video Denoising* IEEE Int. Conf. on Image Processing (ICIP), 2019.

6. Thibaud Ehret, Axel Davy, **Pablo Arias** and Gabriele Facciolo. *Joint demosaicing and denoising by overfitting of bursts of raw images.* Intl. Conf. on Computer Vision (ICCV). Seoul, 2019.

7. **Pablo Arias** and Jean-Michel Morel. *Kalman filtering of patches for frame recursive video denoising.* IEEE Conf. on Compuper Vision and Pattern Recogition Workshops (CVPRW). NTIRE: New Trends on Image Restoration and Enhancement Workshop. Long Beach, 2019.

8. Thibaud Ehret, Axel Davy, Jean-Michel Morel, Gabriele Facciolo and **Pablo Arias**. *Model-blind Video Denoising Via Frame-to-frame Training.* IEEE Conf. on Computer Vision and Pattern Recognition (CVPR 2019). Long Beach, 2019.

9. Thibaud Ehret, **Pablo Arias** and Jean-Michel Morel. *NL-Kalman: A recursive video denoising algorithm.* IEEE Int. Conf. on Image Processing (ICIP 2018). Athens, 2018.

10. **Pablo Arias**, Gabriele Facciolo and Jean-Michel Morel. *A comparison of Patch-Based Models in Video Denoising.* IEEE 13th Image, Video and Multidimensional Signal Processing Workshop (IVMSP 2018). Aristi, 2018.

11. Thibaud Ehret and **Pablo Arias**. *On the convergence of PatchMatch.* IEEE Conf. on Computer Vision and Pattern Recognition (CVPR 2018). Salt Lake City, 2018.

12. **Pablo Arias** and Mila Nikolova. *Below the surface of the Non-Local Bayesian Image Denoising method.* 6th Int. Conf. on Scale Space and Variational Methods (SSVM 2017). Kolding, 2017

13. Thibaud Ehret, **Pablo Arias** and Jean-Michel Morel. *Global patch search boost video denoising.* Proc. of the 12th Int. Joint Conf. on Computer Vision Imaging and Computer Grahpics Theory and Applications (VISIGRAPP 2016), Volume 4: VISAPP. Porto, 2016.

14. Pablo Zinemanas, **Pablo Arias**, Gloria Haro and Emilia Gómez. *Visual music transcription of clarinet video recordings trained with audio- based labelled data.* Int. Conf. on Computer Vision Workshop on Computer Vision for Audio-Visual Media (CVAVM). Venice, 2017.

15. Vadim Fedorov, **Pablo Arias**, Gabriele Facciolo and Coloma Ballester. *Exemplar-based image inpainting using an affine invariant similarity measure.* VISIGRAPP 2016 (Revised Selected Papers).

16. Vadim Fedorov, **Pablo Arias**, Gabriele Facciolo and Coloma Ballester. *Affine invariant self-similarity for exemplar-based inpainting.* Proceedings of the 11th Int. Joint Conf. on Computer Vision Imaging and Computer Grahpics Theory and Applications (VISIGRAPP), Volume 3: VISAPP. Rome, 2016.

17. **Pablo Arias** and Jean-Michel Morel. *Towards a Bayesian video denoising method.* Int. Conf. on Advanced Concepts for Intelligent Vision Systems (ACIVS). Catania, 2015.

18. Vanel Lazcano, **Pablo Arias**, Gabriele Facciolo and Vicent Caselles. *A gradient-based neighborhood filter for disparity interpolation.* IEEE Int. Conf. on Image Processing (ICIP). Miami, 2012.

19. Gabriele Facciolo, **Pablo Arias**, Vicent Caselles and Guillermo Sapiro. *Exemplar-based interpolation of sparsely sampled images.* 7th Int. Conf. on Energy Minimization Methods in Computer Vision and Pattern Recognition (EMMCVPR). Bonn, 2009

20. **Pablo Arias**, Vicent Caselles and Guillermo Sapiro. *A variational framework for non-local image inpainting.* 7th Int. Conf. on Energy Minimization Methods in Computer Vision and Pattern Recognition (EMMCVPR). Bonn, 2009

21. **Pablo Arias**, Gregory Randall and Guillermo Sapiro. *Connecting the Out-of-Sample and the Pre-Image Problems in Kernel Methods.* Proceedings of IEEE Conf. on Computer Vision and Pattern Recognition. Minneapolis, 2007.

22. Pablo Flores, Federico Lecumberry, **Pablo Arias** and Álvaro Pardo. *Video Analysis Platform.* XII Congreso Argentino de Ciencias de la Comunicación, Octubre de 2006.

Invited Talks And Conferences Without Proceedings

1. Pablo Arias. *Video denoising: from Bayesian modelling of patches to CNNs.* "HUAWEI Future ISP technologies workshop". Sophia-Antipolis, 19 September 2019.

2. Pablo Arias. *Video denoising via Bayesian modelling of patches.* "Statistical modeling for shapes and imaging" workshop at the Henrie Poincaré Institute (IHP), 14 March 2019.

3. Thibaud Ehret, Pablo Arias, Jean-Michel Morel and Gwendoline Blanchet. *Débruitage externe en imagerie spatiale.* XXVIème Colloque GRETSI. Juan-Les-Pins, 5-8 Septembre 2017.

4. Thibaud Ehret, Pablo Arias and Jean-Michel Morel. *A pipeline for fast video denoising.* 16èmes journées francophones des jeunes chercheurs en vision par ordinateur (ORASIS 2017). Colleville-sur-mer, 15th of June, 2017.

5. *Gradient-domain video editing* (oral presentation given in behalf of Rida Sadek). SIAM Conf. on Imaging Science. Hong-Kong, 12th of May, 2014.

6. *Variational models for exemplar-based image inpainting* (oral presentation). SIAM Conf. on Imaging Science. Hong-Kong, 12th of May, 2014.

7. *Variational models for exemplar-based image inpainting* (oral presentation). Journées Bordelaises d'Analyse Mathématique des Images, Université Bourdeaux. 6th of April, 2014.

8. *Variational models for image inpainting and video editing* (oral presentation). XXIII Congreso de Ecuaciones Diferencianes y Aplicaciones (XXIII Spanish Congress of Differential Equations and their Applications). Castellón de la Plana, Spain. 12th of September, 2013.

9. *A variational framework for exemplar-based image inpainting* (oral presentation). XXII Congreso de Ecuaciones Diferencianes y Aplicaciones (XXII Spanish Congress of Differential Equations and their Applications). Palma de Mallorca, Spain. 9th of September, 2011.

10. *A variational framework for exemplar-based image inpainting* (oral presentation). Segundas Jornadas de Análisis Matemático en Alicante (Second Workshop of Mathematical Analisys in Alicante). Universidad de Alicante, Alicante, Spain. 18th of May, 2011.

11. *A variational framework for exemplar-based image inpainting* (oral presentation). Trends in mathematical imaging and surface processing. Mathematisches Forschungsinstitut Oberwolfach. Oberwolfach, Germany. 30th of January until the 5th of February, 2011.

12. *Video Analysis Platform* (poster presentation). With Á. Pardo and F. Lecumberry. IMA (Institute for Mathematics and its Applications, University of Minnesota) workshop "The Mathematics and Art of Film Editing and Restoration". Minneapolis, 2006.

13. *Segmentation of ultrasound images with shape priors. Application to automatic cattle rib-eye area estimation* (poster presentation). With A. Pini, P. Sprechmann, G. Sanguinetti, P. Cancela, A. Fernandez, Á. Gómez and G. Randall. IMA workshop "Shape Spaces". Minneapolis, 2006.

14. *Algorithms for computing the mean shape of a cattle muscle* (poster presentation). With G. Sanguinetti and P. Sprechmann. "Representation of Reality by Brains and Machines. Crossed views from Neurosciences and Computer Vision". Montevideo, Uruguay. November 2004.

Patents

1. Juan Francisco Garamendi, **Pablo Arias** and Rida Sadek. *Computer-implemented method and system for processing video with temporal consistency.* European Patent Application No. EP3249609A1 (2016).

2. Carlo De Franchis, Guillaume Lostis, Hefdhi Abdennadher, **Pablo Arias**, Thomas Madaule, Axel Davy, Sylvain Calisti, Jean-Michel Morel. *Method and system for remotely measuring the volume of liquid stored in external floating roof tanks.* US Patent Application No. 20180336693 (2018).

Teaching Experience

- Supervision of five MVA M2 masters (Zhe Zheng and Arnaud Barral in 2021, Valery Dewil in 2019, Louis Vincent in 2019, Thibaud Ehret in 2015).

- Supervision of two L3 projects at ENS Paris-Saclay.

- October 2021: lecturer in the "Master in Computer Vision" of Universitat Pompeu Fabra in the course "Optimization and Inference for Computer Vision". Teaching theory sessions.
- Since September 2018: lecturer in the Master MVA of ENS Paris-Saclay, in the course "Image denoising: the human-machine competition". Teaching theory and practical sessions.
- From September 2011 until August 2014: Part-time lecturer at the Dept. of Information and Communication Technologies (DTIC), University Pompeu Fabra, teaching theory, practical sessions and laboratory sessions in courses of linear algebra and advanced optimization.
- August 2004 - December 2006: Teaching assistant at the Instituto de Ingeniería Eléctrica (Institute of Electrical Engineering), Universidad de la República, Uruguay, teaching in several signal processing and telecommunications courses. Tasks carried out in these courses: classroom and laboratory assistant, design of laboratory practices, exam exercises, etc. the following courses "Digital Filter Design", "Communication Systems" and "Statistical Treatment of Signals". Tasks carried out in these courses: classroom and laboratory assistant, design of laboratory practices, exam exercises, etc.
- September 2001 - December 2004: Teaching assistant at the Instituto de Matemática y Estadística "Prof. Rafael Laguardia" (Institute of Mathematics and Statistics "Prof. Rafael Laguardia"), Universidad de la República, Uruguay, teaching in courses of Linear Algebra, Calculus, Differential Equations and Numerical Methods. Tasks carried out in these courses: classroom and laboratory assistant, design of laboratory practices, exam exercises, etc.

Other academic activities

- PhD thesis defense of Matías Tassano: jury member. October 16, 2019.
- PhD thesis of Nelson Monzón: reviewer. July 7, 2019.
- Editor of *Image Processing On Line* since 2015.
- Reviewer for the following journals:
  - IEEE Transactions on Pattern Analysis and Machine Intelligence
  - IEEE Transactions on Image Processing
  - IEEE Transactions on Circuit and Systems for Video Technology
  - IEEE Signal Processing Letters
  - SIAM Journal on Imaging Sciences
  - International Journal of Computer Vision
  - Journal of Mathematical Imaging and Vision
  - Journal of Visual Communication and Image Representation
  - EURASIP Journal on Image and Video Processing
  - Computer Vision and Image Understanding
  - Image Processing On Line
- *Best reviewer award* for the *Fifth International Conference on Scale Space and Variational Methods in Computer Vision* (SSVM), 2015.