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# ANDREA CRISTOFARO

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Italia

## Dati personali

Nato a Roma il 26/12/1981. Cittadino italiano.

## Istruzione

### PhD Diploma - 2010

Dottorato di ricerca in Scienze dell'Informazione e Sistemi Complessi, Scuola di Scienze e Tecnologie, Università degli Studi di Camerino

Tesi: "Some constrained control problems with application in industrial engineering". Supervisor: Prof. Fabio Giannoni, Prof. Maria Letizia Corradini.

### Master Diploma - 2005

Laurea quadriennale in Matematica, Dipartimento di Matematica "Guido Castelnuovo", Sapienza Università di Roma.

Tesi: "Esistenza di soluzioni di problemi ellittici con termini a crescita naturale". Supervisore: Prof. Lucio Boccardo. Voto: 110/110 con lode.

## Posizione attuale

Agosto 2015-\*\*, Department of Engineering Cybernetics, NTNU, Norway - Research Fellow and Adjunct Associate Professor

## Posizioni accademiche precedenti

Aprile 2014-Luglio 2015, Department of Engineering Cybernetics, NTNU, Norway, e AMOS Centre of Excellence, Norway - Post-doc researcher (ERCIM Allain Bensoussan fellowship - ABCDE project, EU-FP7 Marie Curie Actions)

Aprile 2011-Marzo 2014, Scuola di Scienze e Tecnologie, Università di Camerino, Italia - Assegnista di ricerca

Maggio 2010-Ottobre 2010, e-Motion team, INRIA Rhone-Alpes, Grenoble, France - Post-doc researcher (EU FP7 project "s-Fly", grant n. 231855)

Marzo 2008-Marzo 2010, Scuola di Scienze e Tecnologie, Università di Camerino, Italia - Studente di dottorato in Sistemi di Controllo

Ottobre 2007-Marzo 2009, Department of Economics and Business, LUISS Guido Carli, Roma, Italia - Teaching assistant in Quantitative Methods

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Novembre 2005-Ottobre 2007, Dipartimento di Matematica “Guido Castelnuovo”, Sapienza Università di Roma, Italia - Studente di dottorato in Equazioni Differenziali

### Interessi di ricerca

#### Teoria dei sistemi e del controllo:

Constrained and Robust Control, Optimization, Fault Detection, Fault Tolerant Control, Estimation and Identification, Control Allocation, Nonlinear Systems, Distributed Control of PDEs.

#### Applicazioni:

Robust Control of Twin Rotor Systems, Fault Detection/Isolation in Wind Energy Conversion Systems, Sensorless Control of Permanent Magnet Synchronous Motors, Icing Detection for Unmanned Aerial Vehicles.

#### Robotica:

Simultaneous Localization and Mapping (SLAM), Optimal Motion Planning with Field-of-View Constraints, Visual-servo Control, Visual/Inertial Observability.

### Competenze

#### Analisi funzionale ed equazioni differenziali:

Sobolev Spaces, Vectorial Convex Analysis and Multidimensional Calculus of Variations, Geometric Measure Theory, Elliptic and Evolution PDEs, Homogenization and Composite Materials, Gamma-convergence.

#### Controllo vincolato e robusto

Linear Matrix Inequalities, Lyapunov Methods, Sliding-mode Control, Null Controllable Regions, Invariant Subsets, Anti-windup Schemes.

#### Stima e identificazione:

Unknown Input Observers, Extended Kalman Filter, Extended Information Filter, Sliding-mode Observers, Parameter Estimation using Algebraic Geometry Tools.

#### Control Allocation:

Pseudo-inverse Methods, Direct Allocation Methods, Control Reconfiguration, Virtual Constraints, Dynamic Allocation.

#### Miscellanea:

Pontryagin Maximum Principle, Descriptor Systems, Matrix Theory and Advanced Linear Algebra, Sampled-data Systems.

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## Competenze informatiche

### Simulazione e Programmazione:

Matlab/Simulink, Wolfram Mathematica, C, Visual Basic

### Computer Aided Design:

Altair Hypermesh, Creo Elements (ProE), AutoCAD, Adobe Illustrator.

## Didattica

2015/2016 Insegnante di Linear Systems Theory, Master Degree Course in Cybernetics, Norwegian University of Science and Technology, Norway.

2013/2014 Insegnante di Teoria del Controllo, Laurea magistrale in Matematica e Applicazioni, Università di Camerino, Italia.

2012/2013 Insegnante di Fondamenti di Controlli Automatici, Laurea triennale in Informatica Industriale, Università di Camerino, Italia.

2011/2012 Insegnante di Algebra Lineare, Laurea triennale in Informatica Industriale, Università di Camerino, Italia.

2011/2012 Insegnante di Analisi Funzionale, Laurea magistrale in Matematica e Applicazioni, Università di Camerino, Italia.

2010/2011 Insegnante di Algebra Lineare, Laurea triennale in Informatica Industriale, Università di Camerino, Italia.

2008-2010 Assistente di Analisi Matematica 2, Laurea triennale in Matematica, Università di Camerino, Italia.

2007-2009 Teaching Assistant of Quantitative Methods, Degree Course in Economics and Business, LUISS Guido Carli, Roma, Italia.

2006/2007 Assistente di Calcolo Differenziale, Laurea triennale in Ingegneria Aerospaziale, Sapienza Università di Roma, Italia.

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### Mobilità

Gennaio 2015: KIOS Centre for Intelligent Systems, University of Cyprus, Nicosia, Cyprus. Referente: Prof. Marios Polycarpou. Argomento di ricerca: Fault Detection and Isolation for Nonlinear Systems

Maggio 2014: Department of Electrical Engineering, University of Porto, Portugal. Referente: Prof. Pedro Aguiar. Argomento di ricerca: Fault Tolerant Control of Unmanned Vehicles

Ottobre 2013-Marzo 2014: Dipartimento di Scienze dell'Informazione, Università di Rome Tor Vergata, Italia. Referente: Dr. Sergio Galeani. Argomento di ricerca: Optimal Control Allocation for Weakly Redundant Plants

Ottobre 2012-Novembre 2012: Department of Engineering Cybernetics, NTNU, Trondheim, Norway. Referente: Prof. Tor Arne Johansen. Argomento di ricerca: Robust Control Allocation

Marzo 2009-Giugno 2009: INRIA Rhone-Alpes, Grenoble, France. Referente: Dr. Agostino Martinelli. Argomento di ricerca: Optimal Motion Planning for Mobile Robots

### Conoscenze linguistiche

- Italiano: madrelingua
  - Inglese: fluente
  - Francese: fluente
  - Tedesco: conoscenza di base
  - Norvegese bokmål: conoscenza di base
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### Collaborazioni industriali

2011: Progettazione di algoritmi per il controllo intelligente di inseguitori solari bi-assiali, ETA S.R.L., Ascoli Piceno, Italy e PICCHIO S.R.L., Ancarano (TE), Italia.

2012-2013: Progetto di City-car ibrida, PICCHIO S.R.L., Ancarano (TE), Italy e Belumbury S.P.A., Rome, Italy.

### Partecipazione a progetti

2010: EU FP7 project “s-Fly”, grant n. 231855: Swarm of Micro Flying Robots.

2012: Progetto UniCAM “SCIROCCO”, FAR2012: Strategies for Characterization, Identification and Robust Control of Wind Energy Conversion Systems.

2014: Project “EKSOSYSTEM”: a Lower Extremity Eksoskeleton System, University of Camerino, Italy, University of Berkeley, California, USA and MES S.P.A., Rome, Italy

2015: Co-writing del progetto “Detection and Estimation of Icing in Aerodynamical Systems using LPV Methods”, ABEL Individual Mobility of Researcher Call (ABEL-IM-2014B), NILS Science and Sustainability Programme.

### Revisioni scientifiche

Revisore per le seguenti riviste internazionali:

- International Journal of Control (Taylor & Francis)
  - IEEE Transactions on Automatic Control (IEEE CSS)
  - Systems & Control Letters (Elsevier)
  - Automatica (Elsevier)
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- IEEE Transactions on Control Systems Technology (IEEE CSS)
- IEEE Transactions on Robotics (IEEE RAS)
- International Journal of Robust and Nonlinear Control (Wiley)

### Esperienze lavorative non accademiche

Ottobre 2007-Marzo 2008: Analisi dati and e sviluppo software, ASSET Fundraising S.R.L., Roma, Italia

Febbraio 2008-Maggio 2008: Insegnante di Matematica e Fisica, Liceo Classico "I. Kant", Roma, Italia

2001-2006: Consulente matematico per BBKA Onlus (Biotechnology and Biological Control Agency), Roma, Italia

2002-2004: Co-amministrazione del laboratorio ERASMUS, Dipartimento di Matematica, Sapienza Università di Roma, Italia

Dicembre 2000-Luglio 2001: Inserimento dati e amministrazione di data-base, ASSET Fundraising S.R.L., Roma, Italia

### Corsi

2012

Introduzione all'uso professionale del software ProE

Introduzione all'uso professionale del software Hyperworks

2011

Ciclo di seminari "Ispirare l'eccellenza nella ricerca", Fondazione CRUI

2008

Corso di dottorato "Sistemi non lineari", Sapienza Università di Roma

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Corso di dottorato “Controllo ottimo”, Sapienza Università di Roma

Corso di dottorato “Sistemi switching”, Sapienza Università di Roma

**2007**

Corso di dottorato “Calcolo delle variazioni”, Sapienza Università di Roma

Corso di dottorato “Liouville-type Equations”, Università di Roma Tre

**2006**

Corso di dottorato “Transizioni di fase”, Sapienza Università di Roma

Corso di dottorato “Meccanica dei fluidi”, Sapienza Università di Roma

Corso di dottorato “Numerical Methods for PDEs”, Sapienza Università di Roma

Corso di dottorato “Stochastic Methods for PDEs”, Sapienza Università di Roma

Corso di dottorato “Elliptic Operators and Topology”, Sapienza Università di Roma

Corso di dottorato “Analytical Methods for PDEs”, Sapienza Università di Roma

### **Scuole, Meeting and Workshop**

**2015**

Oppdal Workshop of Centre for Autonomous Marine Operations and Systems (AMOS), Oppdal, Norway

**2013**

3rd Scientific Day of the School of Science and Technology, Università di Camerino, Italia

**2012**

2nd Scientific Day of the School of Science and Technology, Università di Camerino, Italia

**2011**

Research+Innovation= Presentazione della Belumbury DANY City-car, Università di Camerino, Italia

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### 2010

s-Fly project integration week and workshop, ETH Zurich, Switzerland

### 2009

PhD School "SIDRA" in Controllo vincolato e robusto, Bertinoro, Italia

Dobbiaco Summer School, ODEs with discontinuous right-hand side – Theory and Applications, Dobbiaco, Italia

### 2008

PhD School "SIDRA" in Sistemi dinamici non lineari, Bertinoro, Italia

### 2007

Fourth summer school in Analysis and Applied Mathematics, Rome, Italy

Quasiconvexity, quasiregularity and rigidity of gradients, Regensburg, Germany

### 2006

Variational methods in material science, Pisa, Italy

Third summer school in Analysis and Applied Mathematics, Rome, Italy

### International conferences talks

- 53rd IEEE Conference on Decision and Control, 10-13 December 2014, Los Angeles CA, USA
  - IFAC World Congress 2014, 25-29 August 2014, Cape Town, South Africa
  - European Control Conference 2014, 24-27 June 2014, Strasbourg, France
  - 52nd IEEE Conference on Decision and Control, 10-13 December 2013, Florence, Italy
  - American Control Conference 2012, 27-29 June 2012, Montréal, Canada
  - IFAC World Congress 2011, 28 August – 2 September 2011, Milano, Italy
  - American Control Conference 2011, 29 June – 1 July 2011, San Francisco CA, USA
  - Mediterranean Control Conference 2011, 20-23 June 2011, Corfu', Greece
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- 49th IEEE Conference on Decision and Control, 15-17 December 2010, Atlanta GA, USA
- 8th European Workshop on Adv. Control and Diagnosis, 18-19 November 2010, Ferrara, Italy
- Conf. on Control and Fault-Tolerant Systems (Systol'10), 6-8 October 2010, Nice, France
- 48th IEEE Conference on Decision and Control, 16-18 December 2009, Shanghai, China
- European Control Conference 2009, 23-18 August 2009, Budapest, Hungary

### Presentazioni invitate

21 Gennaio 2015, KIOS Centre, University of Cyprus, Nicosia, Cyprus. "Fault-tolerant control allocation: application to icing detection and recovery in overactuated unmanned aerial vehicles"

23 Ottobre 2014, CNR, Pisa, Italia. "Icing detection and protection for small unmanned aerial vehicles"

19 Settembre 2014, Department of Electronics and Telecommunications, NTNU, Trondheim, Norway. "Icing detection for Unmanned Aerial Vehicles: Control Allocation and Fault-Tolerant Control"

21 Maggio 2014, Department of Electrical Engineering, University of Porto, Portugal. "Input allocation and fault-tolerant control: application to icing diagnosis in UAVs"

7 Maggio 2013, Dipartimento di Matematica, Università di Camerino, Italia. "Modelli matematici per l'ingegneria dell'automazione e la robotica"

19 Marzo 2012, Dipartimento di Ingegneria dell'Informazione, Università di Roma Tor Vergata, Italia. Grasselli Symposium: "Robust control of multi-input periodic discrete-time systems with saturating actuators"

14 Dicembre 2011, Dipartimento di Matematica, Università di Camerino, Italia. "Elogio della linearità: dall'algebra delle matrici alla stabilità dei sistemi dinamici"

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## Pubblicazioni

### Riviste

- M. L. Corradini, A. Cristofaro, F. Giannoni, On the Asymptotic Stabilization of Linear Unstable Systems with Bounded Controls, *Far East Journal of Mathematical Science* (ISSN: 0972-0871), 35, 2009, pp. 233-247.
  - M.L. Corradini, A. Cristofaro, G. Orlando, Robust Stabilization on Multi Input Plants with Saturating Actuators, *IEEE Transactions on Automatic Control*, 55, 2010, pp. 419-425.
  - M. L. Corradini, A. Cristofaro, F. Giannoni, Computation of null controllable regions for antistable linear systems subject to input saturation: an iterative approach, *IET J. Control Theory and Applications*, 2011, vol. 5 (5), pp. 744-749.
  - M.L. Corradini, A. Cristofaro, R. Giambò, S. Pettinari, Design of robust fault detection filters for MIMO uncertain plants with quantised information, *Int. Journal of Control*, 85 (3), 2012, pp. 239-250.
  - A. Cristofaro, On the existence of maximal contractive sets for multi input linear systems, *ASME Journal of Dynamic Systems, Measurement and Control*, 135 (3), 2013.
  - M.L. Corradini, A. Cristofaro, G. Orlando, S. Pettinari, Sliding-mode control of multi input periodic systems with saturation constraints, *International Journal of Control*, 86 (7), 2013, pp. 1240-1247.
  - M.L. Corradini, A. Cristofaro, G. Orlando, Sliding-mode control of discrete-time linear plants with input saturation: application to a twin-rotor system, *International Journal of Control*, 87 (8), 2014, pp. 1523-1535.
  - A. Cristofaro, T.A. Johansen, Fault tolerant control allocation using unknown input observers, *Automatica*, 50 (7), 2014, pp. 1891-1897.
  - A. Cristofaro, S. Pettinari, Fault accommodation for multi-input linear sampled-data systems, *International Journal of Adaptive Control and Signal Processing*, 29, 2015, pp. 835-854.
  - P. Salaris, A. Cristofaro, L. Pallottino, A. Bicchi, Epsilon-optimal synthesis for vehicles with vertically bounded Field-of-View, *IEEE Transactions on Automatic Control*, 60 (5), 2015, pp. 1204-1218.
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## Monografie

- M.L. Corradini, A. Cristofaro, F. Giannoni, G. Orlando, Control Systems with Saturating Inputs: Analysis Tools and Advanced Design, Lecture Notes in Control and Information Sciences, 2012, Springer.

## Capitoli di libri

- F. Conte, A. Cristofaro, A. Renzaglia, A. Martinelli, Cooperative Localization and SLAM Based on the Extended Information Filter, in Multi-Robot Systems: Trends and Development, 2011, pp. 149-170, InTech.

## Atti di convegni

- M. L. Corradini, A. Cristofaro, G. Orlando, On the Robust Stabilization of Discrete-Time SISO Plants with Saturating Actuators, Proc. of the 47th IEEE Conference on Decision and Control CDC2008, Cancun, Mexico.
  - M. L. Corradini, A. Cristofaro, F. Giannoni, Asymptotic Stabilization of Planar Unstable Linear Systems by a finite number of Saturating Actuators, Proceedings of European Control Conference ECC2009, Budapest, Hungary.
  - M. L. Corradini, A. Cristofaro, F. Giannoni, Sharp Estimates on the Region of Attraction of Planar Linear Systems with Bounded Controls, Proc. of the 48th IEEE Conference on Decision and Control CDC2009, Shanghai, China.
  - M. L. Corradini, A. Cristofaro, R. Giambò, S. Pettinari, Robust fault detection filters for a class of MIMO uncertain sample-data systems, Proceedings of Conference on Control and Fault-tolerant Systems 2010 SYSTOL'10, Nice, France.
  - A. Cristofaro, A. Martinelli, Optimal Trajectories for Multi Robot Localization, 49th IEEE Conference on Decision and Control 2010, Atlanta, GA.
  - A. Cristofaro, A. Renzaglia, A. Martinelli, Distributed Information Filters for MAV Cooperative Localization, 10th International Symposium on Distributed Autonomous Robotic Systems DARS2010, Lausanne, Switzerland.
  - M. L. Corradini, A. Cristofaro, R. Giambò, S. Pettinari, Design of robust fault detection filters for plants with quantized information, 8th European Workshop on Advanced Control and Diagnosis ACD2010, Ferrara, Italy.
  - A. Cristofaro, A. Martinelli, 3D cooperative localization and mapping: observability analysis, Proceedings of the American Control Conference 2011, San Francisco, CA.
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- M. L. Corradini, A. Cristofaro, G. Orlando, Sliding mode control of periodic discrete-time linear systems with saturating actuators and input disturbances, Proc. of the IFAC World Congress 2011, Milano, Italy.
  - M. L. Corradini, A. Cristofaro, F. Giannoni, An iterative approach for the description of null controllable regions of discrete-time linear systems with saturating inputs, Proc. of the Mediterranean control conference 2011 MED2011, Corfu', Greece.
  - A. Cristofaro, S. Pettinari, Stepwise fault accommodation for hybrid quantized control systems, Proc. of the Mediterranean control conference 2011 MED2011, Corfu', Greece.
  - M.L. Corradini, A. Cristofaro, G. Orlando, Stabilization of discrete-time linear systems with saturating actuators using sliding modes: application to a twin-rotor system, Proc. of the 50th IEEE Conf. on decision and control CDC2011, Orlando, FL.
  - M.L. Corradini, A. Cristofaro, R. Giambò, S. Pettinari, A Lyapunov-based diagnosis signal for fault detection in sampled-data control systems, Proc. of the 50th IEEE Conf. on decision and control CDC2011, Orlando, FL.
  - A. Cristofaro, S. Pettinari, Abrupt fault accommodation for sampled-data control systems, 9th European Workshop on Advanced Control and Diagnosis ACD2011, Budapest, Hungary.
  - M.L. Corradini, A. Cristofaro, S. Pettinari, Design of robust fault detection filters for linear descriptor systems using sliding mode observers, 7th IFAC Symposium on Robust Control Design, Aalborg, Denmark, 2012.
  - A. Cristofaro, S. Pettinari, Hybrid control design for fault accommodation in sampled-data systems, Proceedings of the American Control Conference 2012, Montreal, Canada.
  - M.L. Corradini, A. Cristofaro, S. Pettinari, Robust FDI and fault sensitivity analysis filters for continuous-time descriptor systems, Proc. of the 51th IEEE Conf. on decision and control CDC2012, Maui, Hawaii.
  - P. Salaris, A. Cristofaro, L. Pallottino, A. Bicchi, Shortest paths for wheeled robots with limited Field-Of-View: introducing the vertical constraint, Proc. of the 52th IEEE Conf. on Decision and Control CDC2013, Florence, Italy.
  - A. Cristofaro, T.A. Johansen, Fault-tolerant control allocation: an unknown input observer based approach with constrained output fault directions, Proc. of the 52th IEEE Conf. on Decision and Control CDC2013, Florence, Italy.
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- M.L. Corradini, A. Cristofaro, S. Pettinari, Diagnosis and accommodation of faults affecting the PMSG in variable-speed sensorless wind turbines: a deterministic approach, Proc. of the European Control Conference 2014, Strasbourg, France.
  - M.L. Corradini, A. Cristofaro, A robust speed-tracking controller for sensorless Permanent Magnet Synchronous Motors with uncertain parameters, Proc. of the IFAC World Congress 2014, Cape Town, South Africa.
  - A. Cristofaro, Robust tracking control for a class of perturbed and uncertain reaction-diffusion equations, Proc. of the IFAC World Congress 2014, Cape Town, South Africa.
  - A. Cristofaro, T.A. Johansen, Fault-tolerant control allocation with actuator dynamics: finite-time control reconfiguration, Proc. of the 53rd IEEE Conf. on Decision and Control 2014, Los Angeles, USA.
  - A. Cristofaro, P. Salaris, L. Pallottino, F. Giannoni, A. Bicchi, On time-optimal trajectories for differential-drive vehicles with Field-of-View constraints, Proc. of the 53rd IEEE Conf. on Decision and Control 2014, Los Angeles, USA.
  - A. Cristofaro, S. Galeani, Output invisible control allocation with steady-state input optimization for weakly redundant plants, Proc. of the 53rd IEEE Conf. on Decision and Control 2014, Los Angeles, USA.
  - A. Cristofaro, T.A. Johansen, An unknown input observer approach to icing detection for unmanned aerial vehicles with linearize longitudinal motion, American Control Conference 2015, Chicago, USA
  - M.L. Corradini, A. Cristofaro, Fault-tolerant dynamic control allocation for permanent magnet synchronous motors, American Control Conference 2015, Chicago, USA
  - A. Cristofaro, T.A. Johansen, P. Aguiar, Icing detection and identification for unmanned aerial vehicles: multiple model adaptive estimation, European Control Conference 2015, Linz, Austria.
  - T.A. Johansen, A. Cristofaro, K.L. Sørensen, J.M. Hansen, T.I. Fossen, On estimation of wind velocity, angle-of-attack and sideslip angle of small UAVs using standard sensors, IEEE Conf. on Unmanned Aerial Systems, 2015
  - D. Rotondo, A. Cristofaro, V. Puig, F. Nejjari, T.A. Johansen, Icing detection in unmanned aerial vehicles with longitudinal motion using an LPV unknown input observer, IEEE Multi Conf. on Systems and Control, 2015, Sydney, Australia.
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- A. Cristofaro, M. Polycarpou, T.A. Johansen, Fault diagnosis and fault-tolerant control allocation for a class of nonlinear systems with redundant inputs, IEEE Conf. on Decision and Control, 2015, Osaka, Japan.

Roma, 02/09/2015

Andrea Cristofaro