Sreeja Nag

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Education

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, U.S.A.

PhD. Space Systems Engineering, Department of Aeronautics and Astronautics, June 2015

PhD. Thesis: Design and Evaluation of Distributed Spacecraft Missions for Multi-Angular Earth Observation

S.M. Aeronautics and Astronautics Engineering, June 2012

S.M. in Technology and Policy, Engineering Systems Division, June 2012

Dual S.M. Thesis: Collaborative Competition for Crowdsourcing Spaceflight Software and STEM Education using SPHERES Zero Robotics (a program that allows laymen to write spaceflight satellite code)

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR, India

M.S. in Exploration Geophysics, August 2009

B.S. in Exploration Geophysics with Minor Electives in Electrical Engineering, August 2009

M.S. Thesis in collaboration with University of California, Berkeley: Prediction and Modeling of the San Francisco Bay Area transients using Interferometric Synthetic Aperture Radar Time Series

Professional Experience

NASA AMES RESEARCH CENTER and BAER INSTITUTE, California, U.S.A.

- ***Position Title:*** Senior Research Scientist in the Mission Design Center - Engineering Directorate (June 2014-present)
  Research: Led orbital mechanics research for designing new NASA missions - a satellite constellation to perform atmospheric studies using solar occultation, a Cubesat mission for coral reef monitoring from space, multiple satellites in low Earth orbit for cloud and weather monitoring over Central Asia.
- ***Position Title:*** Senior Research Scientist in Aeronautics Systems Modeling & Optimization Branch (October 2014-)
  Research: Led a Cubesat constellation mission design that proved near continuous space-based coverage of remote airspaces (e.g. Alaska, Greenland) using ADS-B signal reception from aircrafts as a function of airplane density. Developing a similar model for communication and navigation of unmanned aerial vehicles, as per FAA standards.
- ***Position Title:*** Senior Research Scientist in the Earth Science Division (June 2014-present)
  Research: Devised a method for designing new satellite constellations and formation flight for Earth Observation based on tightly coupled Model-Based Systems Engineering and Observing System Simulation Experiments. Developing a new algorithm for satellite pointing and schedule optimization for responsive, Earth imaging.

NASA GODDARD SPACE FLIGHT CENTER, Maryland, and BAER INSTITUTE, California, U.S.A.

Position Title: Senior Research Scientist in the Software Engineering Division (August 2015-present)

Research: Leading the design trades for an open-source, open-access 'Tradespace Analysis Tool for Distributed Space Missions' that will allow multiple users - scientists, missions designers or program managers – to perform new space investigations with multiple spacecraft and optimize those designs with respect to a-priori Science goals. Specific responsibilities include the Executive Driver that gathers requirements from the user interface to formulate search requests in the design tradespace, and data reduction and metric computation modules, which uses the orbit propagation and coverage analysis to the generate multiple potential architectures and their associated performance characteristics.

NASA GODDARD SPACE FLIGHT CENTER and USRA, Maryland, U.S.A.

- ***Position Title:*** Research Associate in the Software Engineering Division (June 2013–January 2014)
  Research: Developed prototype software tools to analyze distributed space mission architecture trades and select optimal designs based on customizable earth science performance metrics at minimum cost, as part of building internal, research resources for the Distributed Space Missions team at NASA.
- ***Position Title:*** Research Associate in the Climate Science and Radiation Lab (June 2012–May 2014)
  Research: Designed the architectural concept of a nano-satellite constellation for measuring angular variations of reflectance off ground and clouds. The mission demonstrates instantaneous and accurate calculation of bidirectional reflectance for estimation of global albedo and photosynthetic efficiency, and its global climate impact. The optical

imager payload is modeled and subsystem feasibility for supporting proposed mission architectures established at minimal risk and cost using model-based systems engineering.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Massachusetts, U.S.A.

- ***Project Collaborator:*** Draper Laboratory, Massachusetts
  Position Title: Graduate Research Assistant (February 2014–May 2014)
  Research: Designed Cubesat radiometer constellations for more accurate estimation of global outgoing radiation.
- ***Project Collaborators:*** DARPA, NASA Headquarters, Aurora Flight Sciences
  Position Title: Program Lead of the SPHERES Zero Robotics Program (January 2011–February 2012)
  Research: Designed and developed software infrastructure for and conducted robotics programming tournaments on the International Space Station (ISS). The robots are SPHERES satellites and participants program strategies onto them using web-tools to play challenging space research games. Logged ~1800 users, ~180000 simulations in the first 4 months. Impact on crowdsourcing and education, individually and with collaboration, was assessed.
- ***Project Collaborators:*** DARPA and Orbital Sciences Corporation Headquarters, Virginia
  Position Title: Graduate Research Fellow in the DARPA System F6 Program (February–May 2010)
  Research: Performed comparative benchmarking and optimization of fractionated spacecraft by value-centric design.
- ***Project Collaborator:*** MIT Lincoln Laboratory, Massachusetts
  Position Title: Graduate Research Fellow in Satellite Engineering (September–December 2009)
  Research: Modeled a laser communication downlink from the moon, developed to rapidly explore communication architectures for the Google Lunar X-Prize. Data rates more than 2 Mbps were proven possible with microwatt scale power and within Lincoln Lab's available capabilities, modulation schemes, aperture, gimbal and APD technologies.

EUROPEAN SPACE AGENCY (ESTEC), Noordwijk, The Netherlands

Position Title: International Research Fellow at ACT – Artificial Intelligence (June–August 2010)

Research: Demonstrated the scatter maneuver technique for satellite clusters using swarm intelligence and behavior-based path planning based on artificial potential fields. Feedback controls were added, technology enablers benchmarked and benefits of autonomous collision avoidance in an uncertain environment with many satellites clearly demonstrated. The algorithms were tested in the MIT SPHERES simulation and ground Laboratory.

ROYAL DUTCH SHELL – SHELL OIL COMPANY, Massachusetts, U.S.A.

Position Title: Automation and Control Engineer at Shell TechWorks (May–June 2013)

Research: Wrote a proposal for the development and utilization of Cost-effective Optimized Wellbore Sensing Systems, specifically Logging While Drilling (LWD) and Measurement While Drilling (MWD) tools. Additionally, conceptualized a satellite constellation for oil slick monitoring on oceans by exploiting the unique BRDF signature of oil films.

NASA JET PROPULSION LABORATORY, California, U.S.A.

Position Title: Summer Intern in Radar Science and Engineering (May–July 2008)

Research: Solved for fracture development on Mars by source theory and boundary element methods constrained by MOLA-DEMs, MOC and THEMIS imagery data as part of the 'Fundamental Mars Research Project'. Developed geometrical models for non-linear inversion for determining physical/mechanical parameters using gridded satellite data.

WOODS HOLE OCEANOGRAPHIC INSTITUTION, Massachusetts, U.S.A.

Position Title: Summer Student Fellow in Ocean Bottom Seismology (April–July 2007)

Research: Proposed the idea and applied Full-waveform inversion to the very complicated region known to have created the Earth's crust – the mid-Atlantic Ridge. Implemented a processing sequence for vertical seismic profiles from the International Ocean Drilling Program Hole 1256D to check the presence of sub-basement reflections.

Notable Awards and Achievements

Awards

1. Best Student Paper Award and winner of the Frank J. Redd Student Competition, Small Sat Conference, Utah 2014
2. IAF Luigi G. Napolitano Award at the International Astronautical Congress, China 2013
3. NASA/GSFC John Mather Nobel Scholar Award 2012
4. Best Student Paper Award, International Workshop for Satellite Constellations and Formation Flying, Portugal 2013

5. MIT Graduate Woman of Excellence Award 2013
6. Clinton Global Initiative (CGI) Special Announcement Award, CGI University, Miami Florida, April 2010

Fellowships

7. NASA Earth and Space Science Fellowship 2014-15
8. Schlumberger Foundation Faculty for the Future Fellowship 2012-15
9. Zonta Foundation's Amelia Earhart Fellowship 2013
10. MIT Zakhartchenko Fellowship 2012-13
11. MIT-Total Energy Initiative Fellowship 2009-10
12. MIT Public Service Centre (Paul and Priscilla Gray) Fellowship 2009
13. NASA Planetary Geology/Geophysics UG Research Program and CalTech's SFP Fellowship 2008
14. Chevron/SEG Fellowship for Student Leadership Symposium, SEG Annual Meeting in Las Vegas, USA 2008
15. UC Berkeley Summer School Fellowship, California, USA 2008
16. Summer Student Fellowship by Woods Hole Oceanographic Institution, Massachusetts, USA 2007

Research Grants and Selected Travel Awards

17. NASA ESTO QRS Grant for Constellation Planning and Scheduling, 2016
18. NASA Advanced Information Systems Technology grant for Constellation Design S/W development, 2015-17
19. NASA ARC Center Innovation Fund to design constellations for space-based Air Traffic Control, 2014-15
20. NASA GSFC Internal R&D Grant (team) for architecture development of Distributed Space Missions 2013-2014
21. SSPI Satellite Futures Scholarship to present/moderate at the Space Generation Congress, South Africa 2011
22. MIT Gordon Engineering Leadership Program - Teaching Assistantship for Spring 2011
23. National Space Research Organization of Taiwan Travel Scholarship for IWSCFF, Taipei, Taiwan 2010
24. DEISA-TerraGrid Travel Scholarship for their Euro-US Summer School on Computational Sciences, Italy 2010
25. Total Travel Scholarship for the Total Summer School on Corporate Education/Social Responsibility, France 2010

Leadership and Outreach

- *Panelist and Reviewer* for NASA Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Heliophysics Technology and Instrument Development for Science (H-TIDeS) and Space Technology Research Fellowships (NSTRF) programs
- *Invited Expert in NASA Headquaters'* Weather Focus Workshop in Washington DC (April 2015) to participate in planning the strategic goals of NASA Earth Science - Weather Focus Area with 69 other invited experts.
- *Session Co-Chair and Technical Committee Member* of the IEEE Aerospace Conference and ESA's 4S Symposium
- *Program Lead, SPHERES Zero Robotics* (Jan 2011-Feb 2012) – Managed the development and maintenance of the international program in collaboration with DARPA, NASA ARC, TopCoder Inc. and Aurora Flight Sciences.
- *Rapporteur* at the *Space Generation Congress, South Africa* (Sept. 2011) - Moderated a group of 35 international students to draft policy recommendations for the African Space Industry's outreach, presented at UN COPUOS meeting 2012.
- *Human Centric Design Lead, Selco Innovation Labs, Bangalore India* (Dec 2010-January 2011) - Designed and prototyped solar powered charging systems for rural schools. Presented in the Energy Research Opp. Workshop, Oregon.
- *Team Leader at Chevron/SEG Student Leadership Symposium, Las Vegas* (November 2008) - Led a team of 52 international students to present an opinion toward on improvement of SEG Student Chapters in 17 countries.
- *Executive Editor 2008-09, Editor 2006-08, The Scholars' Avenue*, IIT Kharagpur's fortnightly campus newsletter delivered to >15,000 students, alumni and faculty. The website registered >3000/hits/day in peak seasons (e.g. elections)

Selected Publications

Journal Articles

1. S. Nag, J. L. Rios, D. Gerhardt, C. Pham, "*CubeSat Constellation Design for Air Traffic Monitoring*", Acta Astronautica 128 (2016), 180-193 , DOI:10.1016/j.actaastro.2016.07.010.
2. S. Nag, C.K. Gatebe, T.Hilker, "*Simulation of Multiangular Remote Sensing Products Using Small Satellite Formations*", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 99, June 2016.
3. S. Nag, C.K. Gatebe, D.W. Miller, O.L. de Weck, "*Effect of Satellite Formation Architectures and Imaging Modes on Albedo Estimation of major Biomes*", Acta Astronautica 126 (2016), 77-97, DOI:10.1016/j.actaastro.2016.04.004
4. S. Nag, C.K. Gatebe, O.L. de Weck, "*Observing System Simulations for Small Satellite Clusters Estimating Bidirectional Reflectance*", International Journal of Applied Earth Observation and Geoinformation, 43 (2015), 102-118.

5. S. Nag, J.A. Hoffman, O.L. de Weck, "*Collaborative and Educational Crowdsourcing of Spaceflight Software using SPHERES Zero Robotics*", International Journal of Space Technology Management and Innovation, vol 2, no. 2, 2012.
6. S. Nag, J.G. Katz, A. Saenz-Otero, "*Collaborative Gaming and Competition for CS-STEM Education using SPHERES Zero Robotics*", Acta Astronautica 83 (2013) 145-174, DOI: 10.1016/j.actaastro.2012.09.006.
7. S. Nag, L. Summerer, "*Behavior-based, Autonomous and Distributed Scatter Manouevres for Satellite Swarms*", Acta Astronautica 82 (2013) 95-109, DOI: /10.1016/j.actaastro.2012.04.030.
8. S. Nag, S. A. Swift, "*Lateral continuity of basement seismic reflections in 15 Ma ultrafast-spreading crust at ODP Site 1256"*, Marine Geophysical Researches, March 2011, DOI: 10.1007/s11001-011-9122-4.

Peer-Reviewed Conference Articles

9. S. Nag, J.J. LeMoigne, D.W. Miller, O.L. de Weck, "*A Framework for Orbital Performance Evaluation in Distributed Space Missions for Earth Observation*", IEEE Aerospace Conference, DOI: 10.1109/AERO.2015.7119227, March 2015.
10. S. Nag, K. Cahoy, O.L. de Weck, "*Subsystem Support Feasibility for Formation Flight measuring Bi-Directional Reflectance*", IEEE Aerospace Conference, Xplore DOI: 10.1109/AERO.2015.7119247, March 2015.
11. S. Nag, C.K. Gatebe, T. Hilker, F.G. Hall, L.P. Dyrud, O.L. de Weck, "*Gross Primary Productivity Estimation using Multi-Angular Measurements from Small Satellite Clusters*", IEEE International Geoscience & Remote Sensing Symp., July 2014
12. S. Nag, C.K. Gatebe, O.L. de Weck, "*Relative Trajectories for Multi-Angular Earth Observation using Science Performance Optimization*", IEEE Aerospace Conference, Xplore DOI: 10.1109/AERO.2014.6836464, March 2014.
13. S. Nag, J.J. LeMoigne, O.L. de Weck "*Cost and Risk Analysis of Small Satellite Constellations for Earth Observation*", IEEE Aerospace Conference, Xplore DOI: 10.1109/AERO.2014.6836396, March 2014.
14. S. Nag, I. Heffan, A. Saenz-Otero, M. Lydon, "*SPHERES Zero Robotics software development: Lessons on crowdsourcing and collaborative competition*", IEEE Aerospace Conference, Xplore DOI: 10.1109/AERO.2012.6187452, March 2012.
15. S. Nag, E. Gomez, S. Feller, J. Gibbs, J.A. Hoffman, "*Laser Communication System Design for the Google Lunar X-Prize*", IEEE Aerospace Conference, Xplore DOI: 10.1109/AERO.2011.5747344, March 2011.

Full-Length Conference Proceedings

16. S. Nag, S.P. Hughes, J.J. Le Moigne, "*Navigating the Design Tradespace of Earth Imaging Constellations using Open-Source Tools*", AIAA Space Conference, Long Beach California, September 2016 (accepted and in press)
17. S. Nag, J. L. Rios, D. Gerhardt, C. Pham "*CubeSat Constellation Design for Air Traffic Monitoring*", International Astronautical Congress, Jerusalem, Israel, October 2015.
18. S. Nag, C.K. Gatebe, D.W. Miller, O.L. de Weck, "*Effect of Satellite Formation Architectures and Imaging Modes on Albedo Estimation of major Biomes*", International Astronautical Congress, Toronto, Canada, September 2014.
19. S. Nag, "*Satellite Constellation Mission Design using Model-Based Systems Engineering and Observing System Simulation Experiments*", AIAA/USU Small Satellite Conference, Logan, Utah, August 2014.
20. S. Nag, O.L. de Weck, D.W. Miller, "*Maintenance Feasibility of a Small Satellite Cluster making Bi-Directional Reflectance Measurements*", 4S - Small Satellites, Systems and Services Symposium, Mallorca, Spain, May 2014.
21. S. Nag, "*Design and Analysis of Distributed Nano-Satellite Systems for Multi-Angular, Multi-Spectral Earth Observation*", International Astronautical Congress, IAC-13-B4.7.2, Beijing, China, September 2013.
22. S. Nag, K. Cahoy, et al, "*Evaluation of Hyperspectral Snapshot Imagers onboard Nanosatellite Clusters for Multi-Angular Remote Sensing*", AIAA Space Conference, San Diego, California, September 2013.
23. S. Nag, "*Design of Nano-satellite Cluster Formations for Bi-Directional Reflectance Distribution Function (BRDF) Estimations*", AIAA/USU Small Satellite Conference, Logan, Utah, August 2013.
24. S. Nag, O.L. de Weck, "*Tradespace Exploration of Distributed Nanosatellite Formations for BRDF Estimation*", International Workshop on Satellite Constellation and Formation Flying (IWSCFF), Lisbon, Portugal, March 2013.
25. S. Nag, J.G. Katz, A. Saenz-Otero, "*SPHERES Zero Robotics: Education using Games*", International Astronautical Congress, IAC-11-E1-5.4, Cape Town, South Africa, October 2011.
26. S. Nag, L. Summerer, O.L. de Weck, "*Autonomous and Distributed Collision Avoidance Maneuvers for Fractionated Spacecrafts*", International Workshop on Satellite Constellation and Formation Flying, Taipei, Taiwan, October 2010.
27. M.G. O'Neill, H.Yue, S. Nag, P.Grogan, O. de Weck, "*Comparing and Optimizing the DARPA System F6 Program Value-Centric Design Methodologies*", AIAA Space Conference, Anaheim, California 2010.

Computer Languages: Python, C, C++, MATLAB, Fortran 94-95, SQL
Hobbies: Reading, History and Travel, Air pistol shooting, Journalism, Performing arts.
Media Coverage of Research: Available at www.sreejanag.com