

# R. J. Cintra

Department of Technology  
Federal University of Pernambuco  
CAA, Caruaru, PE, Brazil

## Academic Web Presence

	Homepage		Google Scholar Profile
	Articles on arXiv		dblp bibliography
	IEEE author profile		ResearcherID: D-1288-2011
	orcid: 0000-0002-4579-6757		Lattes ID: 7413544381333504
	zbMATH Profile		Scopus Identifier: 55930266600

## Main Position

- (Full) Professor of Engineering  
Electrical Engineering; Industrial Engineering; Probability & Statistics  
Federal University of Pernambuco (UFPE), Brazil.
- Director of the Industrial Signal Processing Laboratory  
Department of Technology, UFPE

## Areas of Expertise

Approximate methods, Approximate estimation, Algorithms, Signals & Systems, Probabilistic reasoning & modelling, Numerical computation, Image Processing, Video Processing, Low-complexity algorithms, Wavelets, Data analysis, Statistical signal processing.

## Education

2009 PDF in Electrical Engineering, Department of Electrical and Computer Engineering, University of Calgary, AB, Canada.

Research topic: Arithmetic Transforms; Algebraic Integer Encoding  
Supervisor: Dr. V. S. Dimitrov (University of Calgary)

2005 D.Sc. in Electrical Engineering, Federal University of Pernambuco, Recife, Brazil.

Significant part of doctorate at the University of Calgary, AB, Canada.

Thesis: Spectrum Approximation and Wavelet Design with  
Applications in Electrogastrography

Advisors: Dr. H. M. de Oliveira (UFPE)  
Dr. M. P. Mintchev (University of Calgary)

2001 M.Sc. in Electrical Engineering, Federal University of Pernambuco, Recife, Brazil.

Thesis: Fast Hartley Transform: New Factorizations and an  
Arithmetic Algorithm

Advisor: Dr. H. M. de Oliveira (UFPE)

1999 B.Sc. in Electrical Engineering, Federal University of Pernambuco, Recife, Brazil.

1994 Technician Diploma in Electronics, Federal Technical School of Pernambuco, Recife, Brazil.

## Academic Experience

- 2021-present Full professor, Federal University of Pernambuco, Brazil. In 2021–2023 at the Department of Statistics, Recife; and since 2023 at the Department of Technology (Industrial Engineering), Caruaru, Brazil.
- 2023-present Graduate faculty member, Graduate program in Industrial Engineering, Federal University of Pernambuco, Caruaru, Brazil.
- 2012-present Graduate faculty member, Graduate program in Electrical Engineering, Federal University of Pernambuco, Recife, Brazil.
- 2010-present Research Chair in Signal Processing, Brazilian National Council for Scientific and Technological Development (CNPq).
- 2005-present Graduate faculty member, Graduate program in Statistics, Federal University of Pernambuco, Recife, Brazil.
- 2019-2022 Courtesy Postdoctoral Associate, Department of Electrical and Computer Engineering, College of Engineering and Computing, Florida International University, Miami, FL.
- 2015-2021 Adjunct professor, Department of Electrical and Computer Engineering, University of Calgary, Calgary, Alberta.
- 2005-2021 Associate professor, Federal University of Pernambuco, Recife, Brazil.  
Tenured in 2008.
- 2017-2019 Visiting professor, Department of Electrical and Computer Engineering, University of Calgary, Calgary, Alberta.
- 2015-2015 Visiting researcher, Research Institute of Computer Science and Random Systems (IRISA), French Institute for Research in Computer Science and Automation (INRIA), Rennes, France.
- 2014-2015 Visiting researcher, *Institut National des Sciences Appliquées*, Lyon, France.
- 2014-2020 Graduate faculty member, Graduate program in Intellectual Property & Innovation, Federal University of Pernambuco, Recife, Brazil.
- 2011-2014 *Ad Hoc* Graduate Faculty member, Department of Electrical and Computer Engineering, University of Akron, OH, USA.
- 2008-2009 DFAIT Postdoctoral Fellow, Visiting scholar, Department of Electrical and Computer Engineering, University of Calgary, AB, Canada.
- 2004-2005 Assistant professor, Department of Industrial Engineering, DeVry University, Brazil.  
Instructor of undergraduate course on Operations Research (Stochastic and Deterministic Methods) and Numerical Analysis.
- 2003-2004 CNPq Doctoral Fellow, Research associate, Department of Electrical and Computer Engineering, University of Calgary, AB, Canada.  
Performed experimental and theoretical studies on gastric modeling and detection of gastric electrical uncoupling in animals.
- 2002-2003 Assistant professor, Department of Electrical Engineering, Polytechnic School of Pernambuco, Recife, Brazil.  
Instructor of undergraduate course on Instrumentation, Assembly language, and Control Systems.

## Editorial Board Experience

2016-present Associate Editor, Journal of Communication and Information Systems, Brazilian Telecommunications Society (SBrT) and the IEEE Communications Society (ComSoc).

2018-2024 Subject Editor, IET Electronics Letters, UK.

2017-2021 Associate Editor, IET Circuits, Devices & Systems, UK.

2013-2019 Associate Editor, IEEE Geoscience and Remote Sensing Letters, IEEE.

2015-2018 Associate Editor, Circuits, Systems, and Signal Processing, Springer.

## Peer Reviewing Experience (Selected)

1. Canadian Journal of Electrical and Computer Engineering
2. Elsevier Computational Statistics and Data Analysis
3. Elsevier Digital Signal Processing
4. Elsevier Journal of Computational and Applied Mathematics
5. Elsevier Journal of Visual Communication and Image Representation
6. Elsevier Knowledge-Based Systems
7. Elsevier Linear Algebra and Its Applications
8. Elsevier Signal Processing
9. EURASIP
10. IEEE Access
11. IEEE Signal Processing Letters
12. IEEE Transactions on Signal Processing (1053-587X)
13. IEEE Sensors Journal
14. IEEE Transactions on Circuits and Systems for Video Technology
15. IEEE Transactions on Circuits and Systems, II, Express Briefs
16. IEEE Transactions on Geoscience and Remote Sensing
17. IEEE Geoscience and Remote Sensing Letters (Print)
18. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing
19. IET Circuits, Devices, and Systems
20. IET Electronics Letters
21. IET Journal
22. Springer Circuits, Systems & Signal Processing
23. Springer Journal of Applied Mathematics and Computing (JAMC)
24. Springer Multidimensional Systems and Signal Processing
25. Springer Sensing and Imaging
26. Discussiones Mathematicae - General Algebra and Applications
27. Journal of Applied Statistics
28. Journal of Electronic Imaging (Print)
29. Journal of Electronic Imaging (Print)
30. Journal of Communication and Information Systems (JCIS)
31. Revista da Sociedade Brasileira de Telecomunicações (0102-986X)
32. Wireless Communications And Mobile Computing
33. TEMA. Tendências em Matemática Aplicada e Computacional
34. Several IEEE-sponsored International Conferences.

## **Industry Experience**

2005-2006 Telecommunications engineer, Operations and Maintenance Division, Hydroelectric Company of São Francisco, Brazil.

In charge of WAN synchronization and optimization of atomic clock site location.

2001-2001 Electrical engineer, Control engineering division, Petrobras, Rio de Janeiro, Brazil.

1997-1998 Electronics technician, Hydroelectric Company of São Francisco, Recife, Brazil.

Duties included software development, elaboration of testing procedures, and writing of technical reports.

1996-1997 Research assistant, Pattern Recognition Laboratory, Department of Electronics and Systems, Federal University of Pernambuco.

Performed computational studies on mathematical morphology and pattern detection.

1995-1996 Electronics technician, Division of Telecommunication and Maintenance, Superintendence for the Development of the North-east of Brazil, Recife, Brazil.

Main activities included computer and network maintenance and user support.

## **University Service Experience**

2016-2021 Vice-dean of Exact and Natural Sciences, Federal University of Pernambuco, Recife, Brazil.

2013-2014 Vice-head, Graduate program in Statistics, Federal University of Pernambuco, Recife, Brazil.

2016-present Intellectual Property Adjunct, Federal University of Pernambuco, Recife, Brazil.

2012-2016 Intellectual Property Coordinator, Federal University of Pernambuco, Recife, Brazil.

2010-2011 Vice-head of the Department of Statistics, Federal University of Pernambuco, Recife, Brazil.

## **Professional & Scientific Societies**

1. Institute of Electrical and Electronics Engineers, IEEE (Senior member since Sep. 2010).
2. Society for Industrial and Applied Mathematics, SIAM (Regular member, since 2000).
3. *Associação Brasileira de Estatística* (Brazilian Statistical Association), ABE (Life member, since 2024).
4. American Mathematical Society, AMS (Former Regular member from 2001 to 2016).

## Awards and Recognition

- 2025 Listed among the 2% most influential researchers across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.8]
- 2024 Listed among the 2% most influential researchers across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.7]
- 2023 Listed among the 2% most influential researchers across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.6], [doi:10.17632/btchxktzyw.5]
- 2022 Listed among the 2% most influential researchers across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.4]
- 2021 Listed among the 2% most influential researchers across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.3]
- 2021 Best doctorate thesis (advisor), Brazilian Society for Applied and Computational Mathematics.
- 2020 Listed among the 2% most influential researchers across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.2]
- 2018 Best Paper Award - MERCon 2018, Track of Image, Vision, and Signal Processing, IEEE.
- 2016 Undergraduate Teaching Excellence Award, Department of Statistics, Federal University of Pernambuco.
- 2015-2019 Published work “Low-Power VLSI Architectures for DCTDWT: Precision vs Approximation for HD Video, Biomedical, and Smart Antenna Applications” ranked as top-accessed paper in IEEE Circuits and Systems Magazine during 41 months.
- 2013-2015 Published work “Improved 8-point Approximate DCT for Image and Video Compression Requiring Only 14 Additions” ranked as top-accessed paper in IEEE Transactions on Circuits and Systems I: Regular Papers during 11 months.
- 2013 First place poster at 2013 Ohio Celebration of Women in Computing, graduate category, Association for Computing Machinery.
- 2012 Best undergraduate paper (advisor) at *XXX Simpósio Brasileiro de Telecomunicações (SBrT'12)*, Brazilian Telecommunications Society.
- 2012 Best doctorate thesis (advisor), Brazilian Society for Applied and Computational Mathematics.
- 2012 Best undergraduate paper (advisor) at CNPq/UFPE, Undergraduate Congress for Scientific Initiation.
- 2010-present Research fellow, National Council of Technological and Scientific Development, Brazilian Government.
- 2008-2009 Post-doctoral Research Fellow, Department of Foreign Affairs and International Trade, Government of Canada.
- 2003-2004 Pre-doctoral Research Fellow for Studies Abroad, Brazilian Ministry of Science and Technology.
- 2001-2003 Recipient graduate scholarship for Doctoral Program, Brazilian Ministry of Education.
- 1999-2001 Recipient of graduate scholarship for Master’s Program, Brazilian Ministry of Education.
- 1998 Recipient of graduate scholarship for Master’s Program, Brazilian Ministry of Science and Technology.
- 1996-1997 Recipient of undergraduate scholarship for Digital Image Processing and Mathematical Morphology studies, Brazilian Ministry of Science and Technology.

## Scientometric Indices of Research Productivity

- Listed among the 2% most influential researchers of 2025 across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.8]
- Listed among the 2% most influential researchers of 2024 across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.7]
- Listed among the 2% most influential researchers of 2023 across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.6]
- Listed among the 2% most influential researchers of 2022 across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.4], [doi:10.17632/btchxktzyw.5]
- Listed among the 2% most influential researchers of 2021 across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.3]
- Listed among the 2% most influential researchers of 2020 across all fields of knowledge as shown in [doi:10.17632/btchxktzyw.2]

2025-11 Citations: 3622 (Google), 1910 (Web of Science)

2025-11 h-index: 32 (Google), 23 (Web of Science)

2025-11 i10-index: 86 (Google)

## Publications & Talks

### Journal articles

- [1] A. Madanayake, U. Kumarasiri, S. Sivasankar, K. Lawrance, B. Gayanath, H. Silva, S. Mandal, and R. J. Cintra. Real-time 5.7–5.8 GHz 32-beam approximate discrete Fourier transform spectrum sensor for RF perception on Xilinx Sx475T. *IEEE Transactions on Circuits and Systems I: Regular Papers*, 72(8):3777–3790, August 2025.
- [2] S. Sivasankar, U. Kumarasiri, K. Lawrance, K. Karunanayake, P. Sen, R. J. Cintra, and A. Madanayake. Joint communication and sensing at D-band SDR and at 5.8 GHz via multi-beam arrays. *IEEE Transactions on Microwave Theory and Techniques*, 73(6):3236–3249, June 2025.
- [3] J. M. Vasconcelos, R. J. Cintra, and A. D. C. Nascimento. New Mellin-based estimation and GoF criteria for the Beta-Weibull model. *Journal of Statistical Theory and Applications*, 24:247–274, February 2025.
- [4] B. Sritharan, C. U. S. Edussooriya, C. Wijenayake, R. J. Cintra, and A. Madanayake. Computationally efficient light field video compression using 5-D approximate DCT. *Journal of Low Power Electronics and Applications*, 15(1):2, January 2025.
- [5] W. A. S. Aleixo and R. J. Cintra. Aproximações de baixa complexidade baseadas na distância euclidiana para codificação de imagem. *Proceeding Series of the Brazilian Society of Computational and Applied Mathematics*, 11(1):010053–1–010053–2, January 2025.
- [6] L. M. F. de Oliveira and R. J. Cintra. Uma aproximação escalada para DCT de comprimento 16. *Proceeding Series of the Brazilian Society of Computational and Applied Mathematics*, 11(1):1–2, January 2025.
- [7] R. J. Cintra, P. Martinez, A. Leite, V. A. Coutinho, F. M. Bayer, A. Madanayake, and D. F. G. Coelho. Gaussian kernel approximations require only bit-shifts. *Information*, 15(10):618, October 2024.

- [8] A. P. Radünz, D. F. G. Coelho, F. M. Bayer, R. J. Cintra, and A. Madanayake. Fast data-independent KLT approximations based on integer functions. *Multimedia Tools and Applications*, 83(26):67303–67325, January 2024.
- [9] A. D. C. Nascimento, J. M. Vasconcelos, R. J. Cintra, and A. C. Frery. Regression model for speckled data with extreme variability. *ISPRS Journal of Photogrammetry and Remote Sensing*, 213:1–13, July 2024.
- [10] A. Madanayake, K. Lawrance, B. U. Kumarasiri, S. Sivasankar, T. Gunaratne, C. U. S. Edussooriya, and R. J. Cintra. Design of multichannel spectrum intelligence systems using approximate discrete Fourier transform algorithm for antenna array-based spectrum perception applications. *Algorithms*, 17(8):338, August 2024.
- [11] A. P. Radünz, L. Portella, R. S. Oliveira, F. M. Bayer, and R. J. Cintra. Extensions on low-complexity DCT approximations for larger blocklengths based on minimal angle similarity. *Journal of Signal Processing Systems*, 95(4):495–516, April 2023.
- [12] H. Zhao, A. Madanayake, R. J. Cintra, and S. Mandal. Analog current-mode 8-point approximate-DFT multi-beamformer with 4.7 Gbps channel capacity. *IEEE Access*, 11:53716–53735, May 2023.
- [13] B. G. Palm, F. M. Bayer, and R. J. Cintra. Prediction intervals in the beta autoregressive moving average model. *Communications in Statistics - Simulation and Computation*, 52(8):3635–3656, July 2023.
- [14] A. P. Radünz, T. L. T. da Silveira, F. M. Bayer, and R. J. Cintra. Data-independent low-complexity KLT approximations for image and video coding. *Signal Processing: Image Communication*, 101:116585–1–16, February 2022.
- [15] T. L. T. da Silveira, D. R. Canterle, D. F. G. Coelho, V. A. Couting, F. M. Bayer, and R. J. Cintra. A class of low-complexity DCT-like transforms for image and video coding. *IEEE Transactions on Circuits and Systems for Video Technology*, 32(7):4364–4375, July 2022.
- [16] A. P. Radünz, F. M. Bayer, and R. J. Cintra. Low-complexity rounded KLT approximation for image compression. *Journal of Real-Time Image Processing*, 19(1):173–183, February 2022.
- [17] B. G. Palm, F. M. Bayer, R. Machado, M. I. Pettersson, V. T. Vu, and R. J. Cintra. Robust Rayleigh regression method for SAR image processing in presence of outliers. *IEEE Transactions on Geoscience and Remote Sensing*, 60:1–12, 2022.
- [18] B. G. Palm, F. M. Bayer, and R. J. Cintra. 2-D Rayleigh autoregressive moving average model for SAR image modeling. *Computational Statistics & Data Analysis*, 171:107453–1–16, July 2022.
- [19] L. Portella, D. F. G. Coelho, F. M. Bayer, A. Madanayake, and R. J. Cintra. Radix- $N$  algorithm for computing  $N^{2^n}$ -point DFT approximations. *IEEE Signal Processing Letters*, 29:1838–1842, August 2022.
- [20] B. G. Palm, D. I. Alves, M. I. Pettersson, V. T. Vu, R. Machado, R. J. Cintra, F. M. Bayer, P. Dammert, and H. Hellsten. Wavelength-resolution SAR ground scene prediction based on image stack. *Sensors*, 20(7):2008–1–16, April 2020.
- [21] B. G. Palm, F. M. Bayer, and R. J. Cintra. Signal detection and inference based on the beta binomial autoregressive moving average model. *Digital Signal Processing*, 109:102911–1–102911–12, February 2021.
- [22] V. A. Coutinho, R. J. Cintra, and F. M. Bayer. Low-complexity three-dimensional discrete Hartley transform approximations for medical image compression. *Computers in Biology and Medicine*, 139:105018–1–13, December 2021.

- [23] J. M. Vasconcelos, R. J. Cintra, and A. D. C. Nascimento. Goodness-of-fit measures based on the Mellin transform for beta generalized lifetime data. *Mathematical Methods in the Applied Sciences*, 44(18):14823–14848, September 2021.
- [24] D. F. G. Coelho, R. J. Cintra, A. Madanayake, and S. M. Perera. Low-complexity scaling methods for DCT-II approximations. *IEEE Transactions on Signal Processing*, 69:4557–4566, July 2021.
- [25] A. Madanayake, V. Ariyaratna, S. Madishetty, S. Pulipati, R. J. Cintra, D. Coelho, R. Oliveira, F. M. Bayer, L. Belostotski, S. Mandal, and T. S. Rappaport. Towards a low-SWaP 1024-beam digital array: A 32-beam subsystem at 5.8 GHz. *IEEE Transactions on Antennas and Propagation*, 68(2):900–912, February 2020.
- [26] S. M. Perera, A. Madanayake, and R. J. Cintra. Radix-2 self-recursive sparse factorizations of delay Vandermonde matrices for wideband multi-beam antenna arrays. *IEEE Access*, 8:25498–25508, January 2020.
- [27] R. J. Cintra, T. de Oliveira, and M. P. Mintchev. Leakage prevention and real-time internal detection in pipelines using a built-in wireless information and communication network. *SPE Journal*, 25(05):2496–2507, March 2020.
- [28] J. M. Vasconcelos, R. J. Cintra, A. D. C. Nascimento, and L. C. Rêgo. The compound truncated Poisson Cauchy model: A descriptor for multimodal data. *Journal of Computational and Applied Mathematics*, 378:112887, November 2020.
- [29] V. A. Coutinho, V. Ariyaratna, D. F. G. Coelho, S. Pulipati, R. J. Cintra, A. Madanayake, F. M. Bayer, and V. S. Dimitrov. A low-SWaP 16-beam 2.4 GHz digital phased array receiver using DFT approximation. *IEEE Transactions on Aerospace and Electronic Systems*, 56(5):3645–3654, October 2020.
- [30] S. M. Perera, A. Madanayake, and R. J. Cintra. Efficient and self-recursive delay Vandermonde algorithm for multi-beam antenna arrays. *IEEE Open Journal of Signal Processing*, 1:64–76, 2020.
- [31] A. Madanayake, R. J. Cintra, N. Akram, V. Ariyaratna, S. Mandal, V. A. Coutinho, F. M. Bayer, D. F. G. Coelho, and T. S. Rappaport. Fast radix-32 approximate DFTs for 1024-beam digital RF beamforming. *IEEE Access*, 8:96613–96627, 2020.
- [32] D. R. Canterle, T. L. T. da Silveira, F. M. Bayer, and R. J. Cintra. A multiparametric class of low-complexity transforms for image and video coding. *Signal Processing*, 176:107685, November 2020.
- [33] A. Borges, R. J. Cintra, D. F. G. Coelho, and V. S. Dimitrov. Low-complexity architecture for AR(1) inference. *Electronics Letters*, 56(14):732–734, July 2020.
- [34] B. G. Palm, F. M. Bayer, and R. J. Cintra. Improved point estimation for the Rayleigh regression model. *IEEE Geoscience and Remote Sensing Letters*, 19:1–4, 2020.
- [35] H. M. de Oliveira, V. V. Vermehren, and R. J. Cintra. Multi-dimensional wavelets for scalable image decomposition: Orbital wavelets. *International Journal of Wavelets, Multiresolution and Information Processing*, 18(5):2050038–1–2050038–11, June 2020.
- [36] V. Ariyaratna, D. F. G. Coelho, S. Pulipati, R. J. Cintra, F. M. Bayer, V. S. Dimitrov, and A. Madanayake. Multibeam digital array receiver using a 16-point multiplierless DFT approximation. *IEEE Transactions on Antennas and Propagation*, 67(2):925–933, February 2019.
- [37] F. M. Bayer, A. J. Kozakevicius, and R. J. Cintra. An iterative wavelet threshold for signal denoising. *Signal Processing*, 162:10–20, September 2019.

- [38] G. M. Cordeiro, R. J. Cintra, L. C. Rêgo, and A. D. C. Nascimento. The gamma generalized normal distribution: A descriptor of SAR imagery. *Journal of Computational and Applied Mathematics*, 347:257–272, February 2019.
- [39] A. D. C. Nascimento, A. C. Frery, and R. J. Cintra. Detecting changes in fully polarimetric SAR imagery with statistical information theory. *IEEE Transactions on Geoscience and Remote Sensing*, 57(3):1380–1392, March 2019.
- [40] R. S. Oliveira, R. J. Cintra, F. M. Bayer, T. L. T. da Silveira, A. Madanayake, and A. Leite. Low-complexity 8-point DCT approximation based on angle similarity for image and video coding. *Multidimensional Systems and Signal Processing*, 30(3):1363–1394, July 2019.
- [41] B. G. Palm, F. M. Bayer, R. J. Cintra, M. I. Pettersson, and R. Machado. Rayleigh regression model for ground type detection in SAR imagery. *IEEE Geoscience and Remote Sensing Letters*, 16(10):1660–1664, October 2019.
- [42] V. Ariyaratna, A. Madanayake, X. Tang, D. Coelho, R. J. Cintra, L. Belostotski, S. Mandal, and T. S. Rappaport. Analog approximate FFT 8/16-beam algorithms, architectures and CMOS circuits for 5G beamforming MIMO transceivers. *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, 8(3):466–479, September 2018.
- [43] F. M. Bayer, R. J. Cintra, and F. Cribari-Neto. Beta seasonal autoregressive moving average models. *Journal of Statistical Computation and Simulation*, 88(15):2961–2981, July 2018.
- [44] R. J. Cintra, S. Duffner, C. Garcia, and A. Leite. Low-complexity approximate convolution neural networks. *IEEE Transactions on Neural Networks and Learning Systems*, 29(12):5981–5992, December 2018.
- [45] D. F. G. Coelho, R. J. Cintra, F. M. Bayer, S. Kulasekera, A. Madanayake, P. Martinez, T. L. T. Silveira, R. S. Oliveira, and V. S. Dimitrov. Low-complexity Loeffler DCT approximations for image and video coding. *Journal of Low Power Electronics and Applications*, 8(4):1–26, November 2018.
- [46] D. F. G. Coelho, R. J. Cintra, and V. S. Dimitrov. Efficient computation of the 8-point DCT via summation by parts. *Journal of Signal Processing Systems*, 90(4):505–514, April 2018.
- [47] D. F. G. Coelho, R. J. Cintra, A. C. Frery, and V. S. Dimitrov. Fast matrix inversion and determinant computation for polarimetric synthetic aperture radar. *Computers and Geosciences*, 119:109–114, October 2018.
- [48] D. F. G. Coelho, S. Nimmalapalli, V. S. Dimitrov, A. Madanayake, R. J. Cintra, and A. Tisserand. Computation of 2D  $8 \times 8$  DCT based on the Loeffler factorization using algebraic integer encoding. *IEEE Transactions on Computers*, 67(12):1692–1702, December 2018.
- [49] V. A. Coutinho, R. J. Cintra, F. M. Bayer, P. A. M. Oliveira, R. S. Oliveira, and A. Madanayake. Pruned discrete Tchebichef transform approximation for image compression. *Circuits, Systems, and Signal Processing*, 37(10):4363–4383, October 2018.
- [50] S. M. Perera, V. Ariyaratna, N. Udayanga, A. Madanayake, G. Wu, L. Belostotski, Y. Wang, S. Mandal, R. J. Cintra, and T. S. Rappaport. Wideband  $n$ -beam arrays using low-complexity algorithms and mixed-signal integrated circuits. *IEEE Journal of Selected Topics in Signal Processing*, 12(2):368–382, May 2018.
- [51] C. J. Tablada, T. L. T. da Silveira, R. J. Cintra, and F. M. Bayer. DCT approximations based on Chen’s factorization. *Signal Processing: Image Communication*, 58:14–23, October 2017.
- [52] P. A. M. Oliveira, R. J. Cintra, F. M. Bayer, and A. Madanayake. JPEG quantisation requires bit-shifts only. *Electronics Letters*, 53(9):588–590, April 2017.

- [53] P. A. M. Oliveira, R. J. Cintra, F. M. Bayer, S. Kulasekera, and A. Madanayake. Low-complexity image and video coding based on an approximate discrete Tchebichef transform. *IEEE Transactions on Circuits and Systems for Video Technology*, 27(5):1066–1076, May 2017.
- [54] T. L. T. da Silveira, R. S. Oliveira, F. M. Bayer, R. J. Cintra, and A. Madanayake. Multiplierless 16-point DCT approximation for low-complexity image and video coding. *Signal, Image and Video Processing*, 11(2):227–233, June 2017.
- [55] V. A. Coutinho, R. J. Cintra, and F. M. Bayer. Low-complexity multidimensional DCT approximations for high-order tensor data decorrelation. *IEEE Transactions on Image Processing*, 26(5):2296–2310, May 2017.
- [56] D. F. G. Coelho, R. J. Cintra, N. Rajapaksha, G. J. Mendis, A. Madanayake, and V. S. Dimitrov. DFT computation using Gauss-Eisenstein basis: FFT algorithms and VLSI architectures. *IEEE Transactions on Computers*, 66(8):1442–1448, August 2017.
- [57] R. J. Cintra, F. M. Bayer, A. Madanayake, U. S. Potluri, and A. Edirisuriya. Fast algorithms and architectures for 8-point DST-II/DST-VII approximations. *Journal of Circuits, Systems, and Computers*, 26(3):1750045–1–1750045–11, 2017.
- [58] R. J. Cintra and F. M. Bayer. Comments on ‘Area and power efficient DCT architecture for image compression’ by Dhandapani and Ramachandran. *EURASIP Journal on Advances in Signal Processing*, 2017(50):1–7, July 2017.
- [59] R. J. Cintra, F. M. Bayer, V. A. Coutinho, S. Kulasekera, A. Madanayake, and A. Leite. Energy-efficient 8-point DCT approximations: Theory and hardware architectures. *Circuits, Systems, and Signal Processing*, 35(11):4009–4029, November 2016.
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## ArXiv Pre-prints

- [175] R. J. Cintra. A note on the conversion of nonnegative integers to the canonical signed-digit representation. *arXiv*, January 2025.
- [176] D. F. G. Coelho and R. J. Cintra. Discrete Fourier transform approximations based on the Cooley-Tukey radix-2 algorithm. *arXiv*, 2024.
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- [179] H. M. de Oliveira, R. G. F. Távora, R. J. Cintra, and R. M. Campello de Souza. Fast finite field Hartley transforms based on Hadamard decomposition. *arXiv*, 2015.

## Chapters

- [180] D. F. G. Coelho, V. A. Coutinho, T. L. T. Silveira, R. J. Cintra, F. M. Bayer, A. Madanayake, and V. Dimitrov. *VLSI Architectures for Future Video Coding*, chapter Discrete Transform Approximations for Video Coding, pages 257–297. Institution of Engineering and Technology, August 2019.
- [181] R. J. Cintra, F. M. Bayer, Y. Pauchard, and A. Madanayake. *Signal Processing and Machine Learning for Biomedical Big Data*, chapter Low-Complexity DCT Approximations for Biomedical Signal Processing in Big Data, pages 151–176. CRC Press, Boca Ratón, 1 edition, July 2018.
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## Report

- [184] A. Madanayake, V. Ariyaratana, N. Akram, R. J. Cintra, and D. Coelho. Multi-beam radio frequency (RF) aperture arrays using multiplierless approximate fast Fourier transform (FFT). Final report, Air Force Research Laboratory, DARPA/MTO, August 2017.

## Pending Patents

Upon request.

## Thesis

- [185] R. J. Cintra. *Aproximação Espectral e Construção de Wavelets com Aplicações em Eletrogastrografia [Spectral Approximations and Wavelet Design with Applications in Electrogastrography]*. PhD thesis, Escola de Engenharia, Centro de Tecnologia e Geociências, Universidade Federal de Pernambuco, Recife, PE, February 2005. Advisors: Dr. H. M. Oliveira (UFPE) and Dr. M. P. Mintchev (University of Calgary).

- [186] R. J. Cintra. Transformada rápida de Hartley: Novas fatorações e um algoritmo aritmético [Fast Hartley transform: New factorizations and an arithmetic algorithm]. Master's thesis, Escola de Engenharia, Centro de Tecnologia e Geociências, Universidade Federal de Pernambuco, Recife, PE, July 2001. Advisor: Dr H M de Oliveira.

## Talks

- 2017 Argumentation Ethics and Intelligent Machines, Graduate course in Electrical Engineering, Federal University of Pernambuco, Recife, Brazil.
- 2015 Approximate Methods for Transform Coding, Équipe Cairn, INRIA, Rennes, France.
- 2013c DCT Approximations for Image Compression, Alagoas Workshop for Smart Buildings Applications, Maceió, Brazil.
- 2013b Ethics, Morals, and Economic Consequences, Guest lecturer, Epistemology course, Graduate course in Surgery, Federal University of Pernambuco, Recife, Brazil.
- 2013a Technological Singularity Ahead, Guest lecturer, Epistemology course, Graduate course in Surgery, Federal University of Pernambuco, Recife, Brazil.
- 2010d Number-theoretic and Approximation Methods in Signal Processing, Department of Electrical and Computer Engineering, University of Akron, OH, USA.
- 2010c Arithmetic Methods for the DCT, Department of Electrical and Computer Engineering, University of Akron, OH, USA.
- 2010b An Arithmetic Method for the Discrete Cosine Transform, 19th National Symposium on Probability and Statistics, São Pedro, Brazil.
- 2010a The Arithmetic Cosine Transform, Department of Statistics, Federal University of Pernambuco, Recife, Brazil.
- 2007b Densities over Sets of Integers, Department of Statistics, Federal University of Pernambuco, Recife, Brazil.
- 2007a On a Density over Gaussian Integers Department of Informatics and Statistics, Universidade Federal Rural de Pernambuco, Recife, Brazil.
- 2006c Rounded Trigonometrical Transforms, 17th National Symposium on Probability and Statistics, Caxambu, Brazil.
- 2006b Arithmetic Transforms, Department of Statistics, Federal University of Pernambuco, Recife, Brazil.
- 2006a An Arithmetic Probability, 17th National Symposium on Probability and Statistics, Caxambu, Brazil.
- 2004 Signal Processing in Biomedical Engineering, Department of Electronics and Systems, Federal University of Pernambuco, Recife, Brazil.
- 2003 Voice Processing Using Praat, Department of Electronics and Systems, Federal University of Pernambuco, Recife, Brazil.
- 2002 ATM Technology, Department of Electronics and Systems, Federal University of Pernambuco, Recife, Brazil.
- 2002 Spectral Analysis and Some Applications, DeVry University, Recife, Brazil.

## Funded Projects

### Brazilian Federal Agencies

1. “Low-complexity Numerical Methods Numéricos for Signal and Image Processing” [pt: *Métodos Numéricos de Baixa Complexidade para Processamento de Sinais e Imagem*] funded by CNPq, Mar 2024–2028. Contract number: 315047/2023-2.
2. “Fast, Low-complexity Algorithm for Signal and Image Processing” [pt: *Algoritmos Rápidos de Baixa Complexidade para Processamento de Sinais e Imagem*] funded by CNPq, Mar 2020–Feb 2024. Contract number: 308423/2019-4.
3. “Low-complexity Matrix Approximations for Signal and Image Processing” [pt: *Aproximações Matriciais de Baixa Complexidade em Processamento de Sinais e Imagens*] funded by CNPq, Mar 2016–Feb 2020. Contract number: 306437/2015-5.
4. “Non-conventional Signal Analysis Techniques for Image Processing” [pt: *Técnicas Não-conventionais de Análise de Sinais Aplicadas em Processamento de Imagens*] funded by CNPq, Mar 2013–Feb 2016. Contract number: 304452/2012-2.
5. “Application of Non-conventional Signal Processing Techniques in Communications Systems” [pt: *Aplicação de Técnicas Não-conventionais de Processamento Digital de Sinais em Sistemas de Comunicações*] funded by CNPq, Jan 2010–Feb 2013. Contract number: 305668/2009-9.
6. “Statistical Image Processing via Continuous and Discrete Transforms” [pt: *Processamento Estatístico de Imagens por Transformadas Discretas e Contínuas*] funded by CNPq, Nov 2012–Nov 2014. Contract number: 479668/2012-4.
7. “Polynomial Wavelets in Electrogastrography” [pt: *Wavelets Polinomiais em Eletrogastrografia*] funded by CNPq, Sep 2003–Jul 2004. Contract number: 200863/2003-7.

### International Agencies

1. “Multi-Beam Radio Frequency (RF) Aperture Arrays Using Multiplierless Approximate Fast Fourier Transform (FFT)”, funded by US Government Defense Advanced Research Projects Agency, DARPA/MTO, Aug 2016–Aug 2017. Contract number: FA8650-16-1-7610.
2. “Watermarking Using Non conventional Transform Techniques”, funded by Department of Foreign Affairs and International Trade, Government of Canada, Sep 2008–Sep 2009.

### State Agencies

1. “Discrete Hartley Transform: Approximations, Algorithms and Estimators” [pt: *Transformada discreta de Hartley: Aproximações, Algoritmos e Estimadores*] funded by Pernambuco state government, Feb 2017–Jan 2018. Contract number: FACEPE IBPG-1337-3.04/16.
2. “Matrix Approximations for Discrete Trigonometric Transforms” [pt: *Aproximações matriciais para transformadas discretas trigonométricas*] funded by Pernambuco state government, Aug 2016–Aug 2017. Contract number: FACEPE IBPG-0344-3.04/16.
3. “Multiparametric Class of Low-complexity Linear Transform” [pt: *Uma Classe Multiparamétrica de Transformadas Lineares de Baixo Custo Aritmético*] funded by Pernambuco state government, Feb 2015–Feb 2017. Contract number: FACEPE IBPG-0064-3.04/15.
4. “Statistical Image Processing via Discrete Transforms” [pt: *Processamento Estatístico de Imagens por Transformadas Discretas*] funded by Pernambuco state government, Feb 2013–Jan 2015. Contract number: FACEPE APQ-1180-1.02/12.

5. “Efficient Discrete Transform Methods for Communications Systems” [pt: *Métodos Eficientes em Transformadas Discretas Aplicadas em Sistemas de Comunicações*] funded by Pernambuco state government, Jan 2011–Dec 2012. Contract number: FACEPE APQ-0733-3.04/10.

## As Co-PI or Collaborator

1. (Co-PI) “Signal and Image Analysis Based on Stochastic Distances and Differential Entropy” [pt: *Análise de Sinais e Imagens com Distâncias Estocásticas e Diferenças de Entropias*] funded by CNPq, Nov 2014–Nov 2017. Contract number: 447229/2014-1.
2. (Collaborator) “Spatial Analysis of Determining Factors in the Special Zones Expansion in the City of Recife between 1991 and 2010” [pt: *Uma análise espacial dos Fatores Determinantes na Expansão das Zonas Especiais de Interesse Social na cidade do Recife entre 1991 e 2010*] funded by CNPq, Nov 2014–Nov 2017. Contract number: 447229/2014-1.
3. (Co-PI) “Contributions to Rate and Proportion Models” [pt: *Modelagem e melhoramentos em modelos para taxas e proporções*] funded by CNPq, Jan 2014–Jan 2017. Contract number: MCTI/CNPq No 14/2014.
4. (Co-PI) “PolSAR Data Analysis Based on Information Theory and Signal Processing” [pt: *Análise de dados PolSAR via Teoria Estatística da Informação e Processamento de Sinais*] funded by CNPq, Feb 2014–Feb 2017. Contract number: 458811/2014-9.
5. (Co-PI) “Statistical Methods for Redundancy Removal in Polarimetric Data” [pt: *Métodos estatísticos para reduzir informação em dados polarimétricos*] funded by CNPq, Nov 2013–Nov 2016. Contract number: 470810/2013-0.
6. (Co-PI) “Approximations for the discrete cosine transform in image compression” [pt: *Aproximações para a transformada discreta do cosseno com aplicações em compressão de imagens*] funded by Rio Grande do Sul state government, Mar 2013–Feb 2015. Contract number: FAPERGS n. 001/2013.
7. (Collaborator) “Smart-CPMAT: Specifying Smart Buildings with wireless sensor networks” [pt: *Smart-CPMAT: Configurando edifícios inteligentes com redes de sensores sem fio*] funded by Alagoas state government, Dec 2012–Jul 2015. Contract number: FAPEAL-20110720-006-0018-0006.
8. (Co-PI) “Information Theory for Polarimetric SAR Image Analysis” [pt: *Teoria da Informação na Análise de Imagens SAR Polarimétricas*] funded by CNPq, Dec 2011–Dec 2013. Contract number: 471805/2011-4.

## Teaching Experience

Courses taught at Federal University of Pernambuco for graduate students in Industrial Engineering, Electrical Engineering, Statistics, or Computational Mathematics<sup>1</sup>:

2025.2 - PPGEE979 - Knowledge Methodology in Engineering and Science

2025.2 - EPCAA2 - Special Topics in Industrial Engineering II (Methods for Engineering and Academic Production)

2024.2 - PPGEE979 - Knowledge Methodology in Engineering and Science

2024.2 - PGE986 - Epistemology and Foundations of Statistics

2024.2 - EPCAA2 - Special Topics in Industrial Engineering II (Methods for Engineering and Academic Production)

2023.2 - EPCAA2 - Special Topics in Industrial Engineering II (Methods for Engineering and Academic

<sup>1</sup>‘2020.2’ means: 2nd semester of 2020.

Production)	2016.1 - PGE971 - Signal Processing
2022.2 - PGE976 - Applied Topics in Statistics (Foundational Methods and Epistemology)	2014.1 - PGE952 - Seminar Chair
2022.1 - PGEE922 - Scientific Method	2013.2 - EE925 - Digital Signal Processing
2021.2 - PGEE922 - Scientific Method	2013.2 - PGE971 - Signal Processing
2021.1 - PGEE910 - Digital Signal Processing	2012.2 - PGE971 - Signal Processing
2020.2 - PGEE910 - Digital Signal Processing	2011.1 - PGE960 - Time Series
2020.1 - PGE971 - Signal Processing	2010.1 - PGE971 - Signal Processing
2019.2 - PGE971 - Signal Processing	2008.2 - PGE971 - Signal Processing
2019.2 - EE925 - Digital Signal Processing	2007.1 - PGE971 - Signal Processing
2017.2 - EE960 - Topics in Communications	2006.1 - MES905 - Probability
2016.1 - EE925 - Digital Signal Processing	

Courses taught at Federal University of Pernambuco for Industrial Engineering majors:

2025.2 - PROD52 - Probability and Stochastic Processes I	2024.1 - PROD26 - Industrial Processes II (Control Systems)
2025.2 - PROD103 - Special Topics I (Economics)	2023.2 - PROD96 - Probability and Stochastic Processes II
2025.2 - PROD26 - Industrial Processes II (Control Systems)	2023.2 - PROD56 - Simulation Techniques for Industrial Engineering
2025.1 - PROD52 - Probability and Stochastic Processes I	2023.2 - PROD26 - Industrial Processes II (Control Systems)
2025.1 - PROD56 - Simulation Techniques for Industrial Engineering	2023.1 - PROD52 - Probability and Stochastic Processes I
2025.1 - PROD26 - Industrial Processes II (Control Systems)	2023.1 - PROD56 - Simulation Techniques for Industrial Engineering
2024.2 - PROD52 - Probability and Stochastic Processes I	2023.1 - PROD26 - Industrial Processes II (Control Systems)
2024.2 - PROD26 - Industrial Processes II (Control Systems)	
2024.1 - PROD52 - Probability and Stochastic Pro-	

Courses taught at Federal University of Pernambuco for Statistics majors:

2021.1 - DES663 - Epistemological Foundations of Statistics	2012.1 - ET592 - Stochastic Processes
2021.1 - ET644 - Signal Processing	2011.2 - ET592 - Stochastic Processes
2020.2' - ET583 - Probability III	2011.2 - ET583 - Probability III
2020.2' - ET644 - Signal Processing	2011.1 - ET592 - Stochastic Processes
2020.2 - DES663 - Epistemological Foundations of Statistics	2010.2 - ET589 - Introduction to Optimization
2020.2 - ET583 - Probability III	2010.2 - ET583 - Probability III
2020.1 - DES663 - Epistemological Foundations of Statistics	2010.1 - ET592 - Stochastic Processes
2020.1 - ET583 - Probability III	2008.2 - ET583 - Probability III
2019.2 - ET583 - Probability III	2008.1 - ET592 - Stochastic Processes
2017.1 - ET583 - Probability III	2008.1 - ET583 - Probability III
2016.2 - ET583 - Probability III	2007.2 - ET589 - Introduction to Optimization
2014.1 - ET583 - Probability III	2007.2 - ET583 - Probability III
2013.1 - IF311 - Numerical Methods	2007.1 - ET592 - Stochastic Processes
2012.2 - ET583 - Probability III	2006.2 - ET583 - Probability III
	2006.2 - ET610 - Linear Programming
	2006.1 - ET583 - Probability III
	2005.2 - ET301 - Elements of Statistics

Courses taught at DeVry University for Industrial Engineering majors:

2001.2-2005.2 - Probabilistic Models in Operations Research  
2004.2-2005.2 - Deterministic Models in Operations Research  
2004.2-2005.1 - Numerical Analysis

Courses taught at Polytechnic School of Pernambuco for Electrical Engineering majors:

2003.1 - Microprocessors  
2003.1 - Electrical Instrumentation  
2002.2 - Control Systems

## Students

### Current

- 2025– Eder Silva, MSc (Engineering), Graduate Student (DSc) in Electrical Engg, Field: Signal Processing.
- 2025– Jose Maria de Sousa Neto, Undergrad (Industrial Eng), Undergraduate thesis in Industrial Engg, Field: Signal Processing, Quality Control.
- 2025– W. A. Aleixo, Undergrad (Industrial Eng), Undergraduate thesis in Industrial Engg, Field: Approximation Theory, Optimization, Image Processing.

### Alumni

- 2023–2025 W. A. Aleixo, Undergrad (Industrial Eng), Research assistant, Field: Approximation Theory, Optimization, Image Processing.
- 2023–2025 L. M. de Oliveira, Undergrad (Industrial Eng), Research assistant, Field: Approximation Theory, Optimization, Image Processing.
- 2024–2025 L. A. Silva, Undergrad (Industrial Eng), Research assistant, Field: Approximation Theory, Optimization, Spectral Estimation.
- 2019-2023 Anabeth Petry Radünz, MSc (Statistics), Graduate Student (DSc) in Statistics, Field: Image Processing, Approximation Theory, Karhunen-Loève transform, Optimal decorrelation.
- 2019-2023 Luan Portella da Silva, MSc (Engineering), Graduate Student (DSc) in Statistics, Field: Signal Processing, Fourier Analysis, Low-complexity Methods.
- 2019-2021 Allan dos Santos, BSc (Statistics), Goal: MSc in Statistics, Field: Image Processing, Fractional Cosine Transform.
- 2017-2019 Lucas Araújo, BSc (Electrical Eng), Graduate Student (MSc) in Electrical Engg, Field: Fast algorithms for the discrete Hartley transform and face recognition.
- 2017-2019 Anabeth Petry Radünz, BSc (Statistics), Graduate Student (MSc) in Statistics, Field: Approximation, Karhunen-Loève transform, Optimal decorrelation.
- 2016-2019 Abel Pereira Borges Junior, BSc (Statistics), Graduate Student (MSc) in Statistics, Field: Approximation, Polynomial transforms, Estimation.
- 2015-2018 Vitor de Andrade Coutinho, BSc (Electrical Eng), MSc (Electrical Eng), Graduate Student (DSc) in Electrical Engg, Field: Fast algorithms for image processing and coding.
- 2016-2018 Luciano Barbosa, MSc (Statistics), Graduate Student (DSc) in Electrical Engg, Field: Remote sensing, Image processing

- 2015-2017 Raíza dos Santos Oliveira, BSc (Statistics), Graduate Student (MSc) in Electrical Engg, Field: Fast algorithms for image processing and coding.
- 2016-2019 Bruna Gregory Palm, BSc (Statistics), MSc (Engineering) Graduate Student (DSc) in Statistics, Field: Prediction, Estimation, Time-series.
- 2013-2018 Josimar Mendes de Vasconcelos, MSc (Biostatistics), Graduate Student (DSc) in Statistics, Field: Information Theory and Statistical Modelling.
- 2015-2017 Diego Canterle, BSc (Statistics), Graduate Student (MSc) in Electrical Engg, Field: Fast algorithms for image processing and coding.
- 2013-2016 Paulo André Martinez Oliveira, Research assistant in Electrical engineering, Field: Fast algorithms for polynomial transforms.
- 2012-2015 Raíza dos Santos Oliveira, Research assistant in Statistics, Field: Image processing.
- 2014-2016 Bruna Gregory Palm, BSc (Statistics) Graduate student (MSc) in Production Engineering, Field: Prediction and Estimation.
- 2014-2015 Diego Felipe Gomes Coelho, BSc (Electrical Eng), Graduate student (MSc) in signal processing (Statistics), Field: Transform coding, Fast algorithms, Algebraic integers.
- 2014-2015 Vitor de Andrade Coutinho, BSc (Electrical Eng), Graduate student (MSc) in signal processing (Electrical Engg), Field: Fast algorithms for image processing.
- 2013-2015 Dora Myriam Suarez, BSc (Statistics), Graduate student (MSc) in signal processing (Statistics), Field: Computation-constrained DFT estimation.
- 2012-2014 Abner Barros, MSc (Computer Science), Doctorate student (DSc) in Computer Science, Field: Seismic Signal Processing.
- 2012-2014 Claudio Javier Tablada, BSc (Mathematics), Graduate student (MSc) in signal processing, Field: Approximate transforms and coding.
- 2013-2013 Diego Fernando Ferreira de Araujo, Senior computer engineering undergrad Research assistant, Field: Image compression.
- 2012-2014 Diego Felipe Gomes Coelho, Senior electrical engineering undergrad, Research assistant, Field: Signal processing, Algebraic integers.
- 2012-2013 Pâmela Thays Lins Bezerra, Senior computer engineering undergrad, Research assistant, Field: Image Compression, Fast algorithms.
- 2011-2012 Leandro Carlos de Souza, M.Sc., Doctorate in Statistics, Field: Image Processing, Sampling, Fast algorithms.
- 2008-2012 Abraão David Costa do Nascimento, Doctorate in Statistics, Field: Statistical signal processing, SAR image processing.
- 2010-2011 Isadora Cristina Bezerra de Araújo, Senior biomedical engineering undergrad, Field: Fast algorithms for the discrete Hartley transform.
- 2010-2011 Carolina Karen Alves Silva, Senior biomedical engineering undergrad, Field: Fast algorithms for the discrete Fourier transform.
- 2007 Maíra de Oliveira Santos, Undergraduate dissertation in Statistics, Field: Time series.

## Languages

1. English (full professional proficiency)
2. Portuguese (native tongue)
3. French (can understand)

4. Spanish (can understand)
5. Latin (elementary)

## **Professional Reference List**

Upon request.

Caruaru, November 8, 2025.