María Santos

PhD Candidate · Swarm Robotics

Georgia Institute of Technology · 85 5th St NW, Atlanta, GA 30308

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Research Interests

Heterogeneous Swarms Path planning for multi-robot teams with diverse capabilities in multi-objective domains

Human-Swarm Interaction Design of high level strategies to enable human operators to control large swarms

Robots and Arts Expressive motions for swarms to be used in artistic expositions

Education

Georgia Institute of Technology — *Atlanta, GA, USA*

PhD in Electrical and Computer Engineering — *Aug. 2016 - Jul. 2020 (Expected)*

- Thesis: *Coverage Control: From Heterogeneous Robot Teams to Expressive Swarms*
- Cumulative GPA: 4.0/4.0

Master of Science in Electrical and Computer Engineering — *Aug. 2014 - May 2016*

- Thesis: *Musical Abstractions for Multi-Robot Coordination*
- Cumulative GPA: 4.0/4.0

Universidade de Vigo — *Vigo, Spain*

Master in Advanced Industrial Processes and Technologies Research — *Oct. 2013 - Jul. 2014*

- Thesis: *Obstacle Avoidance System in 3D Based on CVM*
- Cumulative GPA: 9.18/10.00

Industrial Engineering, specialization in Automatic Control and Electronics — *Sep. 2008 - Sept. 2013*

- Thesis: *Adaptation of RIDE Environment Tools to the ROS Architecture*
- 5 year engineering degree equivalent to BSc and MSc
- Cumulative GPA: 8.67/10.00

Conservatorio de Música Manuel Quiroga — *Pontevedra, Spain*

Professional Degree in Music, specialization in Violin — *Sep. 2005 - Jun. 2012*

- Cumulative GPA: 8.60/10.00

Professional Appointments

Georgia Institute of Technology
School of Electrical and Computer Engineering — *Atlanta, GA, USA*

Graduate Research Assistant — *Aug. 2016 - present*

Master's Student — *Jan. 2015 - May 2016*

- GRITS Lab
- Advisor: Dr. Magnus Egerstedt
- Research areas: control theory, swarm robotics, human-swarm interaction, robots and arts

Universidade de Vigo
Department of Automatic Control and Systems Engineering — *Vigo, Spain*

Graduate Research Assistant — *Oct. 2013 - Jul. 2014*

Undergraduate Research Assistant — *Oct. 2012 - Jul. 2013*

- Group of Robotics and Intelligent Systems
- Advisor: Dr. Joaquín López Fernández
- Research areas: robotic control architecture, executive layer, obstacle avoidance

Publications

Journal Articles

[J1] **M. Santos** and M. Egerstedt. "From Motions to Emotions: Can the Fundamental Emotions be Expressed in a Robot Swarm?" *International Journal of Social Robotics*, conditionally accepted. arXiv preprint available at:1903.12118.

[J2] **M. Santos**. Y. Diaz-Mercado and M. Egerstedt, "overage Control for Multirobot Teams With Heterogeneous Sensing Capabilities." *IEEE Robotics and Automation Letters*, vol. 3, no. 2, pp. 919-925, April 2018.

[J3] J. López, D. Pérez, **M. Santos** and M. Cacho. "GuideBot. A Tour Guide System Based on Mobile Robots." *International Journal of Advanced Robotic Systems*, 10:381, November 2013.

Conference Papers

[C1] A. Benevento, **M. Santos**, G. Notarstefano, K. Paynabar, M. Bloch, and M. Egerstedt. "Multi-Robot Coordination for Estimation and Coverage of Unknown Spatial Fields". *2020 IEEE International Conference on Robotics and Automation (ICRA)*, accepted.

[C2] R. Funada, **M. Santos**, T. Gencho, J. Yamauchi, M. Fujita, and M. Egerstedt. "Visual Coverage Maintenance for Quadcopters Using Nonsmooth Barrier Functions". *2020 IEEE International Conference on Robotics and Automation (ICRA)*, accepted.

[C3] G. Notomista, S. Mayya, M. Selvaggio, **M. Santos**, and C. Secchi. "A set-theoretic approach to multi-task execution and prioritization". *2020 IEEE International Conference on Robotics and Automation (ICRA)*, accepted.

[C4] **M. Santos**, S. Mayya, G. Notomista, and M. Egerstedt. "Decentralized Minimum Energy Coverage Control for Time-Varying Density Functions". *2019 IEEE International Symposium on Multi-robot and Multi-agent Systems (MRS)*, New Brunswick, NJ, August 2019. **Outstanding paper finalist**.

[C5] G. Notomista, **M. Santos**, S. Hutchinson, and M. Egerstedt. "Sensor Coverage Control Using Robots Constrained to a Curve". *2019 IEEE International Conference on Robotics and Automation (ICRA)*, Montreal, May 2019, pp. 3010-3016.

[C6] R. Funada, **M. Santos**, J. Yamauchi, T. Hatanaka, M. Fujita, and M. Egerstedt. "Visual Coverage Control for Teams of Quadcopters via Control Barrier Functions". *2019 IEEE International Conference on Robotics and Automation (ICRA)*, Montreal, May 2019, pp. 3010-3016.

[C7] **M. Santos** and M. Egerstedt. "Coverage Control for Multi-Robot Teams with Heterogeneous Sensing Capabilities Using Limited Communications". in *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Madrid, October 2018, pp. 5313-5319.

Workshops

[W1] **M. Santos** and M. Egerstedt."From Motions to Emotions: Exploring the Emotional Expressiveness of Robot Swarms". *ICRA-X: Robotic Art Program*, Montréal, May 2019.

Thesis

[T1] **M. T. Santos Fernández**. "Musical Abstractions for Multi-Robot Coordination". Master's Thesis, Georgia Institute of Technology, 2016.

[T2] **M. T. Santos Fernández**. "Sistema de Evitación de Obstáculos en 3D Basado en CVM (Obstacle Avoidance System in 3D Based on CVM)." Master's Thesis, Universidade de Vigo, 2014.

[T3] **M. T. Santos Fernández**. "Adaptación de Herramientas del Entorno RIDE para su Utilización en la Arquitectura ROS (Adaptation of RIDE Environment Tools to the ROS Architecture)." Proyecto Final de Carrera (Final Degree Project), Universidade de Vigo, 2013.

Teaching Experience

Teaching Staff *Coursera*

Control of Mobile Robots *February. 2019 - present*

- Online course on the application of modern control theory to control mobile robots
- Responsibilities: solving questions in the discussion forums, updating course materials

Graduate Teaching Assistant & Co-Instructor *Georgia Institute of Technology*

Optimal Control and Optimization, ECE 6553 *Spring 2017*

- Graduate course on optimal control of dynamic systems, numerical optimization techniques and their applications in solving optimal-trajectory problems
- Responsibilities: lecturing, holding office hours, helping design homework, grading (97 on-campus students and 25 off-campus)

Graduate Teaching Assistant *Georgia Institute of Technology*

Advanced Programming Techniques, ECE 4122/6122 *Fall 2015*

- Undergraduate/graduate course on advanced topics in programming methods, data management, distributed computing, and advanced algorithms used in typical engineering applications (C & C++)
- Responsibilities: holding office hours, grading (200 on-campus students)

Presentations

Invited Talks and Seminars

Coverage Control: From Heterogeneous Robot Teams to Expressive Swarms *Philadelphia, PA, USA*

Kumar Lab, GRASP Lab *September 2019*

Multi-Robot Systems Group Talk

Coverage Control for Multi-Robot Teams with Heterogeneous Sensing Capabilities Using Limited Communications *Atlanta, GA, USA*

Georgia Institute of Technology *September 2018*

Robotics Student Seminar Series

Coverage Control for Multi-Robot Teams with Heterogeneous Sensing Capabilities *Atlanta, GA, USA*

Georgia Institute of Technology *March 2018*

Decision and Control Labotoratory Student Symposium

Conference Presentations

International Symposium on Multi-robot and Multi-agent Systems (MRS 2019) *New Brunswick, NJ, USA*

Talk *August 2019*

"Decentralized Minimum Energy Coverage Control for Time-Varying Density Functions"

ICRA-X: Robots and Art Program - Expressive Motions (ICRA 2019) *Montréal, Canada*

Spotlight Talk and Poster Presentation *May 2019*

"From Motions to Emotions: Exploring the Emotional Expressiveness of Robot Swarms"

International Conference on Intelligent Robots and Systems (IROS 2018) *Madrid, Spain*

Spotlight Talk and Interactive Presentation *October 2018*

"Coverage Control for Multi-Robot Teams with Heterogeneous Sensing Capabilities Using Limited Communications"

International Conference on Robotics and Automation (ICRA 2018) *Brisbane, Australia*

Poster Presentation *May 2018*

"Coverage Control for Multi-Robot Teams with Heterogeneous Sensing Capabilities"

Honors & Awards

Jul 2016 **La Caixa Scholarship for Graduate Studies in North-America** *Barcelona, Spain*
Awarded by Obra Social La Caixa
Fellowship covered university tuition, fees, monthly stipend, travel costs and health insurance (Aug 2017-Aug 2019).

Oct 2015 **Premio Fin de Carrera, Xunta de Galicia** *Santiago de Compostela, Spain*
Awarded to the most outstanding Industrial Engineer graduating in the academic year 2013-14 in Galicia, Spain

Jan 2015 **Premio Fin de Carrera, Universidade de Vigo** *Vigo, Spain*
Awarded to the most outstanding Industrial Engineer graduating in 2013-14 at the University of Vigo

Jun 2013 **Fulbright Scholarship for Graduate Studies** *Madrid, Spain*
Awarded by the Fulbright Commission in Spain
Fellowship covered university tuition, fees, monthly stipend, travel costs and health insurance (Aug 2014-May 2016).

Media Coverage

[M1] **From motion to emotion: The potential of robot swarms in artistic performances**, *TechXplore*, April 2019.

[M2] **Santos Chosen for La Caixa Fellowship**, *Georgia Tech News Center*, June 2017.

Una caldense ampliará studios en EE.UU. tras lograr una beca "La Caixa" (A woman from Caldas de Reis will further her studies in the US after been awarded a "La Caixa" Fellowship), *La Voz de Galicia*, May 2017.

La violinista que investiga sobre robótica (The violinist that does research in robotics), *La Voz de Galicia*, May 2017.

[M3] **Women of Robotics**, *Georgia Tech News Center*, April 2017.

[M4] **Una mente prodigiosa para idear robots en Georgia** (A prodigious mind to conceive robots in Georgia), *La Voz de Galicia*, April 2014.

Professional Service

Reviewer

IEEE Robotics and Automation Society (RAS)

Robotics and Automation Letters (RA-L), International Conference on Robotics and Automation (ICRA)

IEEE Control Systems Society (CSS)

Control Systems Letters (L-CSS), Transactions on Control of Network Systems (TCNS), Transactions on Automatic Control (TAC)

Outreach

IES Meaño – International Day of Women and Girls in Science Event *Meaõ, Spain*

Presentation *Feb 2020*

Promotion of STEAM disciplines to secondary school students from the perspective of a female researcher.

Atlanta Girls' School – MAKE Her Day *Atlanta, GA, USA*

Panelist *Apr 2019*

Promotion of STEM disciplines to middle school girls from female professionals.

International Mentoring Foundation for the Advancement of Higher Education (IMFAHE) *Spain*

Mentor *Oct 2016 - Jul 2018*

Career mentoring for Spanish master's and PhD students