

Renzo De Nardi

CONTACT INFORMATION

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RESEARCH INTERESTS

My principal research interests lie in the field of sensor technologies, computational intelligence and robotics with a strong emphasis on real world systems. I am particularly interested in using computational intelligence techniques to cope with the challenges of perception that are posed by unstructured indoor and outdoor environments.

RESEARCH EXPERIENCE

Research Associate

University College London, Department of Computer Science, November 2011-present

As part of the ERC funded CompLACS (Composing Learning for Artificial Cognitive Systems) project I developed a realistic multi-platform UAV simulator that not only reproduced the dynamics of the platforms but also incorporates probabilistic models of the UAV sensors and of the flying environment.

I am also responsible for managing and operating the real UAV platforms as well as for conducting outdoor flight tests and data collection activities.

Additionally I have a key role in capturing the constraints imposed by the UAV platforms and in implementing the algorithms results of the theoretical investigation carried out by the project partners.

University College London, Department of Computer Science, February 2009 - October 2011

As part of the EPSRC funded SUAAVE (Sensing Unmanned Aerial Vehicles) project I was co-responsible of the system-level architecture and of the operation of a multi-UAV system to conduct research in the domain of wilderness search and rescue.

In addition I focussed on the problem of mapping and localization and researched techniques to achieve flight behaviour that explicitly takes into account sensors and platforms characteristics.

I also had an active role in the empirical investigation of models for low altitude air-to-ground wireless propagation.

Research Engineer

Swarm Systems Ltd, London (UK), August 2007-August 2008

Swarm Systems was one of the funded entries to the 2008 MoD Grand Challenge. I contributed to the development of a swarm of autonomous outdoor quadrotors for target search and identification.

I was responsible for the design, initial implementation and test of the algorithms position estimation, control and basic navigation. Part of my effort was also dedicated to the test and implementation of an outdoor wireless communication system (802.11abg, ZigBee).

I also had a primary input in the choice of a suitable sensor suite, and in the electronic and mechanical design; I took part in the vast majority of the flight tests as well as to the operations during the Grand Challenge competition.

EDUCATION

Ph.D., Automatic Control of Miniature Vehicles Through Automatic Modelling

University of Essex, Colchester (UK), 2005 - 2010

Supervisor: Professor Owen Holland

In my thesis I have investigated the idea of automatically designing controllers for real robots with non-trivial dynamics (i.e. model helicopters a model car and an aeroplane) without using any specific domain knowledge about the vehicle. My approach relied on automatically modelling the dynamics of the platform under study, and used the resultant model to design a tailored task specific controller.

A considerable number of experiments were carried out using three different types of model helicopters that I converted into fully functional robots. This required the design of custom electronics, interfacing sensors (IMU, encoders), modules for embedded computing (Gumstix) and wireless communications (Bluetooth, 802.11b).

Some of my initial research also covered the topics of flocking and swarming.

Laurea in Ingegneria delle Telecomunicazioni

(degree in telecommunication engineering)

University of Padua, Padua (Italy), 1997-2004

Thesis title: *Flocking of UAVs, software model and simulations.*

As part of my thesis project I developed an aircraft simulator and designed a rule based flocking algorithm which exploited only visual cues. I then analysed flocking under the constraints imposed by a limited field of view. (This research was carried out at the University of Essex as exchange student.)

Perito in Elettronica e Telecomunicazioni

(secondary school in electronics and telecommunications)

I.T.I.S. G.Galilei, Conegliano (Italy), 1992-1997

ACADEMIC EXPERIENCE

Teaching Assistant

University College London

Object Oriented programming with Java, 2010-2012, Computer Architecture 2013, Robotics Programming 2013.

University of Essex

Introduction to programming in C (2005-2008), Programming with Java (2005-2008), Biologically inspired Robotics (2005-2007).

GRANTS/AWARDS

UCL bridging the gaps grant for the project *What is my energy footprint?* (jointly with Dr John Mitchell and others), May 2010.

Prize for the Most Innovative Idea for the Swarm Systems entry at the MoD Grand Challenge, August 2008.

SOCRATES scholarship, exchange student at the University of Essex from September 2003 to June 2004.

University of Padua scholarship, academic years 1998-1999, 1999-2000.

TECHNICAL SKILLS

During my industrial and academic research I gained considerable experience about constructing and operating real world multi-robot systems both in terms of low level hardware and high level algorithms. In specific I have:

knowledge of sensor fusion and evolutionary computation algorithm;

hands-on experience of operating quadrotor UAVs;

practical experience and theoretical understanding of sensors technologies (GPS, IMU, camera)

knowledge of robot-specific software systems (ROS,MOOS);
understanding and direct experience of ad-hoc wireless networking;
good programming skills in C, C++, Java and Matlab;
experience of Linux kernel and microcontroller (ARM) programming.

LANGUAGES Italian (proficient), English (proficient), Spanish (basic).

PUBLICATIONS Among my publications reported below, the two most deserving of note are (2) and (5). The first is good a example of the type of sensor modelling and data fusion that I address in my current research.
The second paper instead is representative of my experience of system identification, control and evolutionary computation applied to real world systems. To the best of my knowledge, at the time (5) was also the first successful example of evolving a controller able to automatically control a real quadrotor helicopter.

1. C. Luo, L. Teacy and R. De Nardi, S. MacClean, G. Parr. UAV Position Estimation and Collision Avoidance using the Extended Kalman Filter. *IEEE Transactions on Vehicular Technology*, 2013.
2. S. Julier, R. De Nardi, J. Nelson. Multi-rate Estimation of Coloured Noise Models in Graph-Based Estimation Algorithms. *Proceedings of Information Fusion Conference*, 2012.
3. S. Varakliotis, S. Hailes, R. De Nardi, M. Ahmed. UAV and cognitive radio technologies in the Emergency Services arena. *Journal of the British Association of Public Safety Communications Officials*,2010.
4. S. Cameron and S. Hailes and S. Julier and S. McClean and G. Parr and N. Trigoni and M. Ahmed and G. McPhillips and R. De Nardi and J. Nie and A. Symington and L. Teacy and S. Waharte. SUAAVE: Combining Aerial Robots and Wireless Networking” *25th Bristol International UAV Systems Conference*,2010.
5. Renzo De Nardi and Owen Holland. Coevolutionary modelling of a miniature rotorcraft. *Proceedings of the 10th International Conference on Intelligent Autonomous Systems (IAS10)*, July 2008.
6. Julian Togelius, Renzo De Nardi and Alberto Moraglio. Geometric PSO + GP = Particle Swarm Programming. *Proceedings of the IEEE Congress on Evolutionary Computation (WCCI08)*, June 2008.
7. Julian Togelius, Renzo De Nardi, Hugo Marques, Richard Newcombe, Simon M. Lucas and Owen Holland. Nonlinear Dynamics Modelling for Controller Evolution. *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO07)*, July 2007.
8. Julian Togelius, Renzo De Nardi and Simon M. Lucas. Towards Automatic Personalised Content Creation for Racing Games. *Proceedings of the IEEE Symposium on Computational Intelligence and Games (IEEE CIG07)*, April 2007.
9. Renzo De Nardi and Owen Holland. UltraSwarm: A Further Step Towards a Flock of Miniature Helicopters. *Proceedings of the SAB Workshop on Swarm Robotics*. September 2006.
10. Julian Togelius, Renzo De Nardi and Simon M. Lucas. Making Racing Fun Through Player Modeling and Track Evolution. *Proceedings of the SAB Workshop on Adaptive Approaches to Optimizing Player Satisfaction*, September 2006.

11. Renzo De Nardi, Julian Togelius, Owen E. Holland and Simon M. Lucas. Evolution of Neural Networks for Helicopter Control: Why Modularity Matters. *Proceeding of the IEEE Congress on Evolutionary Computation (WCCI06)*, July 2006.
12. Renzo De Nardi, Owen Holland, John Woods, and Adrian Clark. SwarMav: A Swarm of Miniature Aerial Vehicles. *Proceedings of the 21st Bristol International UAV Systems Conference*, April 2006.
13. Owen Holland, John Woods, Renzo De Nardi, Adrian Clark. Beyond Swarm Intelligence: The Ultraswarm. *Proceedings of the IEEE Swarm Intelligence Symposium (SIS2005)*, June 2005.