

# 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

Vigo, Spain

#### Department of Automatic Control and Systems Engineering

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

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## 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

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### 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

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### 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 Laboratory 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

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- 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

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- [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 estudios 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

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### 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

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### IES Meaño – International Day of Women and Girls in Science Event

*Meaño, 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