Giacomo Boracchi

Name	Giacomo Boracchi
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Position and Education

Record of Employment

March 2008 – present

Temporary research assistant at Dipartimento di Elettronica e Informazione of Politecnico di Milano

- working on "Intelligent mechanisms for the identification and classification of faults and nonstationarities in sensor/actuator networks" (March 2012 – present)
- working on "Design and Development of algorithms for detecting non-stationarities in signals and images" (March 2011 – February 2012).
- working on "Design and Development of reconstruction algorithms for multiview, possibly calibrated, imaging systems" (March 2008 – February 2011).

March 2005 – February 2008

PhD student at Dipartimento di Elettronica e Informazione of Politecnico di Milano. PhD thesis title "Motion Blur: Analysis and Restoration".

September 2004 – February 2005

Temporary research assistant at TICSP, Tampere International Centre for Signal Processing, Tampere, Finland, working on "Adaptive Filtering Techniques for Image Denoising".

Education

- European Ph.D. in Information Technology at Politecnico di Milano. May 2008.
  Title: *Motion Blur: Analysis and Restoration*.
  Advisor: *V. Caglioti* (Politecnico di Milano).
  Reviewers: *A. Gotchev* (Tampere University of Technology) and *R. Creutzburg* (Brandenburg University of Applied Sciences).
- M.Sc. in Mathematics, at Universitá degli Studi di Milano. April 2004. Grade: 108/110.
  (Thesis title: *Basi Biortogonali di Ondine e Schema di Lifting in* $L^2(\mathbb{R})$, Advisor *M. Salvatori*)
- Scientific high school diploma from Liceo Scientifico G.B. Vico. 1998. Grade: 56/60.

Visiting Experiences

- Visiting Research Fellow at Department of Signal Processing, Tampere University of Technology (July 2013 - August 2013).
- Visiting PhD student at Department of Signal Processing, Tampere University of Technology (July 2007 - October 2007).
- Research collaborations concerning image and video restoration are carried out with regular visits at the Computational Imaging Group in the Department of Signal Processing, Tampere University of Technology, visits since January 2008.

SCHOLARSHIPS

- Grant from C.I.M.O. (Center for International Mobility), Finland (July 2007 - October 2007).
- Awarded an INTAS grant for attending at the 16th Jyväskylä Summer School, Jyväskylä, Finland (July 2006).
- PhD Scholarship from MIUR (March 2005 - February 2008).

Teaching Activity

Since 2005, I have been teaching assistant and laboratory supervisor for several courses at Politecnico di Milano, since 2012 I have been contract professor for one course (7 cfu). Detailed list of courses follows.

2013-2014

Informatica B (*Contract Professor*) - Mechanical and Energy Engineering - Undergraduate level.

2012-2013

Informatica B (*Contract Professor*) - Mechanical and Energy Engineering - Undergraduate level.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Undergraduate level.

2011-2012

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Undergraduate level.

Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Undergraduate level.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

Computer Vision (*Teaching assistant*) - Computer Engineering (CO) - Undergraduate level.

Informatica A (per gestionali) (*Lab. supervisor*) - Management and Production Engineering - Undergraduate level.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Undergraduate level.

2010-2011

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Undergraduate level.

Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Undergraduate level.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

Computer Vision (*Teaching assistant*) - Computer Engineering (CO) - Undergraduate level.

Informatica A (per gestionali) (*Lab. supervisor*) - Management and Production Engineering - Undergraduate level.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Undergraduate level.

Control Centre Management: Data Transmission, Analysis and Design for Intelligent Alerting Systems (*Teaching assistant*) - Management and Production Engineering (LC) - Undergraduate level.

2009-2010

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Undergraduate level.

Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Undergraduate level.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

Computer Vision (*Teaching assistant*) - Computer Engineering (CO) - Undergraduate level.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Undergraduate level.

Informatica A (per gestionali) (*Lab. supervisor*) - Management and Production Engineering - Undergraduate level.

2008-2009

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Undergraduate level.

Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Undergraduate level.

Laboratorio di Analisi delle Informazioni e dei Processi Aziendali (*Teaching assistant*) - Management and Production Engineering - Undergraduate level.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

Computer Vision (*Teaching assistant*) - Computer Engineering (CO) - Undergraduate level.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Undergraduate level.

2007-2008

Laboratorio di Analisi delle Informazioni e dei Processi Aziendali (*Teaching assistant*) - Management and Production Engineering - Undergraduate level.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

Computer Vision (*Teaching assistant*) - Computer Engineering (CO) - Undergraduate level.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Undergraduate level.

2006-2007

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

Informatica B (*Lab. tutor*) - Environmental Engineering - Undergraduate level.

2005-2006

Image Analysis and Synthesis (*Teaching assistant*) - Computer Engineering - Undergraduate level.

STUDENTS' SUPERVISION

Graduate Students Advisor

- *Paolo Moretti* 2012 - 2013, "Detecting Nonstationrities in Image Sequences".

Graduate Students Co-Advisor

- *Mattia Montani* 2012 - 2013, "A distributed change detection and identification algorithm in sensor networks".
- *Manuel Benito Sayago* 2010 - 2011, "Speeded Up Robust Features (SURF): Performance Test".
- *Matteo Maggioni* 2009-2010, "Video Filtering Using separable Four-Dimensional Nonlocal Spatiotemporal Transforms".
- *Alberto Danese* 2007-2008, "Estimating Camera Rotation Parameters from a Single Blurred Image".

- *Andrea Villa* 2007-2008, “Restoration of Blurred Objects Using Cues from the Alpha Matte”.
- Supervision of 4 undergraduate students.

Professional Activities

I am the principal research investigator in the following research project:

- *Gilardoni Raggi X*, INDUSTRIAL, NATIONAL since 2008
  (local project leader: prof. Cesare Alippi)

I am currently contributing as a researcher in the following projects:

- *iSense*, ACADEMIC, EUROPEAN 2011 - 2013
  (local project leader: prof. Cesare Alippi)
- *High-performance filtering for scientific imaging* ACADEMIC, FINNISH NATIONAL 2011 - 2016
  (project leader: Dr. Alessandro Foi, Tampere University of Technology)

In the past, I actively contributed as a researcher in the following projects:

- *M.I.A.R.I.A. (An adaptive hydrogeological monitoring supporting the alpine integrated risk plan)*, INTERREG EU ITALY-SWITZERLAND 2007 - 2013
  (local project leader: prof. Cesare Alippi)
- *Non-local modeling of images and vision for compressive sensing and inverse imaging* ACADEMIC, FINNISH NATIONAL 2008 - 2011
  (project leader: Dr. Alessandro Foi, Tampere University of Technology)

Program Chair and Organization Committees

- Co-organizer of the IEEE Symposium on ”Intelligent Embedded Systems” (IES’14) at IEEE SSCI 2014.
- Co-organizer of the first Workshop on ”Learning strategies and data processing in nonstationary environments” (LEAPS 2013) at AIAI 2013.
- Co-organizer of Special Session ”Intelligent Embedded Systems” at IEEE IJCNN 2013.
- Co-organizer of Special Session ”Intelligent Embedded Systems” at IEEE IJCNN 2012.
- Local Chair for the IEEE Haptic Audio-Visual Environment and Games, HAVE 2009.

Program Committee Membership

- PC member of ”Image Processing: Algorithms and Systems XII” at Electronic Imaging, SPIE 2014.
- PC member of Special Session ”Intelligent Embedded Systems” at IEEE IJCNN 2013.
- PC member of the 4$^{\text{th}}$ Int. Conf. on Intelligent Control and Information Processing, ICICIP 2013.
- PC member of the 9$^{\text{th}}$ Int. Conf. on Artificial Intelligence Applications and Innovations, AIAI 2013.
- PC member of Special Session ”Intelligent Embedded Systems” at IEEE IJCNN 2012.
- PC member of the 7$^{\text{th}}$ Int. Conf. on Artificial Intelligence Applications and Innovations AIAI 2010.

REFEREE SERVICES

I serve as a reviewer for the following international journals:

- Neural Networks and Learning Systems, IEEE Transactions on.
- Neural Networks, IEEE Transactions on.
- Image Processing, IEEE Transactions on.
- Circuits and Systems for Video Technology, IEEE Transactions on.
- Instrumentation and Measurements, IEEE Transactions on.
- Pattern Recognition Letters, Elsevier.
- Neural Networks, Elsevier.
- Computer & Graphics, Elsevier.
- International Journal of Computer Vision, Springer.
- Journal of Mathematical Imaging and Vision, Springer.
- Multimedia Systems, Springer.
- SIAM Journal on Imaging Sciences, SIAM.
- Optical Engineering, SPIE.
- Science, Measurement & Technology, IET.
- Computer Science & Technology, IET.
- Image Processing, IET.

I served as a reviewer for the following international conferences:

- Image Processing: Algorithms and Systems XII at Electronic Imaging, (EI) 2014
- IEEE International Joint Conference on Neural Networks, (IJCNN) 2013, 2012, 2011, 2010 editions.
- IEEE Symposium Series on Computational Intelligence 2013, (SSCI) 2013.
- IEEE International Conference on Acoustics, Speech, and Signal Processing 2013, (ICASSP) 2013.
- The 5^{th}, International Conference on Neural Computation Theory and Applications (NCTA) 2013.
- The 20^{th}, European Signal Processing Conference, (EUSIPCO) 2012.
- International Symposium on Neural Networks, (ISNN) 2011.
- International Conference on Artificial Neural Networks, (ICANN) 2010, 2009 editions.
- International Conference on Intelligent Systems Design and Applications, (ISDA) 2010.
- International Workshop on Local and Non-Local Approximation in Image Processing, (LNLA) 2009, 2008 editions.

Research Interests

My research interests focus on mathematical and statistical methods for intelligent systems for nonstationary environments and image/video processing. In particular, the research activity covers the following lines: change-detection tests, adaptive classifiers, fault detection, image/video restoration, blur analysis.

My research activity is carried out both in the academia and in the industry, since I am the principal investigator in an industrial project involving real-time solutions for airport security.

Intelligent Systems for Nonstationary Environments

Data coming from industrial and environmental processes change their behavior over time because of unknown factors perturbing the system or faults/aging effects affecting the acquisition devices. This dynamic nature is particularly evident in sensors subject to stress and operating in harsh environments. Typically, a nonstationarity, meant as a departure from the initial stationary state, makes an intelligent system obsolete, preventing its proper functioning. In this research line, we are investigating machine-learning solutions to provide intelligent systems with both nonstationarity-detection and adaptation capabilities (this latter meant as the characterization of the process evolution and the prompt reaction to the change).

Concerning the nonstationary-detection issue, we proposed a non-parametric change-detection test (CDT) [IC.10], i.e., an algorithm to detect, online and sequentially, nonstationarities in a data stream, when the data distribution is unknown. We also introduced a hierarchical formulation [IC.7] that combines the CDT with an additional validation phase, which is meant for reducing the occurrence of false positives.

As a meaningful example of intelligent systems we considered classifiers: in the classification scenario a nonstationarity is often referred as concept drift [IB.2]. Based on our CDT [IC.10], we proposed a methodology for designing adaptive classifiers that automatically detect concept drift and learn the new model after each detection. As such, these classifiers are also able to detect further deviations from the newly encountered state [JR.3], thus continuously adapting to an evolving streaming data. We significantly extended such methodology in [IC.1] to detect concept drifts affecting both the stationarity of the observation and of the classification error, and to identify, after each detection, possible recurrent concepts. Adaptive classifiers specifically meant for smooth concept drifts have been presented in [IC.8] and [IC.11].

The other relevant example of intelligent systems we considered are the wireless sensor networks (WSN), where the nonstationarity is often due to a fault. Here we proposed a distributed solution for fault detection [IB.3], an efficient method for estimating the presence of blur/disturbances on the lenses in micro-cameras employed in nodes of a WSN [JR.5], a technique to reconstruct of missing data [IC.2] due –for instance– to communication faults, and a statistical analysis to forecast rock collapse from micro-acoustic bursts recorded by a system that my group deployed in the Alps [IC.6].

Image/Video Processing

Pictures acquired by digital imaging sensors are always noisy. The photographer may prevent excessive noise and improve the signal-to-noise ratio of the image by setting longer exposure times before the acquisition, however, this solution is hardly feasible because of motion, either of the scene or the camera shakes, which would result in a blurred image. Therefore, there is a clear trade-off between blur and noise, which becomes particularly evident at low-light conditions, where short exposures yield images corrupted by an overwhelming noise, while long exposures produce pictures dominated by blur. The effectiveness of image restoration algorithms performing both blur removal (deblurring) and noise suppression (denoising) is significantly influenced by the exposure time, as this balances the amount of blur and noise in the observations. We have been pioneering solutions for maximizing the quality of the restored image by controlling the exposure time: results for uniform motion blur, supported by analytical derivations and experiments, have been published in [JR.4], while a methodology for deriving statistical models predicting the restoration performance in case of random

motion (including camera shake) have been presented in [JR.2]. We also presented a rigorous study to evaluate the performance of denoising multiple short-exposure images as an alternative to deblurring at low-light conditions [WS.2].

My research activity also concerns patch-based imaging methods that exploit the nonlocal self similarity of images and videos: a prior that has shown by far to provide the largest potential for their restoration. In particular, we proposed a powerful video filtering paradigm, VBM4D [JR.1] that exploits both temporal and spatial redundancy characterizing natural video sequences, which achieved state-of-the-art performance in video denoising. Concerning image filtering, we are investigating the role of foveation to measure patch similarity in nonlocal algorithms [IC.3].

In the literature, image blur is typically modeled as a spatially-invariant operator, and only few works consider spatially-variant blur. My research focused on the analysis and restoration of images corrupted by motion blur, which is often spatially variant. More specifically, we have devised models and algorithms for estimating the blur parameters and the 3D motion occurred during the acquisition from a single radial-blurred image [JR.6], a single rotationally-blurred image [IC.13], and a picture of a moving ball [IB.5], [IC.14], [IC.16]. Such algorithms exploit ad-hoc techniques to analyze adaptively selected neighborhoods in the blurred image [IC.15] [IC.17]. We have also presented an effective restoration algorithm for radial-blurred images, which outperforms other approaches thanks to a spatially adaptive denoising step after blur inversion [IC.12].

Part of these works are the result of a research collaboration with the Computational Imaging Group at Tampere University of Technology.

Complete publication list

PUBLICATION LIST

REFEREED INTERNATIONAL JOURNALS

JR.1. Matteo Maggioni, Giacomo Boracchi, Alessandro Foi and Karen Egiazarian, "Video Denoising, Deblocking and Enhancement Through Separable 4-D Nonlocal Spatiotemporal Transforms " *Image Processing, IEEE Transactions on. vol.21, no.9, pp. 3952 - 3966, Sept. 2012 (ISSN: 1057-7149).*
[doi: http://dx.doi.org/10.1109/TIP.2012.2199324]

JR.2. Giacomo Boracchi and Alessandro Foi, "Modeling the Performance of Image Restoration from Motion Blur " *Image Processing, IEEE Transactions on. vol.21, no.8, pp. 3502 - 3517, Aug. 2012 (ISSN: 1057-7149).*
[doi: http://dx.doi.org/10.1109/TIP.2012.2192126]

JR.3. Cesare Alippi, Giacomo Boracchi, Manuel Roveri "A just-in-time adaptive classification system based on the intersection of confidence intervals rule," *Neural Networks, Elsevier* vol.24 (2011), pp.791-800 (ISSN: 0893-6080).
[doi: http://dx.doi.org/10.1016/j.neunet.2011.05.012]

JR.4. Giacomo Boracchi, Alessandro Foi "Uniform motion blur in Poissonian noise: blur/noise trade-off," *Image Processing, IEEE Transactions on.* vol.20, no.2, pp.592-598, Feb. 2011 (ISSN: 1057-7149).
[doi: http://dx.doi.org/10.1109/TIP.2010.2062196]

JR.5. Cesare Alippi, Giacomo Boracchi, Romolo Camplani, Manuel Roveri, "Detecting External Disturbances on Camera Lens in Wireless Multimedia Sensor Networks," *Instrumentation and Measurement, IEEE Transactions on.* vol.59, no.11, pp.2982-2990, Nov. 2010 (ISSN: 0018-9456).
[doi: http://dx.doi.org/10.1109/TIM.2010.2047129]

JR.6. Giacomo Boracchi, "Estimating the 3D Direction of a Translating Camera From a Single Motion-Blurred Image," *Pattern Recognition Letters, Elsevier.* Vol. 30, no. 7, (2009), pp. 671-681 (ISSN: 0167-8655).
[doi: http://dx.doi.org/10.1016/j.patrec.2009.02.002]

REFEREED CHAPTERS IN INTERNATIONAL BOOKS

IB.1. C. Alippi, G. Boracchi, R. Camplani, M. Roveri, "Wireless Sensor Networks for Monitoring Vineyards," in *Methodologies and Technologies for Networked Enterprises, (G. Anastasi, E. Bellini, E. Di Nitto, C. Ghezzi, L. Tanca, E. Zimeo, Editors), Lecture Notes in Computer Science, LNCS 7200, pp 295 - 310, July 2012. Springer.* ISBN: 978-3-642-31738-5.
[doi: http://dx.doi.org/10.1007/978-3-642-31739-2_15]

IB.2. C.Alippi, G.Boracchi, G.Ditzler, R.Polikar, M.Roveri, "Adaptive Classifiers for Nonstationary Environments," *Contemporary Issues in Systems Science and Engineering, IEEE/Wiley Press Book Series,* (2012)

IB.3. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "A distributed Self-adaptive Nonparametric Change-Detection Test for Sensor/Actuator Networks," in *Artificial Neural Networks and Machine Learning ICANN 2011. Lecture Notes in Computer Science, Springer Berlin / Heidelberg*, vol. 6792/2011, pp. 173-180, (2011).
[doi: http://dx.doi.org/10.1007/978-3-642-21738-8_23]

IB.4. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "Adaptive Classifiers with ICI-based Adaptive Knowledge Base Management," in *Artificial Neural Networks and Machine Learning ICANN 2010. Lecture Notes in Computer Science, Springer Berlin / Heidelberg*, vol. 6353/2010, pp. 458-467, (2010).
[doi: http://dx.doi.org/10.1007/978-3-642-15822-3_56]

IB.5. Giacomo Boracchi, Vincenzo Caglioti, Alessandro Giusti, "Estimation of 3D Instantaneous Motion of a Ball from a Single Motion-Blurred Image," in *Computer Vision and Computer Graphics. Theory and Applications. Communications in Computer and Information Science, Springer Berlin Heidelberg*, pp. 225-237, (2009) (ISBN: 978-3-642-10226-4).
[doi: http://dx.doi.org/10.1007/978-3-642-10226-4]

REFEREED INTERNATIONAL CONFERENCES

IC.1. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "Just-In-Time Ensemble of Classifiers," *Proc. IJCNN 2012, IEEE International Joint Conference on Neural Networks* (2012), pp 1-8.
[doi: http://dx.doi.org/10.1109/IJCNN.2012.6252540]

IC.2. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "On-line Reconstruction of Missing Data in Sensor/Actuator Networks by Exploiting Temporal and Spatial Redundancy," *Proc. IJCNN 2012, IEEE International Joint Conference on Neural Networks* (2012), pp. 1-8 .
[doi: http://dx.doi.org/10.1109/IJCNN.2012.6252689]

IC.3. Alessandro Foi, Giacomo Boracchi "Foveated self-similarity in nonlocal image filtering," *Proc. IS&T / SPIE Electronic Imaging 2012, HVEI* (2012), pp. 1-12.
[doi: http://dx.doi.org/10.1117/12.912217]

IC.4. Federico Maggi, Alberto Volpatto, Simone Gasparini, Giacomo Boracchi, Stefano Zanero, "A Fast Eavesdropping Attack Against Touchscreens," *Proc. IEEE IAS 2011* (2011), pp. 320 - 325.
[doi: http://dx.doi.org/10.1109/ISIAS.2011.6122840]

IC.5. Federico Maggi, Alberto Volpatto, Simone Gasparini, Giacomo Boracchi, Stefano Zanero, "POSTER: Fast, Automatic iPhone Shoulder Surfing" *Proc. ACM CCS 2011* (2011), pp. 1-3. **Poster presentation**.

IC.6. Cesare Alippi, Giacomo Boracchi, Antonio Marullo, Manuel Roveri, "A Step Towards the Prediction of a Rock Collapse: Analysis of Micro-Acoustic Bursts," *Proc. IEEE Sensors 2011* (2011), pp. 1273 - 1276.

IC.7. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "A Hierarchical, Nonparametric Sequential Change-Detection Test," *Proc. IJCNN 2011, IEEE International Joint Conference on Neural Networks* (2011), pp. 2889 - 2896.
[doi: http://dx.doi.org/10.1109/IJCNN.2011.6033600]

IC.8. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "An Effective Just-in-Time Adaptive Classifier for Gradual Concept Drifts," *Proc. IJCNN 2011, IEEE International Joint Conference on Neural Networks* (2011), pp. 1675 - 1682.
[doi: http://dx.doi.org/10.1109/IJCNN.2011.6033426]

IC.9. Matteo Maggioni, Giacomo Boracchi, Alessandro Foi, Karen Egiazarian, "Video denoising using separable 4D nonlocal spatiotemporal transforms," *Proc. SPIE Image Processing: Algorithms and Systems VI* (2011), pp. 1 - 11.
[doi: http://dx.doi.org/10.1117/12.872569]

IC.10. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "Change Detection Tests Using the ICI rule," *Proc. IJCNN 2010, IEEE International Joint Conference on Neural Networks* (2010), pp. 1-7.
[doi: http://dx.doi.org/10.1109/IJCNN.2010.5596537]

IC.11. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "Just in time classifiers: Managing the slow drift case," *Proc. IJCNN 2009, IEEE International Joint Conference on Neural Networks*(2009), pp. 114 - 120.
[doi: http://dx.doi.org/10.1109/IJCNN.2009.5178799]

IC.12. Giacomo Boracchi, Alessandro Foi, Vladimir Katkovnik, Karen Egiazarian "Deblurring Noisy Radial-Blurred Images: a spatially adaptive filtering approach," *Proc. SPIE Image Processing: Algorithms and Systems VI* (2008), 12 pages. **Poster presentation**.
[doi: http://dx.doi.org/10.1117/12.769400]

IC.13. Giacomo Boracchi, Vincenzo Caglioti, Alberto Danese "Estimating Camera Rotation Parameters From a Blurred Image," *Proc. VISAPP 2008, 3rd International Conference on Computer Vision Theory and Applications* (2008), pp. 389 - 395.

IC.14. Giacomo Boracchi, Vincenzo Caglioti, Alessandro Giusti "Single-Image 3D Reconstruction of Ball Velocity and Spin From Motion Blur - An Experiment in Motion-from-Blur," *Proc. VISAPP 2008, 3rd International Conference on Computer Vision Theory and Applications* (2008), pp. 22 - 29.

IC.15. Giacomo Boracchi, Vincenzo Caglioti, "Corner Displacement from Motion Blur," *Proc. ICIAP 2007, IEEE International Conference on Image Analysis and Processing* (2007), pp 589 - 594.
[doi: http://dx.doi.org/10.1109/ICIAP.2007.4362841]

IC.16. Giacomo Boracchi, Vincenzo Caglioti, Alessandro Giusti "Ball Position and Motion Reconstruction from Blur in a Single Perspective Image," *Proc. ICIAP 2007, IEEE International Conference on Image Analysis and Processing* (2007), pp 87 -92.**Poster presentation**.
[doi: http://dx.doi.org/10.1109/ICIAP.2007.4362762]

IC.17. Giacomo Boracchi, Vincenzo Caglioti, "Motion Blur Estimation At Corners," *Proc. VISAPP 2007, 2nd International Conference on Computer Vision Theory and Applications* (2007), pp. 296-302 .

IC.18. Vincenzo Caglioti, Pierluigi Taddei, Giacomo Boracchi, Simone Gasparini, Alessandro Giusti, "Single Image Calibration of Off-Axis Catadioptric Cameras Using Line" *Proc. ICCV 2007, IEEE 11th International Conference on Computer Vision* (2007) 6 pages.
[doi: http://dx.doi.org/10.1109/ICCV.2007.4409192]

WORKSHOPS

NC.1. Cesare Alippi, Giacomo Boracchi, Manuel Roveri, "Detecting Drops on Lens in Wireless Multimedia Sensor Network Nodes," *ROSE 2009, IEEE International Workshop on RObotic and Sensors Environments* (2009), pp. 128-133.

NC.2. Giacomo Boracchi, Alessandro Foi "Multiframe Raw-Data Denoising Based On Block-Matching And 3-D Filtering For Low-Light Imaging And Stabilization," *LNLA 2008, the International Workshop on Local and Non-Local Approximation in Image Processing* (2008), 8 pages.

Consapevole delle sanzioni penali, nel caso di dichiarazioni non veritiere, di formazione o uso atti falsi richiamate dallart. 763 del D.P.R. 445 del 28 dicembre 2000, nonch della sanzione ulteriore prevista dallart. 754 del citato D.P.R. 445 del 28 dicembre 2000, consistente nella decadenza dai benefici eventualmente conseguenti al provvedimento emanato sulla base della dichiarazione non veritiera, dichiaro che le informazioni riportate nel presente curriculum vitae sono veritiere.

Date Signature