

Curriculum Vitae

Prof. Dr. MSc. Eng. Eduardo Bayro-Corrochano

CINVESTAV

Full Professor in Geometric Computing and **SNI-III**

Centro de Investigación y de Estudios Avanzados

Electrical Engineering and Computer Science Department

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Personal Details

Nationality: Mexican

Married with polish woman and three children (18,17,15)



Academic Degrees

Ms. degree in Electronic Engineering at the University Técnica Federico Santa Maria, Chile.

PhD under the supervision of Prof. D.T. Pham, University of Wales, Cardiff.

Post Doc at Angewandte Mathematik und Informatik Institut, CA Universität at Kiel, Germany

Fellowships and Recognition

-SNI III (Highest Mexican level as researcher)

-Fellow of IAPR, August 2006 "For contribution in geometric computing for perception and action systems"

- IEEE candidate fellow 2020 For "Geometric Cybernetics perception, cognition, control and action"

- Member of the Mexican Academy of Science

Professional Training and Experience

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| 1978 | MS degree in Electronic Engineering at the University Técnica Federico Santa Maria, Chile. |
| 1982 | Postgraduate student visitor at the Electrical Department of the Technische Hochschule Aachen, West Germany. |
| 1993 | "Artificial Intelligence Techniques for Machine Vision". PhD under the supervision of Prof. D.T. Pham, Director of the Robotics and Intelligent Systems Laboratory at the School of Electrical and Electronic Systems Engineering at the University of Wales, Cardiff. Research topic involved Machine Vision, Fuzzy Logic, Neural Networks and Rule and Neural Net based (hybrid) Systems. Industrial application: Automated Visual Inspection of rubber molded car seals. |
| 1995–1998 | Lecturer and researcher at the Computer Science Department, Cognitive Systems Group of the Christian-Albrecht University, Kiel Germany. Active vision research project: development of algorithms using geometric algebra and geometric interpretation of Clifford algebra for neurocomputing, computer vision and robotics. A DFG (German science association) research project was accepted: Geometric algebra -- a framework for the perception action cycle. |
| 1999–2000 | Invited lecturer and researcher at the CIMAT, Centro de Investigación en Matemáticas, Computer Science Department, Guanajuato--Mexico. |
| 2001–present | Full Professor at the CINVESTAV, Centro de Investigaciones y de Estudios Avanzados, Computer Science Department, Guadalajara--Mexico. Head of the Geometric Vision and Robotics GEOVIS Laboratory. |

Research interests

MS. degree in electronics and telecommunications gave me a very profound and pragmatic background of engineering. As postgraduate visitor in TH Aachen I became acquainted with digital signal processing, filtering and stochastic control engineering. During my PhD at the University of Wales College Cardiff I worked mainly on the development of algorithms for intelligent machine vision involving neural networks, image processing and pattern recognition. My PhD thesis shows successful application in automated visual inspection for the quality control of automobile valve stem seals. During my post-doctoral work at the Christian Albrechts University Kiel Germany I became familiar with geometric computing using the Clifford geometric algebra framework. This opened an unexpectedly and new way of seeing and solving problems in applied mathematics, computer science and engineering. During my next years as a lecturer and researcher I devoted myself to the development and design of perception action systems.

I am interested to develop real time algorithms for controlling the perception (vision, laser, omnidirectional, ultrasound) and action (planning, relocation, navigation, object manipulation). Within a perception action cycle (PAC) our machine should increase its capabilities to recognize relevant categories. Here geometric learning is key for the enlargement of its consciousness. We chose for the design of PAC systems the geometric algebra framework system. In this system many standard algorithms can be integrated for making the system more robust. Currently we are employing modern mathematical formalisms which may elucidate advanced concepts for the assessment and management of uncertainty in geometric computations. Goals and benefits of our research will be of a theoretical, practical and industrial nature. My publications reflect results in a wide spectrum of related disciplines ranging from basic research to real industrial applications.

Since the nineties I have actively worked in training MS and PhD students, guiding industrial projects and enlarging my own theory of geometric computing for cognitive systems where learning plays the key role.

My current theoretical and applied research interests can be categorized as follows

Basic Research

1. Geometric neural networks
2. Quaternion, Clifford Fourier transform and Quaternion, Clifford Wavelet transform
3. Geometry of n uncalibrated cameras (calibration, reconstruction, dynamics)
4. Kinematics and dynamics of serial and parallel manipulators
5. Mobile robots
6. Active vision
7. Sensor fusion (ultrasound, laser, stereo binocular systems, omnidirectional systems)
8. Learning of spatial-temporal events
9. Geometric computing under uncertainty, geometric fuzzy logic
10. Bio-robotics
11. Cognitive robotics
12. Design of robot systems
13. Humanoids (cognitive architecture)
14. Human Machine Interaction
15. quantum computing for neurocomputing and image processing
16. Medical Imaging

Applied research

1. Intelligent automated visual inspection
2. Robots for inspection
3. Visual guided robot manipulators for the electronics and car industries
4. Service mobile robots
5. Computer aided neurosurgery and laparoscopy (fusion of ultrasound and cameras)
6. AI robotics for education and rehabilitation
7. Computer graphics, virtual reality, visualization
8. Programming for geometric computing
9. Social impact low cost health care devices

Lectures

During my career I have been teaching a large variety of courses in computer science and applied mathematics related with the fields of:

- signal processing and filtering,

- modern control theory,
- computer structure,
- image analysis and processing,
- pattern recognition,
- neural networks,
- computer vision
- quantum computing for neurocomputing and image processing
- robotics
- applications of Clifford geometric algebra,
- applications of Lie algebras,
- graphics engineering,
- virtual reality, visualization,
- Algorithmic and complexity.

I have also organized laboratories for

- signal processing,
- neural computing,
- computer vision,
- robotics.

I wrote 7 books for postgraduate courses and intern lecture notes and handouts available for students at the library or my homepage. I also wrote for Windows or Linux programs and subroutines in Assembler, Pascal, C++, Maple and Matlab for illustrating concepts and helping the students to develop and improve their own application programs. I am actively collaborating with other international groups interchanging ideas and programs for the improvement of computational tools.

Student supervision

30 PhD students, 31 MSc.

Publications (the full citations come in an extra file

259 publications: 23 Book chapters, 78 journal articles, 3 Technical Reports, 145 Conference papers, 7 books, 2 patents, Google Scholar 1993 cites, h-index=25

Resume of the most relevant contributions

2 of 7 Books

1. Geometric computing for Perception Action Systems. Eduardo Bayro--Corrochano, Springer Verlag, April 2001.
2. Geometric Algebra Applications Vol. II: Robot Modelling and Control. Eduardo Bayro—Corrochano, Springer Verlag, 2020.

10 best of 74 Journal papers

1. Bayro--Corrochano E. and Kähle D. [2000]. Motor Algebra Approach for Computing the Kinematics of Robot Manipulators. Journal of Robotic Systems, vol. 17(9), pp. 495-516.
2. Bayro--Corrochano E. and Zang Y. [2000]. The motor extended Kalman filter a geometric approach for rigid motion estimation. Journal of Mathematical Imaging and Vision, vol. 13, pag. 205-228.
3. Bayro--Corrochano E., Daniilidis K. [2000]. Motor algebra for 3D kinematics. The case of the hand—eye calibration. Journal of Mathematical Imaging and Vision, vol. 13, pag. 79-99.
4. Bayro-Corrochano E. [2001]. Geometric Neural Computing. IEEE Transactions on Neural Networks, 12(5), September, pp. 968-986.
5. Bayro-Corrochano E and Rosenhan B. [2002]. A geometric approach for the analysis and computation of the intrinsic camera parameters. Journal of Pattern Recognition, 35, pp. 169-186.
6. Bayro-Corrochano E. [2002]. Motor algebra approach for visually guided robotics. Journal of Pattern Recognition, 35, pp. 279-294.

7. Reyes-Lozano L. and Bayro-Corrochano E. [2005] The projective reconstruction of points, lines, quadrics, plane conics and degenerate quadrics using uncalibrated cameras. *Image and Vision Computing*, 23, pp. 693-706.
8. Bayro-Corrochano E. [2006] Theory and use of the quaternion wavelet transform. *Journal of Mathematical Imaging and Vision*, 24, pp. 19-35.
9. Bayro-Corrochano E., Reyes-Lozano L. and Zamora-Esquivel J. [2006] Conformal geometric algebra for robotic vision. *Journal of Mathematical Imaging and Vision*, 24, pp. 55-81.
10. Reyes-Lozano, Medioni G. and Bayro-Corrochano E. [2007]. Registration of 3D points using geometric algebra and tensor voting. *Journal of Computer Vision*, February.

See in an extra attached file below the complete list of all contributions: 3 Technical Reports, 23 Book Chapters, 78 Journal articles and 145 conference papers, 3 proceedings and 7 books. Total: 259.

Other professional activities, such as workshops, seminars and consultations

Visiting Professor

Sept 2007- August 2008 (visiting Full Professor W3) By Prof. Rudiger Dillman Universität Karlsruhe (TH), Informatik, Robotik und Humanoid Laboratory under Merkator DFG Guest Professuer Program

Sept 2013- August 2014 (visiting full Professor) By Prof. Ramesh Rasklar, MISTI Program, Media Lab., MIT, Boston, USA.

Conference organization

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| September 1997 | Program organizer of the Int. Workshop "Algebraic Frames for the Perception-Action Cycle", September 1997, Kiel Germany. Arrangements for the Proceedings appeared as Lecture Notes of Springer Verlag. |
| July 1999 | Chair of the Special Parallel Session "Applications of Geometric Algebra in Computer Vision, Robotics, Computer Science and Engineering" AGACSE'99 of the 5th Int. Conference on Clifford Algebras and their Applications in Mathematical Physics, held in Ixtapa-Zihuatanejo, Mexico, July 1999. |
| October 2000 | Chair of the First Int. Workshop "Advances in Artificial Perception and Robotics", Centro de Investigaciones Matemáticas, Guanajuato, Mexico. |
| July 2003 | Chair of the special session Geometric Neurocomputing at the Int. Join Conference on Neural Networks IJCNN'2003, July 21-24, Portland Oregon, 2003 |
| May 2005 | Organization y co-chair of session on Applications in computer science, robotics and engineering at the Int. Conf. on Clifford Algebras and their Applications, Toulouse, France, May 19-29, 2005. |
| September 2008 | Organization and co-chair of Int. Conf. on Applications of Clifford Geometric) Algebras in computer science, robotics and engineering ICAGA'2008, Leipzig, Germany, September 24-27, 2008. |
| October 2009 | 14 th Iberoamerican Conference on Pattern Recognition, CIARP'2009, Guadalajara, Jalisco, Mexico, November 2009.
Chairs: Eduardo Bayro-Corrochano and Jan-Olof Eklund (Eds.) |
| November 2014 | Chair of the Iberoamerican Congress on Pattern Recognition. CIARP'2014, Pto. Vallarta, November 2th-15th 2014, Jalisco, México. |

December 2016
1th-6th

General Chair of International Conference on Pattern Recognition, Cancun, ICPR'2016, Cancun, December 1-7, 2016.
1200 paper submitted, 673 accepted and published

November 2016 General Chair of Humanoids'2016, Cancun, México. 290 papers submitted, 193 accepted and published.

15th -17th

Invited speaker/plenary talk

- July 1999 First Int. Workshop on Applied Clifford Algebra in Cybernetics, Robotics, Image Processing and Engineering : ACACSE'99 (Ixtapa, Mexico, 28.06.99-- 03.07.99). Theme: Application of Geometric Clifford Algebras in Computer Vision.
- April 2003 MATA'2003, Third International Conference on Multivariate Approximation: Theory and Applications. Cancun, Mexico, April 24-29, 2003. Theme: The quaternion wavelet transform: theory and applications.
- June 2004 ICAISC'2004, International Conference on Artificial Intelligence and Softcomputing. Zakopane, Poland, June 7-11, 2004. Theme: Geometric neurocomputing using Clifford geometric algebra for visual and robotic learning.
- October 2004 Iberoamerican Congress on Pattern Recognition, CIARP'2004, Puebla, Mexico, October 2004, Theme: (key note) Clifford geometric algebra: a promising framework for computer vision, robotics and learning.
- May 2005 plenary talk at the Int. Conf. on Clifford Algebras and their Applications, Toulouse France, May 19-29, 2005, Theme: Conformal geometric algebra for robotics vision.
- November 2005 Iberoamerican Congress on Pattern Recognition, CIARP'2005, Habana, Cuba, November 2005, Theme: (key note) Conformal computational geometry for perception and action.
- May 2008 plenary talk at the Int. Conf. on Clifford Algebras and their Applications, Sao Paulo, Campinas, Brazil, May 26-30, 2008, Theme: Conformal geometric algebra for robotics vision.
- Juli 2011 plenary talk at the Int. Conf. on Clifford Algebras and their Applications, ICCA9, Weimar, Germany, July 15-20, 2011, Theme: Geometric algebra for robot physics.

Associate Editor

Journal Robotica, Journal of Advanced Robotic Systems, Journal of Pattern Recognition
IEEE Transaction of Neural Networks and Learning Systems, ICRA's conferences
IROS's conferences, Humanoids's conferences

Editorial Board Member

Journal of Mathematical Imaging and Vision, Journal of Theoretical And Numerical Approximation, ICRA Editor

Guest Editor 2007

1. Special Issue of Journal Robotica: Geometry in robotics and sensing, Volume 26, Special Issue 04, 2008
2. Special Issue of International Journal of Humanoid robotics: Cognitive Humanoid Robot Vision 7(3), 2010.
3. Special Issue of Patter Recognition Letters: Advances in Theory and Applications of Pattern Recognition, Image Processing and Computer Vision. Vol. 32 2011.