

Ricardo Legarda-Sáenz

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Summary of qualifications

- Doctoral degree in optics with postdoctoral experience in optical metrology.
- Independent research-work with publications in peer-reviewed journals and proceedings.
- Experience with moiré deflectometry, camera calibration and fringe processing techniques.
- Skills in numerical methods for image processing, and programming with C/C++, MatLabTM, and CUDATM.
- Native speaker of Spanish, fluent speaking of English, and basic knowledge of German.

Scientific interests

My principal interest is the applications of optical shape measurement for the evaluation of complex objects. At present, I am working in the calibration and measurement of a fringe projection system, and the measured data matching from different views and/or different devices. A second interest is the processing of fringe patterns using inverse-problems approach.

Education

- Doctoral degree in Sciences (Optics), Centro de Investigaciones en Óptica. A. C. (Mexico), 2000.
 - Distinction for academic performance.
 - Thesis work related with computational techniques for the moiré deflectometry technique:
 - a) simulation of geometrical propagation of light through an inhomogeneous medium

using ray-tracing techniques, and b) processing the experimental data generated by the technique.

- Master degree in Electronic Engineering (Computation), Instituto Tecnológico de Chihuahua (Mexico), 1997.
 - Special recognition for degree examination.
 - Thesis work related with character recognition using invariant moments as descriptors and neural networks as classifier.
- Bachelor degree in Industrial Engineering (Electronic), Instituto Tecnológico de Chihuahua (Mexico), 1991.

Professional experience

2004–present Faculty of Mathematics, Universidad Autónoma de Yucatán, Mexico.

Profesor Investigador Titular C (equivalent to Associate Professor).

- Teaching on graduate and undergraduate courses related with scientific computing and image processing.
- Researching in fringe processing techniques, 3D reconstruction and camera calibration.
- Supervision of graduate and undergraduate thesis.
- Administration duties related with graduate faculty advising and graduate program curriculum development.

2001–2003 Bremer Institut für Angewandte Strahltechnik (BIAS), Germany.

Guest Researcher (postdoctoral)

- Researching in fringe processing techniques, writing technical report and research paper, and development of software tool for the Fringe ProcessorTM software (including its help file and user-manual chapter).
- Software development for shape measurements for the Fringe ProcessorTM software.
- Development of calibration methods applied to fringe projection technique.

2000 Centro de Investigaciones en Óptica. A. C., Mexico

Research Associate

- Assisting in the research activities of the optical metrology group in CIO.
- Researching related with my doctoral work.

Publications

Publications in peer-review journals

- Jorge L. Flores, José A. Ferrari, G. GarcíaTorales, Ricardo Legarda-Saenz, Adriana Silva, "Color-fringe pattern profilometry using a generalized phase-shifting algorithm," *Appl. Opt.* 54, 8827-8834 (2015).
- Adonai Gonzalez, Mariano Rivera, Manuel Servin, Ricardo Legarda-Saenz, Oscar Dalmau, and Amalia Martinez, "Synchronous phase demodulation algorithm for conic carrier Hartmann topographer," *Opt. Lasers Eng.* 67, 157–162 (2015).
- J. L. Flores, R. Legarda-Saenz, and G. Garcia-Torales, "Color deflectometry for phase retrieval using phase-shifting methods," *Opt. Commun.* 334, 298–302 (2015).
- R. Legarda-Saenz, C. Brito-Loeza, and A. Espinosa-Romero, "Total variation regularization cost function for demodulating phase discontinuities," *Appl. Opt.* 53, 2297–2301 (2014).
- R. Legarda-Saenz, C. Brito-Loeza, M. Rivera, and A. Espinosa-Romero, "Variational method for integrating radial gradient field," *Opt. Lasers Eng.* 63, 53–57 (2014).
- A. Espinosa-Romero and R. Legarda-Saenz, "GPU based real-time quadrature transform method for 3-D surface measurement and visualization," *Opt. Express* 19, 12125–12130 (2011).
Times cited: 5.
- R. Legarda-Saenz and A. Espinosa-Romero, "Wavefront reconstruction using multiple directional derivatives and Fourier transform," *Opt. Eng.* 50, 040501 (2011).
Times cited: 4.
- R. Legarda-Saenz, R. Rodriguez-Vera, and A. Espinosa-Romero, "Dynamic 3-D shape measurement method based on quadrature transform," *Opt. Express* 18, 2639–2645 (2010).
Times cited: 1.
- O. S. Dalmau-Cedeno, M. Rivera, and R. Legarda-Saenz, "Fast phase recovery from a single closed-fringe pattern," *J. Opt. Soc. Am. A* 25, 1361–1370 (2008).
Times cited: 16.
- R. Legarda-Saenz, "Robust wavefront estimation using multiple directional derivatives in moiré deflectometry," *Opt. Lasers Eng.* 45, 915–921 (2007).
Times cited: 5.
- R. Legarda-Saenz and M. Rivera, "Fast half-quadratic regularized phase tracking for nonnormalized fringe patterns," *J. Opt. Soc. Am. A* 23, 2724–2731 (2006).
Times cited: 10.

- R. Legarda-Saenz, T. Bothe, and W. P. Juptner, "Accurate procedure for the calibration of a structured light system," *Opt. Eng.* 43, 464–471 (2004).
Times cited: 78.
- R. Legarda-Saenz, W. Osten, and W. P. Juptner, "Improvement of the regularized phase tracking technique for the processing of nonnormalized fringe patterns," *Appl. Opt.* 41, 5519–5526 (2002).
Times cited: 23.
- R. Legarda-Saenz, M. Rivera, and R. Rodriguez-Vera, "Quadratic cost functional for wave-front reconstruction," *Appl. Opt.* 41, 1515–1521 (2002).
Times cited: 1.
- R. Legarda-Saenz, M. Rivera, R. Rodriguez-Vera, and G. Trujillo-Schiaffino, "Robust wave-front estimation from multiple directional derivatives," *Opt. Lett.* 25, 1089–1091 (2000).
Times cited: 7.
- R. Legarda-Saenz, R. Rodriguez-Vera, and M. Rivera, "Nonparaxial method for computing the gradient field of a wavefront using moiré deflectometry," *Opt. Commun.* 160, 214–218 (1999).

Proceedings and technical reports (English)

- A. Silva, R. Legarda-Saenz, G. Garcia-Torales, S. Balderas-Mata, and J. L. Flores, "3D shape measurement with binary phase-shifted technique and digital filters," in *Proceedings of SPIE*, M. Strojnik Scholl and G. Páez, eds. (2014), Vol. 9219, p. 92190L.
- O. E. Castillo, R. Legarda, J. L. Flores, and G. Garcia-Torales, "Measurement of phase objects by the use of color phase-shifting technique," in *Proceedings of SPIE*, M. Strojnik Scholl and G. Páez, eds. (2013), Vol. 8867, p. 886710.
- B. Bravo-Medina, G. Garcia-Torales, R. Legarda-Sáenz, and J. L. Flores, "Wavefront recovery Fourier-based algorithm in a vectorial shearing interferometer," in *Proceedings of SPIE*, M. Strojnik Scholl and G. Páez, eds. (2013), Vol. 8867, p. 88670Z.
Times cited: 1.
- A. Espinosa-Romero and R. Legarda-Saenz, "Real-time parallel method for quadrature transform estimation and 3D surface measurement," in *Proceedings of SPIE* (2011), Vol. 8011, p. 80117A.
- R. Legarda-Saenz, R. Rodriguez-Vera, and J. A. Rayas, "Surface contouring of vibrating objects using quadrature transform," in *Fringe 2009. The 6th International Workshop on Advanced Optical Metrology* (2009), pp. 455–460.

- R. Legarda-Saenz, "Fast wavefront estimation using multiple directional derivatives and quadrature transform," in Proceedings of SPIE (Spie, 2008), Vol. 7155, p. 715531.
- R. Legarda-Saenz, "Robust wavefront reconstruction using multiple directional derivatives and computer monitor," in Proceedings of SPIE (Spie, 2007), Vol. 6422, p. 64220W-1.
- R. Legarda-Sáenz, "Tridimensional reconstruction using structured light systems," in Proceedings of SPIE (Spie, 2006), Vol. 6046, p. 60461M.
- R. Legarda-Sáenz, R. Legarda-Sáenz, Mariano Rivera, "New improvements of the regularized phase tracking technique for the processing of non-normalized fringe patterns," in Proceedings of SPIE (Spie, 2005), Vol. 5776, p. 692.
- T. Bothe, A. Gesierich, R. Legarda-Saenz, and W. Juptner, "Three-dimensional camera," in Proceedings of SPIE (2003), Vol. 5144, p. 295.

Times cited: 3.

- R. Legarda-Saenz, D. Kaiser, W. Osten, "Registration of two patches measured with different resolution in the optical measurement technique," Technical Report BIAS-CIO. Junio 2001.

Proceedings and technical reports (Spanish)

- R. Legarda-Sáenz, "Processing multiple directional derivatives using quadrature transform," XIX Annual Meeting of Optics / LIX National Congress of the Mexican Physical Society. San Luis Potosí, México. October 2006.
- J. A. Centeno, G. E. Gutiérrez-Valencia, R. Legarda-Sáenz, "Digitization of archaeological objects using photogrammetric techniques," II Workshop on Image Processing and Optics (PIO2005). Guanajuato, Mexico. November 2005.
- L. A. Muñoz, A. Espinosa, R. Legarda Sáenz, F. Heredia, O. Santos, "Computer Engineering: between constructivism and scientific research," ANIEI XVII National Congress y III International Congress of Informatics and Computation. Nayarit, México. October 2004. (ISBN 970-36-0155-3).
- R. Legarda S., R. Rodriguez V., M. Servín G., "Wavefront reconstruction using ray tracing," III Ibero-American Meeting of Optics. Cartagena de Indias, Colombia. 1998. (ISBN 958-9205-32-1)
- R. Legarda S., M. I. Chacón M., "Binarization of printed text," Proceedings of XVII International Academic Congress of Electronic Engineering ELECTRO 95 (ISSN 1405-2172, Vol. XVII). Pag. 815 - 823.

- R. Legarda S., M. I. Chacón M., "Group generation using K-means algorithm on the character recognition by neural networks," Proceedings of XVII International Academic Congress of Electronic Engineering ELECTRO 95 (ISSN 1405–2172, Vol. XVII). Pag. 645 – 651.
- R. Legarda S., M. I. Chacón M., "Performance and analysis study of MD1210 fuzzy sets comparator on pattern recognition," Technical report 9 of the research project "Electronic Aids for Visually Impaired." Electrical and Electronic Department. Instituto Tecnológico de Chihuahua. November 1993.
- R. Legarda S., M. I. Chacón M., "Performance study of intelligent device on pattern recognition," Proceedings of XIV National Congress of Electronic Engineering ELECTRO 92. Pag. 629 – 636.

Research Grants and Fellowships

- Principal Investigator. *Three-dimensional reconstruction of objects from two-dimensional images.* (SEP–CONACYT, México. 2009) \$4,000 dollars.
- Principal Investigator. *New techniques for estimating asymmetric surfaces using deflectometry experimental arrangements. ID 49739.* (SEP–CONACYT, México. 2005) \$30,000 dollars.
- Principal Investigator. *Three-dimensional reconstruction of objects using structured light.* (SEP, Mexico. 2004) \$30,000 dollars.
- Principal Investigator. *Experimental setup of a structured light projection system.* (UADY, Mexico. 2004) \$4,000 dollars.

Thesis supervision

Master degree

- José Francisco Quintal Vázquez, *Reconstrucción tridimensional de objetos estáticos basado en un sistema de proyección de patrones.* Faculty of Mathematics, Universidad Autónoma de Yucatán. March 2016 (In Spanish).
- Adriana Silva Mejía, *Reconstrucción 3D de objetos, empleando proyección de patrones binarios y algoritmos de corrimiento de fase.* CUCEI, Universidad de Guadalajara. February 2015 (In Spanish).
- Oscar E. Castillo Serrano, *Dynamic phase object visualization using parallel computing.* CUCEI, Universidad de Guadalajara. February 2014 (In Spanish).

- Irving D. Sanchez Machay, *Automatization of aerial capture system for mosaicing construction*. Faculty of Mathematics, Universidad Autónoma de Yucatán. January 2014 (In Spanish).
- Xavier Sierra Canto, *Homography estimation in aerial georeferenced images for mosaicing construction*. Faculty of Mathematics, Universidad Autónoma de Yucatán. March 2012 (In Spanish).
- Iván May Cen, *Integration of directional derivatives in module 2π* . Faculty of Mathematics, Universidad Autónoma de Yucatán. November 2009 (In Spanish).
- Alejandro Tellez Quiñones, *Estimated parameters of the surfaces of a progressive ophthalmic lens using ray tracing*. Faculty of Mathematics, Universidad Autónoma de Yucatán. December 2008 (In Spanish).
- Heidy Cecilia Escamilla Puc, *Sensitivity analysis of radial fringe patterns to obtain a wavefront using a single image*. Faculty of Mathematics, Universidad Autónoma de Yucatán. July 2008 (In Spanish).

Bachelor degree

- Karla Denaly Palma Alejandro *Recovery of the topography of human skin in-vivo using fringe projection*. Faculty of Engineering, Universidad Autónoma de Yucatán. March 2008 (In Spanish).
- Emmanuel A. Castillo Solis, *Comparative study of segmentation techniques applied to images of the coastline of Yucatan*. Faculty of Mathematics, Universidad Autónoma de Yucatán. September 2006 (In Spanish).

Teaching

I have had experience in teaching large undergraduate classes as well as small specialist graduate courses.

Currently: Animation and Simulation in 3D (Undergraduate course).

Graduate courses: Parallel programming with CUDA, Scientific Computing, Digital Image Processing, Numerical Optimization, Research Seminar.

Undergraduate courses: Computer Graphics, 3-D Vision.

Academic Awards and Distinction

- Special distinction for Master Degree examination. Instituto Tecnológico de Chihuahua, November 1997.
- Distinction for academic performance of the Doctoral Program. Universidad de Guanajuato, December 1999.
- Recognition of Full Time Professors with Desirable Profile. Secretaria de Educación Publica (Mexico), since 2006.
- National System of Researchers Level I. CONACYT (México), 2005 - 2015.
- National System of Researchers Level II. CONACYT (México), 2016 - 2019.

Reviewing committees

Journal and Conferences papers: Optical Society of America; Optics and Laser Technology; Journal of Faculty of Engineering, Universidad Autónoma de Yucatán (Mexico); Optical Section of the Annual Meeting of the Mexican Society of Physics; Computer Congress, Information Technology, Biomedical and Electronics CONCIBE 2005 (Mexico); 22nd Congress of International Commission for Optics on Mexico 2011.

Grant applications: Ciencia Básica SEP-CONACYT, Fondos Mixtos CONACYT (México).

Graduate admission committees: Master degree program of the Faculty of Mathematics, Universidad Autónoma de Yucatán.

Professional affiliations

- SPIE, International Society for Optics and Photonics, member since 2002.
 - Organizing Committee of the 8th International Symposium on Laser Metrology, February 2005.
 - Organizing Committee of the V Simposio "La Óptica en la Industria", Septiembre 2005.
 - Organizing Committee of the VI Simposio "La Óptica en la Industria". March 2007.
 - SPIE Visiting Lecturer. Scientific Computing Course (20 hrs) at the Student Chapter of the University of Guadalajara. January 2014.
- Optical Society of America, member since 2002.
 - Peer reviewer of scientific manuscripts.

- Mexican Optical Academy, member since 2015.
 - Participation in the election committees of Board of Directors.
 - Topical editor of the proceedings of the XXV Annual Meeting of the Mexican Optical Academy (2012).
 - Topical editor of the proceedings of the XXVI Annual Meeting of the Mexican Optical Academy (2013).