Pedro Miraldo

Last updated on March 25, 2024

Activities

[2022-] **Principal Research Scientist**, at MERL Mitsubishi Electric Research Labs, Cambridge;

[2019-2022] **Assistant Research Professor** (*Inv. Aux.*), at "Instituto Superior Técnico, Lisboa";

[2018-2019] **Post-Doctoral Associate**, at KTH Royal Institute of Technology, Stockholm;

[2014-2018] **Post-Doctoral Researcher**, at "Instituto Superior Técnico, Lisboa";

Education

[2009-2013] **PhD degree** at the University of Coimbra (ECE);

[2007-2008] **MSc degree** at the University of Coimbra (ECE);

[2003-2007] **BSc degree** at the University of Coimbra (ECE);

Awards

[2023] **ATC-M**, Development of location-based system technologies for ADAS/Autonomous;

[2018] **Outstanding Reviewer Award**, Computer Vision and Image Understanding (CVIU);

[2003-2008] **Academic merit (<u>four times</u> – years 2004/2005, 2005/2006, 2006/2007, and 2007/2008)**, Name of the award: "Prémio 3% dos Melhores Estudantes" (best 3% student award).;

Research Grants

[2016-2022] **Individual Post-Doctoral grant**: Awarded by the Portuguese Foundation for Science and Technilogy (FCT), Reference: `SFRH/BPD/111495/2015`;

[2009-2013] **PhD grant**: Awarded by the Portuguese Foundation for Science and Technology (FCT), Reference: `SFRH/BD/49054/2008`;

Research

Publications

Top Conference and Journal papers

[T40] Xinhang Liu, Yu-Wing Tai, Chi-Keung Tang, **Pedro Miraldo**, Suhas Lohit, and Moitreya Chatterjee. "Gear-NeRF: Free-Viewpoint Rendering and Tracking with Motion-aware Spatio-Temporal Sampling". In: *IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR)*. doi. 2024.

[T39]   Arihant Gaur, G. Dias Pais, and **Pedro Miraldo**. "Oriented-grid Encoder for 3D Implicit Representations". In: *Int'l Conf. 3D Vision (3DV)*. [*arXiv:2402.06752*,doi]. 2023.

[T38]   Valter Piedade and **Pedro Miraldo**. "BANSAC: A dynamic BAyesian Network for adaptive SAmple Consensus". In: *IEEE/CVF Int'l Conf. Computer Vision (ICCV)*. [*arXiv:2309.08690*,doi]. 2023.

[T37]   Fabien Delattre, Dave Dirnfeld, Phat Nguyen, Stephen Scarano, **Mike Jones**, Pedro Miraldo, and Erik Learned-Miller. "Robust Frame-to-Frame Camera Rotation Estimation in Crowded Scenes". In: *IEEE/CVF Int'l Conf. Computer Vision (ICCV)*. [*arXiv:2309.08588*,doi]. 2023.

[T36]   Andre Mateus, Siddhant Ranade, Srikumar Ramalingam, and **Pedro Miraldo**. "Fast and Accurate 3D Registration from Line Intersections Constraints". In: *Int'l J. Computer Vision (IJCV)* 131 (2023). [doi], pp. 2044–2069.

[T35]   **Pedro Miraldo** and José Iglesias. "A Unified Model for Line Projections in Catadioptric Cameras with Rotationally Symmetric Mirrors". In: *IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR)*. [doi]. 2022, pp. 15776–15785.

[T34]   André Mateus, Pedro U. Lima, and **Pedro Miraldo**. "An observer cascade for velocity and multiple line estimation". In: *IEEE Int'l Conf. Robotics and Automation (ICRA)*. [*arXiv:2203.01879*,doi]. 2022, pp. 9418–9424.

[T33]   João R. Cardoso and **Pedro Miraldo**. "Solving the discrete Euler–Arnold equations for the generalized rigid body motion". In: *Journal of Computational and Applied Mathematics (CAM)* 402 (2022). [*arXiv:2109.00505*, doi], p. 113814.

[T32]   André Mateus, Omar Tahri, A. Pedro Aguiar, Pedro U. Lima, and **Pedro Miraldo**. "On Incremental Structure-from-Motion using Lines". In: *IEEE Trans. Robotics (T-RO)* 38.1 (2022). [*arXiv:2105.11196*, doi], pp. 391–406.

[T31]   Siddhant Ranade, Yu Xin, Shantnu Kakkar, **Pedro Miraldo**, and Srikumar Ramalingam. "Mapping of Sparse 3D Data using Alternating Projection". In: *Asian Conf. Computer Vision (ACCV)*. [*arXiv:2010.02516*,doi] – **Oral presentation**. 2020, pp. 295–313.

[T30]   Pedro Roque, Elisa Bin, **Pedro Miraldo**, and Dimos V. Dimarogonas. "Fast Model Predictive Image-Based Visual Servoing for Quadrotors". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [doi]. 2020, pp. 7566–7572.

[T29]   **Pedro Miraldo** and João R. Cardoso. "On the Generalized Essential Matrix Correction: An efficient solution to the problem and its applications". In: *Journal of Mathematical Imaging and Vision (JMIV)* 62 (2020). [*arXiv:1709.06328*, doi], pp. 1107–1120.

[T28]   André Mateus, Srikumar Ramalingam, and **Pedro Miraldo**. "Minimal Solvers for 3D Scan Alignment with Pairs of Intersecting Lines". In: *IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR)*. [doi]. 2020, pp. 7232–7242.

[T27]   G. Dias Pais, Srikumar Ramalingam, Venu Madhav Govindu, Jacinto C. Nascimento, Rama Chellappa, and **Pedro Miraldo**. "3DRegNet: A Deep Neural Network for 3D Point Registration". In: *IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR)*. [*arXiv:1904.01701*,doi]. 2020, pp. 7191–7201.

[T26]   R. T. Rodrigues, **P. Miraldo**, D. V. Dimarogonas, and A. P. Aguiar. "Active Depth Estimation: Stability Analysis and its Applications". In: *IEEE Int'l Conf. Robotics and Automation (ICRA)*. [*arXiv:2003.07137*,doi]. 2020, pp. 2002–2008.

[T25]   P. U. Lima et al. "SocRob@Home Integrating AI Components in a Domestic Robot System". In: *Künstliche Intelligenz (KI)* 33.4 (2019). [doi], pp. 343–356.

[T24] R. Rodrigues, **P. Miraldo**, D. V. Dimarogonas, and A. P. Aguiar. "A Framework for Depth Estimation and Relative Localization of Ground Robots using Computer Vision". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [*arXiv:1908.00309*, doi]. 2019, pp. 3719–3724.

[T23] **P. Miraldo**, S. Saha, and S. Ramalingam. "Minimal Solvers for Mini-Loop Closures in 3D Multi-Scan Alignment". In: *IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR)*. [*arXiv:1904.03941*, doi]. 2019, pp. 9691–9700.

[T22] G. Pais, J. C. Nascimento, and **P. Miraldo**. "OmniDRL: Robust Pedestrian Detection using Deep Reinforcement Learning on Omnidirectional Cameras". In: *IEEE Int'l Conf. Robotics and Automation (ICRA)*. [*arXiv:1903.00676*, doi]. 2019, pp. 4782–4789.

[T21] J. Campos, J. R. Rodrigues, and **P. Miraldo**. "POSEAMM: A Unified Framework for Solving Pose Problems using an Alternating Minimization Method". In: *IEEE Int'l Conf. Robotics and Automation (ICRA)*. [*arXiv:1904.04858*, doi]. 2019, pp. 3493–3499.

[T20] A. Mateus, D. Ribeiro, **P. Miraldo**, and J. C. Nascimento. "Efficient and Robust Pedestrian Detection using Deep Learning for Human-Aware Navigation". In: *Robotics and Autonomous Systems (RAS)* 113 (2018). [*arXiv:1607.04441*, doi], pp. 23–37.

[T19] **P. Miraldo**, T. Dias, and S. Ramalingam. "A Minimal Closed-Form Solution for Multi-Perspective Pose Estimation using Points and Lines". In: *European Conf. Computer Vision (ECCV)*. [*arXiv:1807.09970*, doi]. 2018, pp. 490–507.

[T18] A. Mateus, O. Tahri, and **P. Miraldo**. "Active Structure-from-Motion for 3D Straight Lines". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [*arXiv:1807.00753*, doi]. 2018, pp. 5819–5825.

[T17] **P. Miraldo**, F. Eiras, and S. Ramalingam. "Analytical Modeling of Vanishing Points and Curves in Catadioptric Cameras". In: *IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR)*. [*arXiv:1804.09460*, doi]. 2018, pp. 2012–2021.

[T16] R. Rodrigues, M. Basiri, A. P. Aguiar, and **P. Miraldo**. "Low-level Active Visual Navigation: Increasing robustness of vision-based localization using potential fields". In: *IEEE Robotics and Automation Letters (RA-L) and IEEE Int'l Conf. Robotics and Automation (ICRA)* 3.3 (2018). [*arXiv:1801.07249*, doi], pp. 2079–2086.

[T15] X. Liu, Z. Li, K. Zhong, Y. Chao, **P. Miraldo**, and Y. Shi. "Generic distortion model for metrology under optical microscopes". In: *Optics and Lasers in Engineering (OLEN)* 103 (2018). [doi], pp. 119–126.

[T14] J. Iglésias, **P. Miraldo**, and R. Ventura. "Towards an Omnidirectional Catadioptric RGB-D Camera". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [doi]. 2016, pp. 2506–2513.

[T13] T. Veiga, **P. Miraldo**, R. Ventura, and P. Lima. "Efficient Object Search for Mobile Robots in Dynamic Environments: Semantic Map as an Input for the Decision Maker". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [doi]. 2016, pp. 2745–2750.

[T12] X. Liu, Z. Li, **P. Miraldo**, K. Zhong, and Y. Shi. "A framework to calibrate the scanning electron microscope under any magnifications". In: *IEEE Photonics Technology Letters (PT-L)* 28.16 (2016). [doi], pp. 1715–1718.

[T11] T. Dias, **P. Miraldo**, and N. Gonçalves. "A Framework for Augmented Reality using Non-Central Catadioptric Cameras". In: *Springer J. Intelligent & Robotic Systems (JINT)* 83.3 (2016). [doi], pp. 359–373.

[T10] F. Amigoni et al. "Competitions for Benchmarking: Task and Functionality Scoring Complete Performance Assessment". In: *IEEE Robotics Automation Magazine (RA-M)* 22.3 (2015). [doi], pp. 53–61.

[T9] T. Dias, **P. Miraldo**, N. Gonçalves, and P. Lima. "Augmented Reality on Robot Navigation using Non-Central Catadioptric Cameras". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [doi]. 2015, pp. 4999–5004.

[T8] **P. Miraldo** and H. Araujo. "Pose Estimation for Non-Central Cameras Using Planes". In: *Springer J. Intelligent & Robotic Systems (JINT)* 80.3 (2015). [doi], pp. 595–608.

[T7] **P. Miraldo** and H. Araujo. "Generalized Essential Matrix: Properties of the Singular Value Decomposition". In: *Image and Vision Computing (IVC)* 34 (2015). [doi], pp. 45–50.

[T6] **P. Miraldo**, H. Araujo, and N. Gonçalves. "Pose Estimation for General Cameras Using Lines". In: *IEEE Trans. Cybernetics (T-CYB)* 45.10 (2015). [doi], pp. 2156–2164.

[T5] **P. Miraldo** and H. Araujo. "Direct Solution to the Minimal Generalized Pose". In: *IEEE Trans. Cybernetics (T-CYB)* 45.3 (2015). [doi], pp. 404–415.

[T4] **P. Miraldo** and H. Araujo. "Planar Pose Estimation for General Cameras using Known 3D Lines". In: *IEEE/RSJ Int'l Conf. Intelligent Robots and Systems (IROS)*. [doi]. 2014, pp. 4234–4240.

[T3] **P. Miraldo** and H. Araujo. "A Simple and Robust Solution to the Minimal General Pose Estimation". In: *IEEE Int'l Conf. Robotics and Automation (ICRA)*. [doi]. 2014, pp. 2119–2125.

[T2] **P. Miraldo** and H. Araujo. "Calibration of Smooth Camera Models". In: *IEEE Trans. Pattern Analysis and Machine Intelligence (T-PAMI)* 35.9 (2013). [doi], pp. 2091–2103.

[T1] **P. Miraldo**, H. Araujo, and J. Queiró. "Point-based Calibration Using a Parametric Representation of General Imaging Models". In: *IEEE/CVF Int'l Conf. Computer Vision (ICCV)*. [doi]. 2011, pp. 2304–2311.

Book Chapters

[B2] Helder Jesus Araujo, **Pedro Miraldo**, and Nathan Crombez. "Omnidirectional Vision". In: John Wiley & Sons, 2023. Chap. Localization and Navigation with Omnidirectional Images. ISBN: 978-1-394-25643-3.

[B1] L. Iocchi, G. Kraetzschmar, D. Nardi, P. U. Lima, **P. Miraldo**, and E. Bastianelli. "RoCKIn – Benchmarking Through Robot Competitions". In: IntechOpen, 2017. Chap. RoCKIn@Home: Domestic Robots Challenge. ISBN: 978-953-51-3374-2.

Other Conferences

[C13] Yuri Shimane, **Pedro Miraldo**, Karl Berntorp, Marcus Greiff, and Avishai Weiss. "High-Fidelity Simulation of Horizon-Based Optical Navigation with Open-Source Software". In: *International Astronautical Congress (IAC)*. [merl-tr]. 2023.

[C12] Karl Berntorp, Marcus Greiff, Stefano Di Cairano, and **Pedro Miraldo**. "Bayesian Sensor Fusion for Joint Vehicle Localization and Road Mapping Using Onboard Sensors". In: *Int'l Conf. on Information Fusion (FUSION)*. [doi]. 2023, pp. 1–8.

[C11] A. Mateus, O. Tahri, and **P. Miraldo**. "Active Estimation of 3D Lines in Spherical Coordinates". In: *American Control Conf. (ACC)*. [*arXiv:1902.00473*, doi]. 2019, pp. 3950–3955.

[C10] R. Rodrigues, M. Basiri, A. P. Aguiar, and **P. Miraldo**. "Feature Based Potential Field for Low-level Active Visual Navigation". In: *Iberian Robotics Conf. (ROBOT)*. [*arXiv:1709.04687*,doi]. 2017, pp. 791–800.

[C9] D. Ribeiro, A. Mateus, **P. Miraldo**, and J. C. Nascimento. "A Real-Time Deep Learning Pedestrian Detector for Robot Navigation". In: *IEEE Int'l Conf. on Autonomous Robot Systems and Competitions (ICARSC)*. [*arXiv:1607.04436*,doi]. 2017, pp. 165–171.

[C8] T. Dias, H. Araujo, and **P. Miraldo**. "3D Reconstruction with Low-Resolution, High Radial Distortion Stereo Images". In: *ACM Int'l Conf. on Distributed Smart Cameras (ICDSC)*. [*arXiv:1709.06451*,doi]. 2016, pp. 98–103.

[C7] J. Cardoso, **P. Miraldo**, and H. Araujo. "Plcker correction problem: Analysis and improvements in efficiency". In: *IEEE Int'l Conf. Pattern Recognition (ICPR)*. [*arXiv:1602.05990*,doi]. 2016, pp. 2796–2801.

[C6] R. Ventura, M. Basiri, A. Mateus, J. Garcia, **P. Miraldo**, P. Santos, and P. U. Lima. "A Domestic Assistive Robot Developed Through Robotic Competitions". In: *WS Autonomous Mobile Service Robots, joint with Int'l Joint Conference on Artificial (IJCAI)*. 2016.

[C5] A Mateus, **P. Miraldo**, P. Lima, and J. Sequeira. "Human-Aware Navigation using External Omnidirectional Cameras". In: *Iberian Robotics Conf. (ROBOT)*. [doi]. 2015, pp. 283–295.

[C4] Tiago Dias, **Pedro Miraldo**, and Nuno Goncalves. "A Framework for Augmented Reality using Non-Central Catadioptric Cameras". In: *IEEE Int'l Conf. on Autonomous Robot Systems and Competitions (ICARSC)*. [doi]. 2015, pp. 213–220.

[C3] **Pedro Miraldo** and Helder Araujo. "Pose Estimation for Non-Central Cameras Using Planes". In: *IEEE Int'l Conf. on Autonomous Robot Systems and Competitions (ICARSC)*. [doi]. 2014, pp. 104–109.

[C2] **Pedro Miraldo** and Helder Araujo. "Improving the Resolution of the Generic Camera Model by Means of a Parametric Representation". In: *Portuguese Conf. Automatic Control (CONTROLO)*. 2010.

[C1] **Pedro Miraldo** and Helder Araujo. "Gestures Interpretation Using Computer Vision for Human-Machine Interaction". In: *Portuguese Conf. Pattern Recognition (RECPAD)*. 2008.

Research Impact

Invited Talks

[04/2021]: Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA;
Title: **Localization and Mapping: 3D Registration, Omnidirectional cameras, and Active SfM**;

[06/2019]: Microsoft Research, HoloLens team, Zurich;
Title: **Robust Pose Estimation: Multi-perspective absolute pose and 3D Scan Alignment**;

[01/2019]: Ericsson Research, Kista, Stockholm;
Title: **Non-Conventional Imaging Devices and their Applications in Robotics**;

[03/2018]: KTH Royal Institute of Technology, Stokholm, Department of Automatic Control;
Title: **Non-Conventional Imaging Devices and their Applications in Robotics**;

Principal Investigator (PI) in Research Projects

[2020-2023] **STORESLAM:** Accurate Agent Localization and Mapping Methods for Structured Indoor Retail Store Environments [`link`];

Participation in Research Projects

[2016-2018] **RockEU2:** Robotics coordination action for Europe two [`link`];

[2014-2015] **RoCKIn:** Robot competitions kick innovation in cognitive systems and robotics [`link`];

[2018-2019] **COIN:** Co-adaptive human-robot interactive systems [`link`];

[2016-2019] **HaRoDE:** Human-aware service robots for domestic environments [`link`];

[2014-2016] **SocRob:** Soccer Robots and Society of Robots [`link`];

[2013-2014] "Novas Tecnologias para apoio à Saúde e Qualidade de Vida: Projecto A-Cirurgia e Diagnóstico Assistido por Computador Usando Imagem";

[2012-2015] Calibration and 3D Reconstruction in Omnidirectional Catadioptric Systems [`link`];

[2011-2012] Automatic heart scan with ultrasound using visual servoing techniques;

[2010-2013] **UniProjection:** Unified Projection Model of Non SVP Systems – Application to Endoscopy and Graphics [`link`];

Teaching and Supervision

Teaching and Supervision

[2021-2022] **Artificial Intelligence and Decision Systems** (ECE,DCE,AerE);

[2020-2021] **Artificial Intelligence and Decision Systems** (ECE,DCE,AerE);

[2017-2018] **Computer Graphics** (CS&E);

[2016-2017] **Algorithms & Data Structures** (ECE);

[2015-2016] **Automatic Control** (ECE);

[2014] **Computer Vision; and Mobile Robotics** (ECE);

Students

Completed PhD

#1: **André Mateus** (2017-2021): *On the Exploitation of 3D Straight Lines for Active Mapping and Camera Localization*. Distinction and Honour by unanimity (the highest grade)

Ongoing PhD

#2: **G. Dias Pais** (2020-): *All SLAM leads to Rome: Localize and Map Dynamic Environments with 3D Sensors and Semantic Information*.

#3: **Valter Piedade** (2022-): *Real-time SLAM in Indoor Environments*.

#4: **Andre Nogueira** (2023-): *Online Visual-Inertial Framework for Navigation*.

Interns

#1: **Fabien Delattre** (2023);

#2: **Jiachen Liu** (2023);

#3: **G. Dias Pais** (2022);

#4: **Arihant Gaur** (2022);

#5: **Arihant Gaur** (2021-2022);

Other Research Grants (Graduate and Undergraduate)

#6: **Luis Lopes** (2020-2021);

#7: **Valter Piedade** (2020-2021);

#8: **G. Dias Pais** (2018-2019);

#9: **João Campos** (2017-2018);

#10: **Tiago Dias** (2015-2019);

#11: **Francisco Eiras** (2017-2018);

#12: **Rômulo Rodrigues** (2016-2017);

#13: **José Iglesias** (2015-2017);