

# Roberto Mecca

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## Curriculum Vitae

### Research Interests

#### **Main research topics in computer vision and graphics:**

- modeling and computational techniques for inverse problems in computer vision
- theoretical and physical aspects of the acquisition of images
- deep learning for 3D shape reconstruction using computer graphics generated training datasets
- reinforcement learning for autonomous visual navigation
- highly accurate 3D surface reconstruction using Photometric Stereo and Polarization
- 3D shape reconstruction using multi-view stereo

### Employment

January 2019 – Senior Research Scientist  
present

Supervisor Professor Roberto Cipolla

Institution Toshiba Europe Ltd

Description Development of 3D scanning methods along with hardware engineering of working prototypes

June 2018 – Postdoctoral Research Fellow  
December 2018

Supervisor Professors Lorenzo Rosasco, Giorgio Metta, Lorenzo Natale

Institution Laboratory for Computational and Statistical Learning, Istituto Italiano di Tecnologia, Italy

Description Development of machine learning algorithm for applications in robotics and vision, theory and implementation. Incremental learning and kernel based approaches.

December 2017 Research Associate  
– May 2018

Supervisor Professor Roberto Cipolla

Institution Department of Engineering, University of Cambridge, United Kingdom

Description Photometric Stereo problem using highly non-linear irradiance equations.

December 2015 Marie Curie Research Fellow of the INdAM, Italy

– Novemb 2017 INdAM COFUND 2012 - Grant Agreement Number 600198

Supervisor Professor Roberto Cipolla and Professor Fiorella Sgallari

*Toshiba Europe Ltd – Cambridge Research Laboratory, United Kingdom*

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- Institution Department of Engineering, University of Cambridge, United Kingdom and Department of Mathematics, University of Bologna
- Description Combining Diffuse and Specular reflection into a single framework based on hyperbolic PDEs related to the 3D shape reconstruction with the Photometric Stereo technique. New differential approaches for the Shape from Polarization and Defocusing problems.
- February - November 2015 Postdoctoral Research Fellow
- Supervisor Professor Fiorella Sgallari
- Institution Department of Mathematics, University of Bologna, Italy
- Description Numerical analysis of new approach to the (Uncalibrated) Photometric Stereo problem. Fractional derivative operators. Novel numerical approach to high order generalized Grünwald-Letnikov type of formula for fractional derivative.
- 2013 - 2015 Postdoctoral Research Fellow
- Supervisor Professor Vittorio Murino and Alessio Del Bue
- Institution Department of Pattern Analysis and Computer Vision, Italian Institute of Technology, Italy
- Description Shape from Photometric Stereo with bias of ambient light. Shape from Uncalibrated Photometric Stereo and Shape from Polarization.
- 2012 - 2013 Postdoctoral Research Fellow
- Supervisor Professors Alfred Marcel Bruckstein and Ron Kimmel
- Institution Department of Computer Science, Technion - Israel Institute of Technology, Israel
- Description New models for the Perspective Shape from Shading problem solved using Photometric Stereo technique and related Numerical Methods for Non-Linear Partial Differential Equations.
- 2011 - 2012 Postdoctoral Research Fellow
- Supervisor Professor Maurizio Falcone
- Institution Department of Mathematics, Sapienza - University of Rome, Italy
- Description Numerical Methods for Non-Linear Partial Differential Equations. Numerical analysis for hyperbolic partial differential equations applied to Shape from Shading problem and granular flow.

## Education

- 2007 - 2011 PhD Student
- Advisor Professor Maurizio Falcone
- Institution Department of Mathematics, Sapienza - University of Rome, Italy
- Description 3D shape recovery from digital images using Photometric Stereo, system of non-linear PDE of the Hamilton-Jacobi type.

2005 - 2007 Undergraduate Student  
Advisor Professor Maurizio Falcone  
Institution Department of Mathematics, Sapienza - University of Rome, Italy  
Description A Variational Approach to the Image Warping and Applications. Interpolation with radial basis functions used for the deformation of digital images.

## Industrial Experiences

2007 **Digital Video** - cartoon animation, Rome, Italy  
Activity Research and implementation of image warping algorithm for a special effect option for the development of the software "Toonz 5.1".

## Awards and Funding

2015–2017 Marie Curie Fellowship of the INdAM (Italian Institute of Advanced Mathematics)  
2007–2011 Italian Government scholarship for the Ph.D. course in Applied Mathematics

## Publications

### Peer Reviewed Journal Papers

- (1) F. Logothetis, **R. Mecca**, F. Sgallari and R. Cipolla, A Differential Approach to Shape from Polarisation: a Level-Set Characterisation, *International Journal of Computer Vision*, 2019.
- (2) Y. Quèau, **R. Mecca**, J.D. Durou, X. Descombes, Photometric Stereo with Only Two Images: A Theoretical Study and Numerical Resolution, *Image and Vision Computing*, Vol. 57, pp. 175-191, 2017.
- (3) **R. Mecca**, Y. Quèau, F. Logothetis and R. Cipolla, A Single Lobe Photometric Stereo Approach for Heterogeneous Material, *SIAM Journal on Imaging Sciences*, Vol. 9, No. 4, pp. 1858-1888, 2016.
- (4) S. Tozza, **R. Mecca**, M. Duocastella and A. Del Bue, Direct Differential Photometric Stereo Shape Recovery of Diffuse and Specular Surfaces, *Journal of Mathematical Imaging and Vision*, Vol. 56, No. 1, Page 57, 2016.
- (5) **R. Mecca**, E. Rodolà and D. Cremers, Realistic photometric stereo using partial differential irradiance equation ratios, *Computers & Graphics*, Vol. 51, pp. 8-16, 2015.
- (6) **R. Mecca**, A. Wetzler, A. M. Bruckstein and R. Kimmel, Near Field Photometric Stereo with Point Light Sources, *SIAM Journal on Imaging Sciences*, Vol. 7, No. 4, pp. 2732-2770, 2014.
- (7) **R. Mecca**, A. Tankus, A. Wetzler and A. M. Bruckstein, A Direct Differential Approach to Photometric Stereo with Perspective Viewing, *SIAM Journal on Imaging Sciences*, Vol. 7, No. 2, pp. 579-612, 2014.
- (8) **R. Mecca** and M. Falcone, Uniqueness and approximation of a Photometric Shape-from-Shading model, *SIAM Journal on Imaging Sciences*, Vol. 6, No. 1, pp. 616-659, 2013.

### Book Chapters

- (1) **R. Mecca** and S. Tozza, Shape Reconstruction of Symmetric Surfaces using Photometric Stereo, In book: *Innovations for Shape Analysis*, Publisher: Springer Berlin Heidelberg, Editors: Breuß, Michael and Bruckstein, Alfred and Maragos, Petros, pp.219-243 (2013).

## Peer Reviewed Conference Publications

- (1) F. Logothetis, I. Budvytis, **R. Mecca**, R. Cipolla, A CNN Based Approach for the Near-Field Photometric Stereo Problem, British Machine Vision Conference, 2020, **Best Industry Paper Award**
- (2) S.D. Morad, **R. Mecca**, R.P.K. Poudel, S. Liwicki, R. Cipolla, Embodied Visual Navigation with Automatic Curriculum Learning in Real Environments, arXiv preprint arXiv:2009.05429
- (3) F. Logothetis, I. Budvytis, **R. Mecca**, R. Cipolla, PX-NET: Simple, Efficient Pixel-Wise Training of Photometric Stereo Networks, arXiv preprint arXiv:2008.04933
- (4) **R. Mecca**, F. Logothetis and R. Cipolla, A Differential Approach to Shape from Polarisation, *Proceedings of the British Machine Vision Conference (BMVC 2017)*, London, UK, September 4 - 7, 2017.
- (5) F. Logothetis, **R. Mecca** and R. Cipolla, Semi-calibrated Near Field Photometric Stereo, *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2017)*, Hawaii, USA, July 22 - 25, 2017.
- (6) F. Logothetis, **R. Mecca**, Y. Quèau and R. Cipolla, Near-Field Photometric Stereo in Ambient Light, *Proceedings of the British Machine Vision Conference (BMVC 2016)*, York, UK, September 19 - 22, 2016.
- (7) Y. Quèau, **R. Mecca** and J.D. Durou, Unbiased Photometric Stereo for Colored Surfaces: A Variational Approach, *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2016)*, Las Vegas, USA, June 26 - July 1, 2016.
- (8) **R. Mecca** and Y. Quèau, Unifying Diffuse and Specular Reflections for the Photometric Stereo Problem, *Proceedings of IEEE Winter Conference on Applications of Computer Vision (WACV 2016)*, Lake Placid, USA, March 7-9, 2016.
- (9) **R. Mecca**, E. Rodolà and D. Cremers, Analysis of surface parametrizations for modern photometric stereo modeling, *Proceedings of the Twelfth International Conference on Quality Control by Artificial Vision (QCAV 2015)*, Le Creusot, France, June 3-5, 2015;
- (10) A. Wetzler, **R. Mecca**, A. M. Bruckstein and R. Kimmel, Close-range Photometric Stereo with Point Light Sources, *Proceedings of 3D Vision Conference (3DV 2014)*, Tokyo, Japan, December 8-11, 2014;
- (11) **R. Mecca**, A. Wetzler, R. Kimmel, and A. M. Bruckstein, Direct Shape Recovery from Photometric Stereo with Shadows, *Proceedings of 3D Vision Conference (3DV 2013)*, Seattle, United States, June 29-July 1, 2013;
- (12) **R. Mecca**, G. Rosman, R. Kimmel, and A. M. Bruckstein, Perspective Photometric Stereo with Shadows, *Proceedings of the 4th International Conference on Scale Space and Variational Methods in Computer Vision (SSVM 2013)*, Leibnitz, Austria, June 2-6, 2013;
- (13) **R. Mecca**, A. Tankus and A. M. Bruckstein, Two-Image Perspective Photometric Stereo using Shape-from-Shading, *Proceedings of the 11th Asian Conference on Computer Vision (ACCV 2012)*, Daejeon, South Korea, November 5-9, 2012;
- (14) S. Larnier and **R. Mecca**, Fractional-Order Diffusion for Image Reconstruction, *Proceedings of the 2012 IEEE International Conference on Acoustic Speech and Signal (ICASSP 2012)*, Kyoto, Japan, March 25-30, 2012;
- (15) **R. Mecca**, Uniqueness for Shape from Shading via Photometric Stereo Technique, *in the Proceeding of the 2011 IEEE International Conference on Image Processing (ICIP 2011)*, Brussels, Belgium, September 11-14, 2011, pp. 2994-2997;
- (16) **R. Mecca** and J.D. Durou, Unambiguous Photometric Stereo Using Two Images, *in G. Maino and G.L. Foresti (Eds.), Image Analysis and Processing, ICIAP 2011, 16th International Conference*

on *Image Analysis and Processing, Ravenna, Italy, September 14-16, 2011. Lectures Notes on Computer Science, Volume 6978, pp. 286-295, Springer, 2011.*

## Patents

- Title 3D shape recovery from photometric stereo with shadows - Technion, Israel Institute of Technology  
Patent application no. WO2015036994A1
- Title Task performing agent system methods, Toshiba Europe Ltd  
Patent application no. 2014285.7
- Title A computer vision method and system, Toshiba Europe Ltd  
Patent application no. 2012490.5
- Title System and method for performing 3D imaging of an object, Toshiba Europe Ltd  
Patent application no. 1911354.7

## Reviewing Activity for Scientific Journals

American Mathematical Society  
Nature Scientific Reports  
International Journal of Computer Vision  
Journal of Mathematical Imaging and Vision  
IEEE Transactions on Image Processing

## Computer skills

- Computer Programming C, MatLab, PYTHON
- Computer Graphics Blender
- Operative System Mac OS X, Linux, Microsoft Windows
- Text Editing L<sup>A</sup>T<sub>E</sub>X, OpenOffice, Microsoft Office, Pages, Keynote, Numbers
- Image/Video Editing Final Cut Pro, Adobe Illustrator, After Effects, Photoshop, Muse

## Soft Skills

- Team building and leadership skills, mentorship/coaching strategies proven throughout the supervision of students
- Excellent communication techniques
- Ability to prioritize and meet deadlines as needed, as well as coordinate the group activities juggling multiple tasks effectively

## Languages

Italian Native speaker

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English Fluent in writing and speaking  
French Basic knowledge

## Interests

- Trumpet
- Classic Music
- First Person View (FPV) Quadcopters
- Football
- Cinema
- Cycling