# Siddhartha Mehta


CONTACT INFORMATION

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EDUCATION

**University of Florida**, Gainesville, FL, USA

*Doctor of Philosophy* in mechanical engineering — **January 2007 – May 2010**
*Master of Science* in mechanical engineering — **August 2003 – December 2006**
*Master of Science* in agricultural engineering — **August 2004 – May 2007**

**University of Pune**, Government College of Engineering, MH, India

*Bachelor of Engineering* in mechanical engineering — **July 1998 – May 2002**

RESEARCH INTERESTS

Visual servo control of autonomous systems, nonlinear adaptive control, nonlinear networked control systems, human-robot interaction, robust pose estimation, nonlinear filtering, precision agriculture and agricultural robotics.

PUBLICATIONS

### Book Chapters

1. **S. S. Mehta**, G. Hu, N. Gans, W. E. Dixon, "A Daisy-Chaining Visual Servoing Approach with Applications in Tracking, Localization, and Mapping," in *Robot Localization and Map Building*, Edited by Hanafiah Yussof, In-Tech Press, ISBN 978-953-7619-83-1.
2. P. E. K. Berg-Yuen, **S. S. Mehta**, D. L. Waden, J. W. Curtis, "Particle Filter-Based Ground Target Tracking in a Constrained Road Network," in *Dynamics of Information Systems, Springer Proc. in Mathematics*, to appear.

### Patents

1. **S. S. Mehta**, W. E. Dixon, P. Barooah, "Systems and Methods for Estimating Pose," *Invention Discloser UF#-13311, PCT International Application #PCT/US11/41419.*
2. N. Gans, K. Kaiser, W. E. Dixon, **S. S. Mehta**, "Image-Based System and Method for Vehicle Guidance and Navigation," *Invention Discloser UF#-12277, USPTO Serial #12/376709.*
3. R. Lind, W. E. Dixon, **S. S. Mehta**, R. Causey, "Vision-Based Navigation with Respect to Moving Object," *Invention Discloser UF#-12772.*

### Journal Papers

1. **S. S. Mehta**, V. Jayaraman, T. F. Burks, W. E. Dixon, "Teach by Zooming: A unified Approach to Visual Servo Control," *Mechatronics Sp. Issue on Visual Servoing*, pp. 436-443, vol. 22(4), 2012.
2. **S. S. Mehta**, T. Burks, W. E. Dixon, "Vision-Based Localization of a Wheeled Mobile Robot for Greenhouse Applications: A Daisy-Chaining Approach," *Computers and Electronics in Agriculture Sp. Issue on Bio-Robotics, Trans. on*, pp. 28-37, vol. 63, 2008 (Ranked in Top 25 hottest articles in Computers and Electronics in Agriculture by ScienceDirect during 04-06/2009).
3. **S. S. Mehta**, P. Barooah, W. E. Dixon, "PEGUS: An Image-based Robust Pose Estimation Method for Visual Servo Control," *Pattern Analysis and Machine Intelligence (PAMI), IEEE Trans. on*, under review.
4. **S. S. Mehta**, W. E. Dixon, "Homography-based Visual Servo Control of a Nonholonomic Mobile Robot via a Moving Monocular Camera," *Control Systems Tech. (CST), IEEE Trans. on*, under review.
5. **S. S. Mehta**, G. Hu, N. Gans, W. E. Dixon, "Adaptive Daisy-Chaining Tracking Control of an Autonomous Agent using a Moving Monocular Camera," *Control Systems Tech. (CST), IEEE Trans. on*, under review.
6. **S. S. Mehta**, T. Burks, "Visual Servo Control in Autonomous Citrus Harvesting," *Systems, Man, and Cybernetics (SMC) Part C: Applications and Reviews, IEEE Trans. on*, under review.
7. S. Thorn, E. L. Pasiliao, **S. S. Mehta**, "Localization of GPS Jammers and GPS Denied Navigation: A Particle Filter Approach," *Guidance, Control, and Dynamics (JGCD), AIAA Journal of*, under review.

8. T. Hand, E. L. Pasiliao, E. Feron, **S. S. Mehta**, "Visual Servo Control of a Sensorless Missile," *Guidance, Control, and Dynamics (JGCD), AIAA Journal of*, under review.
9. **S. S. Mehta**, P. Berg-Yuen, E. L. Pasiliao, R. Murphey, "Control of Human-Robot Interaction for Wide Area Search Munitions," *Systems, Man, and Cybernetics (SMC) Part A: Systems and Humans, IEEE Trans. on*, under review.
10. **S. S. Mehta**, J. W. Curtis, "Visual Servo Control with Boundary Conditions in the Absence of Reference Image," *Systems, Man, and Cybernetics (SMC) Part B: Cybernetics, IEEE Trans. on*, under review.
11. **S. S. Mehta**, W. MacKunis, J. W. Curtis, "Adaptive Visual Servo Control of Uncertain Missile Airframes," *Guidance, Control, and Dynamics (JGCD), AIAA Journal of*, under review.
12. **S. S. Mehta**, W. MacKunis, S. Subramanian, C. L. Pasiliao, "Nonlinear Control of Hypersonic Missiles for Maximum Penetration," *Guidance, Control, and Dynamics (JGCD), AIAA Journal of*, under review.
13. **S. S. Mehta**, J. W. Curtis, "Human-Machine Cooperation in Urban Target Tracking," *Systems, Man, and Cybernetics (SMC) Part A: Systems and Humans, IEEE Trans. on*, in preparation.
14. **S. S. Mehta**, W. MacKunis, S. Subramanian, J. W. Curtis, "Model-based Control of Nonlinear Networked Systems," *Automatic Control (TAC), IEEE Trans. on*, in preparation.
15. S. Subramanian, **S. S. Mehta**, J. W. Curtis, E. L. Pasiliao, J. M. Shea, W. E. Dixon, "Nonlinear Stabilization in Noisy Feedback Channels," *Automatic Control (TAC), IEEE Trans. on*, in preparation.

**Peer-reviewed Conference Papers**

1. **S. S. Mehta**, W. MacKunis, S. Subramanian, E. L. Pasiliao, J. W. Curtis, "Stabilizing a Nonlinear Model-based Networked Control System with Communication Constraints," *American Control Conf. (ACC), Proc. of IEEE*, 2013, submitted.
2. W. MacKunis, **S. S. Mehta**, S. Subramanian, J. W. Curtis, "A Computationally Efficient Method for Estimation of Multidimensional Data with Limited Measurements," *American Control Conf. (ACC), Proc. of IEEE*, 2013, submitted.
3. W. MacKunis, S. Subramanian, **S. S. Mehta**, J. W. Curtis, M. Reyhanoglu, and C. Ton, "Robust Nonlinear Aircraft Tracking Control Using Synthetic Jet Actuators," *American Control Conf. (ACC), Proc. of IEEE*, 2013, submitted.
4. **S. S. Mehta**, P. E. K. Berg-Yuen, E. L. Pasiliao, R. A. Murphey, "A Control Architecture for Human-Machine Interaction in the Presence of Unreliable Automation and Operator Cognitive Limitations," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Minneapolis, MN, 2012.
5. **S. S. Mehta**, P. E. K. Berg-Yuen, D. L. Waden, E. L. Pasiliao, J. W. Curtis, "An Efficient Framework for Particle Filter-Based Urban Target Tracking," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Minneapolis, MN, 2012. **(Invited Paper)**
6. **S. S. Mehta**, W. MacKunis, E. L. Pasiliao, J. W. Curtis, "Adaptive Image-Based Visual Servo Control of an Uncertain Missile Airframe," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Minneapolis, MN, 2012.
7. **S. S. Mehta**, W. Mackunis, S. Subramanian, C. L. Pasiliao, "Nonlinear Control of Hypersonic Missiles for Maximum Target Penetration," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Minneapolis, MN, 2012.
8. **S. S. Mehta**, E. L. Pasiliao, J. W. Curtis, P. Barooah, W. E. Dixon, "PEGUS: An Image-Based Robust Pose Estimation Method," *Computer and Robot Vision (CRV), Proc. of IEEE Conf. on*, Toronto, Canada, pp. 78-85, 2012.
9. **S. S. Mehta**, P. E. K. Berg-Yuen, E. L. Pasiliao, R. A. Murphey,"Control of Human-Machine Interaction for Wide Area Search Munitions in the Presence of Target Uncertainty," *Human-Robot Interaction (HRI), Proc. of ACM/IEEE Intl. Conf. on*, Boston, MA, 2012, pp.195-196.
10. **S. S. Mehta**, J. W. Curtis, "A Geometric Approach to Visual Servo Control in the Absence of Reference Image," *Systems, Man, and Cybernetics (SMC), Proc. of IEEE Intl. Conf. on*, Anchorage, Alaska, 2011, pp. 3113-3118.

11. **S. S. Mehta**, W. MacKunis, J. W. Curtis, "Adaptive Vision-based Missile Guidance in the Presence of Evasive Target Maneuvers," *World Congress, Proc. of 18th IFAC*, Milano, Italy, pp. 5471-5476, 2011.
12. P. Berg-Yuen, **S. S. Mehta**, D. Waden, J. W. Curtis,"Particle Filter-Based Ground Target Tracking in a Constrained Road-Network," *Dynamics of Information Systems (DIS), Intl. Conf. on*, Florida, 2011.
13. **S. S. Mehta**, T. F. Burks, W. E. Dixon, "Target Reconstruction-Based Visual Servo Control for Autonomous Robotic Citrus Harvesting," *Agricontrol 2010, Proc. of IFAC*, Kyoto, Japan, 2010.
14. **S. S. Mehta**, P. Barooah, S. Susca, W. E. Dixon, "A Novel Algorithm for Feature-Based Pose Estimation Using Monocular Camera," *Decision and Control (CDC), Proc. of IEEE Conf. on*, Shanghai, China, pp. 8452-8457, 2009.
15. **S. S. Mehta**, G. Hu, A. P. Dani, W. E. Dixon, "Multi-Reference Visual Servo Control of an Unmanned Ground Vehicle," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Honolulu, Hawaii, AIAA-2008-744, 2008. **(Invited Paper)**
16. K. Dupree, **S. S. Mehta**, C. Crane, W. E. Dixon, "Euclidean Calculation of the Pose of an Unmanned Ground Vehicle: A Daisy Chaining Approach," *Emergency Preparedness & Response and Robotics & Remote Systems, Proc. of American Nuclear Societys Meeting on*, Albuquerque, New Mexico, 2008.
17. G. Hu, **S. S. Mehta**, N. Gans, W. E. Dixon, "Daisy Chaining Based Visual Servo Control Part I: Adaptive Quaternion-Based Tracking Control," *Multi-Conf. on Systems and Control (MSC), Proc. of IEEE*, October 2007, Suntec City, Singapore, pp. 1474-1479.
18. G. Hu, N. Gans, **S. S. Mehta**, W. E. Dixon, "Daisy Chaining Based Visual Servo Control Part II: Extensions, Applications and Open Problems," *Multi-Conf. on Systems and Control (MSC), Proc. of IEEE*, October 2007, Suntec City, Singapore, pp. 729-734.
19. R. S. Causey, **S. S. Mehta**, R. Lind, W. E. Dixon, "Dynamic Target State Estimation for Autonomous Aerial Vehicles using a Monocular Camera System," *AeroTech Congress & Exhibition, Proc. of SAE*, pp. 2007-01-3844, Los Angeles, CA, 2007.
20. **S. S. Mehta**, K. Kaiser, N. Gans, W. E. Dixon, "Homography-Based Coordinate Relationships for Unmanned Air Vehicle Regulation," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Keystone, Colorado, 2006. **(Invited Paper)**
21. M. K. Kaiser, N. R. Gans, **S. S. Mehta**, W. Dixon, "Position and Orientation of an Aerial Vehicle through Chained, Vision-Based Pose Reconstruction," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, Keystone, Colorado, 2006. **(Invited Paper)**
22. **S. S. Mehta**, T. Burks, "A Theoretical Model for Vision-Based Localization of a Wheeled Mobile Robot in Greenhouse Applications: A Daisy Chaining Approach," *Bio-Robotics, Information Technology and Intelligent Control for Bioproduction Systems, Proc. of 3rd IFAC Intl. Workshop on*, Sapporo, Japan, 2006.
23. **S. S. Mehta**, W. E. Dixon, D. MacArthur, C. D. Crane, "Visual Servo Control of an Unmanned Ground Vehicle via a Moving Airborne Monocular Camera," *American Control Conf. (ACC), Proc. of IEEE*, Minneapolis, Minnesota, pp. 5276-5281, 2006. **(Invited Paper)**
24. **S. S. Mehta**, G. Hu, N. Gans, W. E. Dixon, "Adaptive Vision-Based Collaborative Tracking Control of an UGV via a Moving Airborne Camera: A Daisy Chaining Approach," *Decision and Control (CDC), Proc. of IEEE Conf. on*, San Diego, California, pp. 3867-3872, 2006.
25. **S. S. Mehta**, W. E. Dixon, "Camera Independent Visual Servo Tracking of Unmanned Air Vehicle/Smart-Munitions," *South-Eastern Regional Conf., Proc. of AIAA*, Gainesville, Florida, 2005.
26. **S. S. Mehta**, W. Dixon, T. Burks, S. Gupta, "Teach by Zooming Visual Servo Control for an Uncalibrated Camera System," *Guidance, Navigation and Control Conf. (GNC), Proc. of AIAA*, AIAA-2005-6095, San Francisco, California, 2005.

**Theses**

1. **S. S. Mehta**,"Daisy-Chaining Approach for Vision-Based Control and Estimation," *Ph.D. Dissertation*, University of Florida, 2010.
2. **S. S. Mehta**,"Vision-based Control for Autonomous Robotic Citrus Harvesting," *Masters Thesis*, University of Florida, 2007. **(Best Thesis Award)**

**Grants & Contracts**

1. "Vision-based Networked Control of Unmanned Systems with Connectivity and Nonlinear Dynamic Constraints," *Air Force Office of Scientific Research (AFOSR-LRIR)*, $1500000, 2013–2015. (co-PI)
2. "Dynamic Emotional Behavior and Automation Reliability in the Human-Machine Social Network," *Air Force Office of Scientific Research (AFOSR-LRIR)*, $600000, 2013–2015. (co-PI)
3. "Over the Top Citrus Harvesting Equipment for Fresh Markets in High Density Groves," *United States Department of Agriculture (USDA) CSREES SBIR Program*, $100000, 5/2012–12/2013. (PI)
4. "Vision-Based Guidance and Control of Nonlinear Airframes," *Air Force Research Laboratory (AFRL), Munitions Directorate, Eglin AFB*, $283140, 6/2010–5/2013. (senior personnel)

## Professional Experience

**GeoSpider Inc.**, Gainesville, FL, USA

*Senior R&D Project Engineer* **June 2012 – present**

- Program director for USDA SBIR "Over the Top Citrus Harvesting Equipment for Fresh Markets in High Density Groves".
- Conduct research on visual servo control of hyper-redundant manipulators for citrus harvesting. Analyze and improve the harvesting efficiency through field trials.

**University of Florida - REEF**, Shalimar, FL, USA

*Research Assistant Scientist* **September 2012 – present**
*Department of Industrial and Systems Engineering*

- Networked Control System (NCS): Stabilization of model-based nonlinear NCS with limited communication; minimum data rate requirement in the bandwidth limited and noisy channels.
- Human-Robot Interaction (HRI): Optimal control of HRI in the presence of automation reliability and cognitive workload constraints; dynamics of emotions in human-robot social networks.
- Consensus in Vision Systems: Vision-based consensus in large-scale sensor networks; vision-based network topology control; effect of soft-information on convergence properties of the network.
- Control of Uncertain Systems: Nonlinear adaptive control of mechanical systems; robust nonlinear Lyapunov-based guidance of uncertain hypersonic airframes.
- Apart from conducting research in the aforementioned areas, other duties include publishing in peer-reviewed journals and conferences, presenting research at conferences, writing grant proposals to various funding agencies, service to the scientific community (reviewer for journals and conferences), mentoring summer interns, and conducting short courses or seminars.

**University of Florida - REEF**, Shalimar, FL, USA

*Postdoctoral Research Associate* **June 2010 – September 2012**
*Department of Mechanical and Aerospace Engineering*

- Visual Servo Control: Model-free vision-based control in the absence of reference image; vision-based adaptive control of airframes; Daisy-chaining networked control of nonlinear systems.
- Control of Uncertain Systems: Nonlinear adaptive control of mechanical systems; robust nonlinear Lyapunov-based guidance of uncertain hypersonic airframes.
- State Estimation: Particle filter-based target tracking in a constrained road network; potential-field approach to constraint modeling in particle filter.
- Apart from conducting research in the aforementioned areas, other duties included publishing in peer-reviewed journals and conferences, presenting research at conferences, writing grant proposals to various funding agencies, service to the scientific community (reviewer for journals and conferences), and mentoring summer interns.

**University of Florida**, Gainesville, FL, USA

*Graduate Research Assistant* **January 2007 – May 2010**
*Nonlinear Controls and Robotics Laboratory*

*A Daisy-Chaining Approach for Vision-Based Control and Estimation*

- Daisy-Chaining Control: Lyapunov-based nonlinear tracking control of an autonomous moving agent using a moving camera with unknown time-varying trajectory; navigation of an unmanned

aerial vehicle in GPS denied zones; satellite attitude estimation; nonlinear control of an aircraft for autonomous aerial refueling; localization of a wheeled mobile robot for greenhouse applications; simultaneous localization, mapping, and control (SLMAC) of an autonomous agent.

- Pose Estimation: Vision-based robust, non-iterative pose estimation and refinement algorithm, PEGUS, based on the directional statistics.
- Visual Servo Control: Model-free, camera invariant teach-by-zooming (TBZ) visual servo controller in the presence of camera uncertainty; camera independent tracking control of smart munitions.
- **Relevant sub-projects:** Camera independent tracking of smart-munitions, vision+GPS based estimation of overhead bridges in vehicle navigation, FLIR+GPS based IED detection, vision-based weight estimation of livestock.
- Apart from conducting research in the aforementioned areas, other duties included publishing in peer-reviewed journals and conferences, presenting research at conferences, service to the scientific community (reviewer for journals and conferences), and mentoring undergraduate and new graduate students.

*Graduate Research Assistant* **August 2004 – December 2006**
*Agricultural Robotics and Mechatronics Group*

*Vision-Based Control for Autonomous Robotic Citrus Harvesting*

- Pattern Classification and Pose Estimation: Fisher linear discriminant-based classification scheme for citrus detection; model-based Euclidean reconstruction using perspective projection geometry for pose estimation.
- Visual Servo Control: Cooperative visual servo controller to regulate a robot manipulator to the desired position using the pose estimates obtained from the camera in-hand and a global map generated by the fixed camera.
- System Integration: Hardware design and selection; image processing and control algorithm implementation in C++ and OpenCV via INtime RTOS communication network on a 7-DOF robotic manipulator; indoor validation in a controlled condition and outdoor testing in citrus groves.
- **Relevant sub-project:** Vision-based localization of a WMR for greenhouse applications using the daisy-chaining approach.
- Apart from conducting research in the aforementioned areas, other duties included publishing in peer-reviewed journals and conferences, and presenting research at conferences.

**Prioria Robotics**, Gainesville, FL, USA

*Research Intern* **January 2010 – April 2010**

- Navigation in GPS denied zones using the daisy-chaining method.
- Nonlinear observer-based range identification of a stationary target using a moving camera.
- Apart from conducting research in the aforementioned areas, other duties included providing deliverables in the form of MATLAB code and providing the know-how of camera calibration.

**Thermax Limited**, Pune, MH, India

*Design Engineer* **July 2002 – July 2003**

- Mechanical design of water treatment plants such as sea water desalination and reverse osmosis.
- Software development for vessel and piping design.
- Manpower planning and management, team leader.

## Teaching Experience

**Student Supervision**

- Lawrence Stratton, B.S. (University of Florida) - Honor's Thesis
- Troy Hands, M.S. (Georgia Institute of Technology) - AFRL Summer Intern (Summer 2012)
- Samantha Thorn, M.S.(University of Florida) - AFRL Summer Intern (Summer 2012)

**Graduate Teaching Assistant**

Conducted lectures and tutoring sessions for the following courses at the University of Florida:

- Control of Mechanical Engineering Systems **(Fall 2008, Spring 2009, Fall 2009)**
- Statics **(Fall 2007)**
- Engineering Graphics **(Fall 2003)**

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| Affiliations & Services | Professional: AIAA senior member, IEEE member, NPA member<br>Reviewer for *Journals:* Transactions on Robotics, Mechatronics, African Journal of Agricultural Research, *Conferences:* Conference on Decision and Control, American Control Conference, Multi-systems Conference, International Conference on Robotics and Automation, International Conference on Intelligent Robots and Systems. |
| Honours & Awards | Recipient of the Technology Innovator Award, University of Florida, 2012<br>Best Thesis Award in College of Agricultural and Life Sciences major, University of Florida, 2008<br>Recipient of the National Merit Scholarship, India, 2002<br>Recipient of the State Mathematics Award, State of Maharashtra, India, 2002<br>Best Outgoing Student, Abhinav Vidyalaya High School, 1996. |
| Programming & Packages | C, C++, OpenCV, Matlab/Simulink, GNU SL, LaTeX, PLC programming, html, QMotor, LabView, Visual Basic, Pro/Engineer, Mechanical Desktop, AutoCAD, Linux OS, QNX OS, Windows OS. |
| Hardware Experience | Robotics Research K1207 and K1607 manipulators, Unimation Puma 700 manipulator, Fanuc Arcmate industrial manipulator, 2-DOF planar manipulator, HIL visualization facility, Allen-Bradley PLC, CCD cameras, IR cameras. |