
Héctor Manuel Becerra Fermín

Nationality: Mexican
Current Position: Associate researcher at CIMAT (Center for Research in Mathematics), Guanajuato, Mexico.
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Research interests: · vision-based control of robots · visual servoing · visual navigation · robot vision · nonlinear control · intelligent control.

Academic Formation

- 08/2008-04/2011 **PhD** by University of Zaragoza, Spain, Department of Computer Science and Systems Engineering, Thesis: “*Unifying vision and control for mobile robots*” (English), under the supervision of Prof. Carlos Sagues and Dr. G. Lopez-Nicolas. Distinction: Cum Laude.
- 08/2007-08/2008 **Master in Engineering of Systems and Informatics**. University of Zaragoza, Spain. Research in Robotics. Thesis: “*Visual control of differential-drive robots using a robust control technique*” (English).
- 2003-2005 **Master of Science** in electrical engineering. Center of Research and Advance Studies (CINVESTAV), Campus Guadalajara, Mexico. Research in Automatic Control. Thesis: “*Hybrid intelligent control of an autonomous mini-helicopter*” (Spanish).
- 1998-2003 **Engineering in Electronics**, specialty in Instrumentation and Automatic Control. Technological Institute of Ciudad Guzman, Mexico. Did not need to present degree thesis due to high overall mark (98/100). Two awards (see corresponding section).
- 1995-1998 **Technician in Electronics** by the CBTis 226 of Ciudad Guzman, Mexico.

Professional Experience

- 06/2012- **Associate researcher** at CIMAT, Guanajuato.
- 02/2012-05/2012 **Associate researcher** in the Department of Computer Science and Engineering at CUValles, University of Guadalajara, Mexico. Participant in the proposal of a master in Mechatronics in the CUValles Campus.
- 05/2011-07/2011 **Part-time researcher** in the Department of Computer Science and Systems Engineering at University of Zaragoza, Spain, as part of the project TEams of robots for Service and SEcurity missions (TESSEO).
- 06/2007-08/2007 **Consultant for the evaluation of the entertainment robot Pleo**. Engaged by ASCI Company in order to perform hardware tests in beta units of the robot Pleo. Solutions to overcome electrical and mechanical issues were proposed. Guadalajara, Mexico.
- 2005-2007 **Founder member of Laboratorio de Invenciones** in Guadalajara, Mexico. This company promoted the use of Pedagogical Robotics by representing two trademarks in the region: Lego Education and Fischertechnik. We started the annual Mini-Robotics Regional Competition in Jalisco, Mexico, in 2005.

Teaching Experience

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| Fall 2014, 2015 | Master in Mechatronics Engineering of CUValles, University of Guadalajara: Robot's navigation |
| Every Fall since 2013 | Master and PhD program in Computer Science of CIMAT: Visual control of robots. |
| Every Spring since 2013 | Basics of robotics. |
| Fall 2012 | Basics of control theory. |
| 02/2012-05/2012 | Teaching in the programs of Electronics and Mechatronics at Department of Computer Science and Engineering at CUValles, University of Guadalajara. Subjects: Robotic Systems and Analysis of Circuits and Electric Networks. |
| 01/2012-05/2012 | Teaching in the program of Engineering in Mechatronics at ITESM, Campus Guadalajara, Mexico. Subjects: Continuous Control Systems, Discrete Control Systems, Manufacturing Systems. |
| 01/2006-04/2007 | Teaching in the program of Engineering in Mechatronics at ITESM, Campus Guadalajara, Mexico. Subjects: Automatic Control Lab., Industrial Electronics Lab., Instrumentation and Measurements Lab., Electric Actuators and Robotics. |

Former and Current Students

Former Master students:

- [5] Juan Eduardo Machado Martínez (CIMAT). Thesis: Modelación y control de un robot bípedo. Dec. 2014. Main director H. M. Becerra, co-directed with Mónica Moreno (CIMAT).
- [4] O. Salvador Torres Muñoz (CIO). Thesis: Implementación de un control visual para robots móviles con ruedas. Oct. 2014. Directors: J. A. Guerrero (CIO), H. M. Becerra and J.B. Hayet (CIMAT).
- [3] Noé G. Aldana Murillo (CIO). Thesis: Localización de robots humanoides basada en apariencia a partir de una memoria visual. Oct. 2014. Directors: J. A. Guerrero (CIO), H. M. Becerra and J.B. Hayet (CIMAT).
- [2] David Jacobo Guillén (CIMAT). Thesis: Visual feedback-based time-optimal motion strategies for capturing an unpredictable evader. Nov. 2013. Main director H. M. Becerra, co-directed with R. Murrieta-Cid (CIMAT).
- [1] Guillermo J. Laguna Mosqueda (CIMAT). Thesis: Exploration of an unknown environment with a differential drive disc robot. Oct. 2013. Main director R. Murrieta-Cid (CIMAT), co-directed with H. M. Becerra.

Former Undergraduate students:

- [1] Mario A. Zarco López (UNAM). Thesis: Evaluación de técnicas de control visual monocular para la locomoción de robots humanoides Nao. June 2015. Directors: Juan M. Angeles Cervantes (UNAM) and H. M. Becerra.

Current students:

- [6] Edgar D. Martínez Rodríguez. PhD student (CIMAT) co-directed with R. Murrieta (CIMAT).
- [5] Noé G. Aldama Murillo. PhD student (CIMAT) co-directed with J. B. Hayet (CIMAT).
- [4] Emmanuel Ovalle Magallanes. Master student (CIMAT) co-directed with J. B. Hayet (CIMAT).
- [3] Salvador Botello Aceves. Master student (CIMAT) co-directed with I. Valdés (CIMAT).
- [2] E. Axel Palomares Ponce. Undergraduate student (ITL) co-directed with C. Esteves (U. de Guanajuato).
- [1] Daniel Rugerio Rugerio. Undergraduate student (BUAP) co-directed with C. Esteves (U. de Guanajuato).

Research Projects

- Navegación de robots móviles cinemáticamente complejos basada en una memoria visual. Responsible: H. M. Becerra. Jan. 2015 – Dec. 2017. Funded by **SEP-CONACyT grant 220796**, Mexico. Institution: CIMAT.
- TESSEO (TEams of robots for Service and SEcurity missiOns). Participation. Jan 2010 – Dic 2011. Funded by Ministerio de Educación y Ciencia of Spain. Institution: Universidad de Zaragoza.
- NERO (NEtworked RObots). Networked mobile robots for service and intervention tasks. Participation. Oct 2007 – Dec 2009. Funded by Ministerio de Educación y Ciencia of Spain. Institution: Universidad de Zaragoza.

- COLIBRI – Design, implementation and testing of a control system and navigation for a mini-helicopter robot. Participation. Oct 2004 – Oct 2005. Funded by Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología (Colciencias). Institutions: Universidad EAFIT and Cinvestav Guadalajara.

Awards and Grants

- Member **Level 1** of the National System of Researchers (SNI), Mexico, until December 2018.
- Grant of Banco Santander Central Hispano-U. Zaragoza for doctoral studies at University of Zaragoza, Spain. Support for 2.5 years from November 2007.
- Complementary grant by Consejo Nacional de Ciencia y Tecnología (CONACyT), Mexico, for doctoral studies at University of Zaragoza. Support for 3 years from October 2007.
- Mexican grant by CONACyT for master studies at CINVESTAV. Support for 2 years from September 2003.
- Award as one of the best students in electrical engineering in Mexico for the year 2003. Given by Asociación Nacional de Facultades y Escuelas de Ingeniería (ANFEI), Chihuahua, Mexico, August 2003.
- Medal of Honor as the best engineering student of the generation 2003 of the Instituto Tecnológico de Ciudad Guzmán, Ciudad Guzmán, Mexico, May 2003.

Academic and Research Stays

- Research stay at LASMEA (LABoratoire des Sciences et Matériaux pour l'Electronique et d'Automatique) of the Université Blaise Pascal / CNRS, Clermont-Ferrand, France. Supervised by Dr. Youcef Mezouar. Research on visual navigation of mobile robots employing the epipolar geometry. April-June, 2009.
- Academic stay at Centro de Ingeniería y Desarrollo Industrial (CIDESI), Querétaro, Mexico. *Third Summer School of Engineering*, organized by Sistema Nacional de Institutos Tecnológicos. July-August 2002.

Scientific Service Activities

- Co-organizer of the weekly seminar of the department of Computer Science of CIMAT since April 2014.
- Co-organizer of the 5th workshop on robotics and motion planning at CIMAT, February 5-6, 2014.
- Regular participant for scientific dissemination with conferences and workshops for primary and secondary school students at CIMAT.
- Member of the committee for the design of a new master program in Mechatronics Engineering in the Centro Universitario de los Valles (CUValles), University of Guadalajara. June-Dic, 2012.
- Member of the program committee of the Workshop on Visual Control of Mobile Robots (ViCoMor), editions 2011, 2012 and 2014.
- Member of the *Institute of Electrical and Electronics Engineers (IEEE)* since 2008.
- Regular reviewer for robotic's journals: IEEE Transaction on Robotics (IEEE T-RO), International Journal of Robotics Research (IJRR), Autonomous Robots (AURO) and Robotics and Autonomous Systems (RAS). Also, reviewer for Asian Journal of Control (AJC), International Journal of Intelligent Automation and Soft Computing (AutoSoft), IEEE Transactions on Automation Science and Engineering (TASE), IEEE Transactions on Cybernetics (CYB).
- Regular reviewer for the conferences: IEEE ICRA and IEEE/RSJ IROS, and additionally ViCoMor'11, ViCoMor'12, MICAI'12, PSVIT'13 and CLCA'14.

List of Publications

Journal papers:

- [11] J. Delfín, H. M. Becerra and G. Arechavaleta, "Visual servo walking control for humanoids with finite-time convergence and smooth robot velocities," In press in *International Journal of Control*, 2016. (I.F. 2014=1.654, Q2).

- [10] J. E. Machado, H. M. Becerra and M. Moreno-Rocha, "Modeling and finite-time walking control of a biped robot with feet," *Mathematical Problems in Engineering*, Vol. 2015, Article ID 963496, 17 pages, 2015. (I.F. 2014=0.762, Q3).
- [9] D. Jacobo, U. Ruiz, R. Murrieta-Cid, H. M. Becerra and J. L. Marroquin, "A visual feedback-based time-optimal motion policy for capturing an unpredictable evader," *International Journal of Control*, Vol. 88, No. 4, pages 663-681, Sept. 2014. (I.F. 2014=1.654, Q2).
- [8] H. M. Becerra, J.B. Hayet and C. Sagüés, "A single visual-servo controller of mobile robots with super-twisting control", *Robotics and Autonomous Systems*, Vol. 62, No. 11, pages 1623-1635, Aug. 2014. (I.F. 2014=1.256, Q2).
- [7] H. M. Becerra, C. Sagüés, Y Mezouar and J. B. Hayet, "Visual navigation of wheeled mobile robots using direct feedback of a geometric constraint", *Autonomous Robots*, Vol. 37, No. 2, pages 137-156, Aug. 2014. (I.F. 2014=2.066, Q2).
- [6] F. Jurado, G. Palacios, F. Flores and H. M. Becerra, "Vision-based trajectory tracking system for an emulated quadrotor UAV", *Asian Journal of Control*, Vol. 16, No. 3, pages 729--741, May 2014. (I.F. 2014=1.556, Q2).
- [5] H. M. Becerra, "Fuzzy visual control for memory-based navigation using the trifocal tensor", *International Journal of Intelligent Automation and Soft Computing (AutoSoft)*, Vol. 20, No. 2, pages 245-262, April 2014. (I.F. 2014=0.218, Q4).
- [4] H. M. Becerra and C. Sagüés, "Exploiting the trifocal tensor in dynamic pose estimation for visual control", *IEEE Transactions on Control Systems Technology*, Vol. 21, No. 5, pages 1931-1939, Sept. 2013. (I.F. 2013=2.521, Q1)
- [3] H. M. Becerra, G. López-Nicolás and C. Sagüés, "A sliding mode control law for mobile robots based on epipolar visual servoing from three views", *IEEE Transactions on Robotics*, Vol. 27, No. 1, pages 175-183, Feb. 2011. (I.F. 2011=2.536, Q1).
- [2] H. M. Becerra, G. López-Nicolás and C. Sagüés, "Omnidirectional visual control of mobile robots based on the 1d trifocal tensor", *Robotics and Autonomous Systems*, Vol. 58, No. 6, pages 796-808, June 2010. (I.F. 2010=1.313, Q2).
- [1] E. Sánchez, H. M. Becerra, C. M. Vélez, "Combining fuzzy, PID and regulation control for an autonomous mini-helicopter", *Information Sciences*, Vol. 177, No. 10, pages 1999-2022, May 2007. (I.F. 2007=2.147, Q1).

Submitted journal papers:

- [1] N. G. Aldana-Murillo, J. B. Hayet and H. M. Becerra. "Comparison of local descriptors for humanoid robots localization using a visual bag of words approach", submitted to *International Journal of Intelligent Automation and Soft Computing (AutoSoft)*, April 2015.

Books:

- [1] H. M. Becerra and C. Sagüés, "Visual Control of Wheeled Mobile Robots: Unifying Vision and Control in Generic Approaches", *Springer Tracts in Advanced Robotics 103*, B. Siciliano and O. Khatib (Eds.), ISBN 978-3-319-05782-8, Springer, 118 pages, April 2014. DOI: 10.1007/978-3-319-05783-5.

Book chapters:

- [3] N. G. Aldana-Murrillo, J. B. Hayet and H. M. Becerra, "Evaluation of local descriptors for vision-based localization of humanoid robots," *Lecture Notes in Computer Science 9116, Proc. of 7th Mexican Conference on Pattern Recognition (MCPR'15)*, J. A. Carrasco-Ochoa et al. (Eds.), Springer-Verlag, pages 179-189, 2015.
- [2] H. M. Becerra, J. B. Hayet and C Sagüés, "Virtual target formulation for singularity-free visual control using the trifocal tensor," *Lecture Notes in Computer Science 7914, Proc. of 5th Mexican Conference on Pattern Recognition (MCPR'13)*, J.A. Carrasco-Ochoa et al. (Eds.), Springer-Verlag, pages 30-39, 2013.
- [1] H. M. Becerra and C. Sagüés, "Sliding Mode Control for Visual Servoing of Mobile Robots using a Generic Camera", Chapter 12, *Sliding Mode Control*, A. Bartoszewicz (Ed.), ISBN: 978-953-307-370-5, INTECH, pages 221-236, April 2011.

Conference papers:

- [11] J. Delfín, H. M. Becerra and G. Arechavaleta, "Visual path following using a sequence of target images and smooth robot velocities for humanoid navigation", *IEEE/RAS International Conference on Humanoid Robots (ICHR'14)*, pages 354-359, Madrid, Spain, Nov. 2014.
- [10] J. E. Machado, H. M. Becerra y M. Moreno, "Control de un robot bípedo de 7 vínculos usando un algoritmo twisting", *Congreso Latinoamericano de Control Automático (CLCA'14)*, pages 892-898, Cancún, México, Oct. 2014.
- [9] J. Delfín, G. Arechavaleta y H. M. Becerra, "Locomoción humanoide basada en estrategias de control servo visual", *Congreso Latinoamericano de Control Automático (CLCA'14)*, pages 438-444, Cancún, México, Oct. 2014.
- [8] G. Laguna, R. Murrieta-Cid, H. M. Becerra, R. Lopez-Padilla and S. M. LaValle, "Exploration of an unknown environment with a differential drive disc robot", *IEEE Int. Conf. on Robotics and Automation (ICRA'14)*, pages 2527-2533, Hong Kong, China, June 2014.
- [7] H. M. Becerra and C. Sagüés, "Visual control for memory-based navigation using the trifocal tensor", *World Automation Congress (WAC'12)*, pages 1-6, Puerto Vallarta, Mexico, June 2012.
- [6] H. M. Becerra and C. Sagüés, "Dynamic pose-estimation from the epipolar geometry for visual servoing of mobile robots", *IEEE Int. Conf. on Robotics and Automation (ICRA'11)*, pages 417-422, Shanghai, China, May 2011.
- [5] H. M. Becerra, J. Courbon, Y. Mezouar and C. Sagüés, "Wheeled mobile robots navigation from a visual memory using wide field of view cameras", *IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS'10)*, pages 5693-5699, Taipei, Taiwan, Oct. 2010.
- [4] H. M. Becerra and C. Sagüés, "Pose-estimation-based visual servoing for differential-drive robots using the 1D trifocal tensor", *IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS'09)*, pages 5942-5947, St. Louis, MO, USA, Oct. 2009.
- [3] H. M. Becerra and C. Sagüés, "A novel 1D trifocal tensor-based control for differential-drive robots", *IEEE Int. Conf. on Robotics and Automation (ICRA'09)*, pages 1104-1109, Kobe, Japan, May 2009.
- [2] H. M. Becerra and C. Sagüés, "A sliding mode control law for epipolar visual servoing of differential-drive robots", *IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS'08)*, pages 3058-3063, Nice, France, Sept. 2008.
- [1] E. Sánchez, H. M. Becerra and C. M. Vélez, "Combining fuzzy and PID control for an unmanned helicopter", *North American Fuzzy Information Processing Society Annual Conference (NAFIPS'05)*, pages 235-240, Ann Arbor, MI, USA, June 2005.

Seminars and Workshops:

- [4] G. López-Nicolás, H. M. Becerra, M. Aranda, and C. Sagüés, "Visual navigation by means of three view geometry", *Workshop Robot 2011*, pages 17-24, Sevilla, Spain, November 2011.
- [3] H. M. Becerra, "Control visual robusto de robots móviles utilizando restricciones geométricas entre imágenes", *Seminar in CIMAT*, Guanajuato, Mexico, October 2011.
- [2] H. M. Becerra, G. López-Nicolás and C. Sagüés, "Weakly-calibrated visual control of mobile robots using the trifocal tensor and central cameras", *IEEE/RSJ IROS Workshop on Visual Control of Mobile Robots (ViCoMoR)*, pages 27-32, San Francisco, CA, Sept. 2011.
- [1] H. M. Becerra, "Employing robust control on visual servoing schemes for mobile robots", *Seminar in LASMEA*, Clermont-Ferrand, France, April 2009.

Artículos en congresos nacionales:

- [3] C. R. Vázquez, R. O. Domínguez y H. M. Becerra, "Maestría en Ingeniería Mecatrónica en línea y profesionalizante," *XIII Congreso Nacional de Ingeniería Electromecánica y de Sistemas (CNIES)*, IPN-Zacatenco, México, D.F., págs. 1--6, Noviembre de 2012
- [2] H. M. Becerra, "Avances recientes en el control de robots móviles usando visión artificial", *XII Semana Nacional de Investigación Científica*, Centro Universitario del Sur (CUSur), Universidad de Guadalajara, Ciudad Guzman, Mexico, November, 2011.
- [1] E. Sánchez, H. M. Becerra and C. M. Vélez, "Combining fuzzy, PID and regulation control for an unmanned helicopter", *International Seminar on Computational Intelligence*, pages 18-31, Mexico City, Mexico, October 2005.