

# Yash Mulgaonkar



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## Education

**University of Pennsylvania**, Philadelphia, PA, U.S.A.

Ph.D. Student, Mechanical Engineering and Applied Mechanics, August 2013 - present

Advisor: Prof. Vijay Kumar

**University of Pennsylvania**, Philadelphia PA, U.S.A.

M.S., Robotics, March 2012

Advisor: Prof. Vijay Kumar

Thesis: Automated Recharging for Persistence Missions with Multiple Micro Aerial Vehicles

**University of Mumbai**, Mumbai, India

B.E., Electronics Engineering, May 2010

Capstone Project: SAINTs: Satellite Aided Intelligent Navigation and Tracking System.

## Experience

### *Research and Vocational*

**DJI Research, LLC**, Philadelphia, PA, U.S.A.

Robotics Engineering Intern, August 2017 - October 2017

Conceptualized and designed an open-source, lightweight micro aerial vehicle based on the NVIDIA Jetson TX2 single-board computer and a monocular vision based inertial navigation system capable of fully autonomous flight in confined, GPS-denied spaces.

The design files will be released shortly under a open hardware license.

**KMel Robotics, LLC**, Philadelphia, PA, U.S.A.

Acquired by Qualcomm Technologies, Inc.

Mechatronics Engineer, August 2012 - August 2013

Responsible for mechanical and electrical design of autonomous UAVs for academic research in academics and use in the entertainment industry. Played a leading role in the design and development of airframes for UAVs and hardware peripherals for ground stations and communication modules.

**Robosoft Systems**, Mumbai, India.

Design Engineering Intern, May 2008 - July 2008

Contributed to and lead a team for rapid prototyping of new concepts for educational robots and DIY electronics kits for academics and hobbyists. Development involved PCB design, mechanical fabrication and product assembly.

## Teaching

**Teaching Assistant**, Performance and Design of Unmanned Aerial Vehicles - Spring 2016  
**Teaching Assistant**, Mechanical Engineering Design - Fall 2015  
**Teaching Assistant**, Feedback Controls - Spring 2015  
**Judge**, MED-X Medical Devices Hackathon - 2014  
**Mentor**, NSF Research Experiences for Undergraduates (REU) - Summer 2012  
**Teaching Assistant**, Robotics & Automation - Spring 2012  
**Teaching Assistant**, Mechatronic System Design - Fall 2011  
**Teaching Assistant**, Medical Devices - Spring 2011  
**Teaching Assistant**, Electrical Systems Lab II - Spring 2011  
**Teaching Assistant**, Electrical Systems Lab I - Fall 2010  
**Technical Advisor & Judge**, Indian Institute of Technology, Bombay, Techfest - 2008, 2010

## Awards / Honors

- [A2] Featured on the “**2016 Forbes 30 Under 30 List for Science**,” for breakthrough contributions in the field of Robotics, including hardware development and cooperative control.
- [A1] Robot Design Award for “**The Pico-Quadrotor: An Autonomous 20g Micro Aerial Vehicle**,” at the ASME Student Mechanism and Robot Design Competition, Buffalo, NY 2014.

## Patents

- [P2] V. Kumar, G. Loianno, **Y. Mulgaonkar**, “Systems, devices, and methods for on-board sensing and control of micro aerial vehicles,” U.S. Patent No. 10037028. Granted, July 2018.
- [P1] V. Kumar, G. Cross, C. Qu, J. Das, A. Makineni and **Y. Mulgaonkar**, “Systems, devices, and methods for robotic remote sensing for precision agriculture,” U.S. Provisional Patent Application Serial No. PCT/US2016/015093.

## Research Grants

- [G8] **Fast Lightweight Autonomy (DARPA-FLA)** (HR001151626, HR0011516850)  
 Defense Advanced Research Projects Agency (DARPA)
- [G7] **Flying Smartphones**  
 Qualcomm Technologies, Inc. (QTI)
- [G6] **Rapid Response Research (NSF-RAPID)** (1138110)  
 National Science Foundation (NSF)
- [G5] **Micro Autonomous Systems and Technology (MAST)** (W911NF-08-2-0004)  
 U.S. Army Research Laboratory (ARL)
- [G4] **Printable Programmable Machines** (IIS-1138847)  
 National Science Foundation (NSF)
- [G3] **Robot Swarms For Persistent Monitoring Of Specialty Crops** (2015-67021-23857)  
 U.S. Department of Agriculture (USDA)
- [G2] **Robotics Collaborative Technology Alliance** (W911NF-10-2-0016)  
 U.S. Army Corps of Engineers (USACE)
- [G1] **Multidisciplinary University Research Initiatives (MURI)** (N00014-07-1-0829, N00014-09-1-1051)  
 U.S. Office of Naval Research (ONR)

## Publications

### *Book Chapters*

- [B3] S. Shen , **Y. Mulgaonkar**, N. Michael and V. Kumar, “Initialization-Free Monocular Visual-Inertial State Estimation with Application to Autonomous MAVs,” in *Experimental Robotics* Vol. 109, Pg. 211-227, Springer 2016.
- [B2] T. Özaslan, S. Shen, **Y. Mulgaonkar**, N. Michael and V. Kumar, “Inspection of Penstocks and Featureless Tunnel-like Environments Using Micro UAVs,” in *Field and Service Robotics*, Vol. 105, Pg. 123-136, Springer 2015.
- [B1] **Y. Mulgaonkar**, C. Powers, V. Kumar, “Kinematic Analysis of Quadrotors with Manufacturing Errors,” in *Mechanisms and Machine Science : Advances in Mechanisms, Robotics and Design Education and Research*. Vol. 14, Pg 205-214, Springer 2013.

### *Refereed Journal Publications*

- [J6] M. Quigley, K. Mohta, S. Shivakumar, M. Watterson, **Y. Mulgaonkar**, et al., 2018. “The Open Vision Computer: An Integrated Sensing and Compute System for Mobile Robots,” arXiv preprint arXiv:1809.07674.
- [J5] **Y. Mulgaonkar**, A. Makineni, L. Guerrero-Bonilla and V. Kumar, “Robust Aerial Robot Swarms Without Collision Avoidance,” *IEEE Robotics and Automation Letters*, vol. 3, no. 1, pp. 596-603, Jan. 2018.
- [J4] G. Loianno, **Y. Mulgaonkar**, C. Brunner, D. Ahuja, A. Ramanandan, M. Chari, S. Diaz, and V. Kumar, “Autonomous Flight and Cooperative Control for Reconstruction using Aerial Robots Powered by Smartphones,” *The International Journal of Robotics Research*, IJRR, 2018, 37(11), 1341–1358.
- [J3] K. Mohta, M. Watterson, **Y. Mulgaonkar** et al. “Fast, autonomous flight in GPS-denied and cluttered environments,” *Journal of Field Robotics*. vol. 35, no. 1, pp. 101-120, 2018.
- [J2] K. Sun, K. Mohta, B. Pfrommer, M. Watterson, S. Liu, **Y. Mulgaonkar**, C. J. Taylor, V. Kumar, “Robust Stereo Visual Inertial Odometry for Fast Autonomous Flight,” Submitted to RAL and ICRA 2018. vol. 3, no. 2, pp. 965-972, 2018.
- [J1] N. Michael, S. Shen, K. Mohta, **Y. Mulgaonkar**, V. Kumar, K. Nagatani, Y. Okada, S. Kiribayashi, K. Otake, K. Yoshida, K. Ohno, E. Takeuchi, and S. Tadokoro. “Collaborative mapping of an earthquake-damaged building via ground and aerial robots,” *J. Field Robot.*, 29(5):832-841, Sept. 2012.

### *Refereed Conference Proceedings*

- [C17] K. Mohta, K. Sun, S. Liu, M. Watterson, B. Pfrommer, J. Svacha, **Y. Mulgaonkar**, C. J. Taylor, and V. Kumar, “Experiments in fast, autonomous, gps-denied quadrotor flight,” *IEEE International Conference on Robotics and Automation (ICRA)*, 2018, Brisbane, QLD, 2018, pp. 7832-7839.
- [C16] J. Koh, D. Aukes, B. Araki, S. Pohorecky, **Y. Mulgaonkar**, M. Tolley, V. Kumar, D. Rus, R. J. Wood, Robert, “Modular Folded Laminate Robot Capable of Multi Modal Locomotion,” *International Symposium on Experimental Robotics (ISER)*, October 2017, Tokyo, Japan.
- [C15] T. Özaslan, K. Mohta, J. Keller, **Y. Mulgaonkar**, C. J. Taylor, V. Kumar, J. Wozencraft, T. Hood, “Towards fully autonomous visual inspection of dark featureless dam penstocks using MAVs,” *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* 2016, pp. 4998-5005, Daejeon, South Korea.
- [C14] **Y. Mulgaonkar**, B. Araki, J. Koh, L. Guerrero-Bonilla, D. Aukes, A. Makineni, M. Tolley, D. Rus, R. Wood, and V. Kumar, “The Flying Monkey: a Mesoscale Robot that can Run, Fly, and Grasp,” *IEEE Int. Conf. on Robotics and Automation*, Stockholm, Sweden, May, 2016.
- [C13] G. Loianno, **Y. Mulgaonkar**, C. Brunner, D. Ahuja, A. Ramanandan, M. Chari, S. Diaz and V. Kumar, “SmartPhones Power Flying Robots,” *Intelligent Robots and Systems (IROS)*, 2015 *IEEE/RSJ International Conference on*, Hamburg, 2015, pp. 1256-1263.
- [C12] J. Das, G. Cross, C. Qu, A. Makineni, P. Tokekar, **Y. Mulgaonkar** and V. Kumar, “Devices, Systems, and Methods for Automated Monitoring Enabling Precision Agriculture,” 2015 *IEEE International Conference on Automation Science and Engineering (CASE)*, Gothenburg, 2015, pp. 462-469.

- [C11] **Y. Mulgaonkar**, T. Kientz, M. Whitzer and V. Kumar, “Design and Fabrication of Safe, Light-Weight, Flying Robots,” ASME IDETC/CIE 2015, Boston, MA.
- [C10] **Y. Mulgaonkar**, G. Cross and V. Kumar, “Design of small, safe and robust quadrotor swarms,” IEEE ICRA, 26-30 May 2015, Seattle, WA.
- [C9] G. Loianno, G. Cross, C. Qu, **Y. Mulgaonkar**, J. A. Hesch and V. Kumar, “Flying Smartphones: Automated Flight Enabled by Consumer Electronics,” in IEEE Robotics & Automation Magazine, vol. 22, no. 2, pp. 24-32, June 2015.
- [C8] S. Shen, **Y. Mulgaonkar**, N. Michael, and V. Kumar, “Initialization-free monocular visual-inertial estimation with application to autonomous MAVs”, in Proc. of the International Symposium on Experimental Robotics (ISER), Marrakech, Morocco, June 2014.
- [C7] **Y. Mulgaonkar**, V. Kumar, “Autonomous charging to enable long-endurance missions for small aerial robots”. Proc. SPIE 9083, Micro- and Nanotechnology Sensors, Systems, and Applications VI, 90831S (June 4, 2014).
- [C6] **Y. Mulgaonkar**, M. Whitzer, B. Morgan, C. M. Kroninger, A. M. Harrington, V. Kumar, “Power and weight considerations in small, agile quadrotors”. Proc. SPIE 9083, Micro- and Nanotechnology Sensors, Systems, and Applications VI, 90831Q (June 4, 2014).
- [C5] S. Shen, **Y. Mulgaonkar**, N. Michael, V. Kumar, “Multi-sensor fusion for robust autonomous flight in indoor and outdoor environments with a rotorcraft MAV,” Robotics and Automation (ICRA), 2014 IEEE International Conference on, pp.4974,4981, May 31 2014-June 7 2014.
- [C4] A. M. Mehta and D. Rus; K. Mohta, **Y. Mulgaonkar**, M. Piccoli, and V. Kumar, “A Scripted Printable Quadrotor: Rapid Design and Fabrication of a Folded MAV,” in Proc. 16th International Symposium of Robotics Research (ISRR '13), Singapore, December, 2013.
- [C3] T. Özaslan, S. Shen, **Y. Mulgaonkar**, Nathan Michael, and V. Kumar, “Inspection of Penstocks and Feature-less Tunnel-like Environments using Micro UAVs,” International Conference on Field and Service Robotics, 2013.
- [C2] S. Shen, **Y. Mulgaonkar**, N. Michael, and V. Kumar. “Vision-based state estimation and trajectory control towards high-speed flight with a quadrotor,” In Proc. of Robot.: Sci. and Syst., Berlin, Germany, June 2013.
- [C1] S. Shen, **Y. Mulgaonkar**, N. Michael, and V. Kumar. “Vision-based state estimation for autonomous rotorcraft MAVs in complex environments.” In Proc. of the IEEE Intl. Conf. on Robot. and Autom., pages 1750–1756, Karlsruhe, Germany, May 2013.

## Workshops / Tutorials

- [W1] J. Thomas, **Y. Mulgaonkar**, M. Whitzer and V. Kumar, “T3: Kinematics, Dynamics and Control of Quadrotors,” ASME 2014 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (ASME-IDETC), August 2014.

## Invited Talks / Seminars

- [TS6] G. Loianno, **Y. Mulgaonkar** and V. Kumar, “A Swarm of Flying Phones,” International Consumer Electronics Show (CES2016), Las Vegas, Nevada. January 2016.
- [TS5] V. Kumar, **Y. Mulgaonkar**, G. Loianno, S. Liu, “The future of flying robots,” TEDxPenn, Philadelphia, USA. April 2015.
- [TS4] V. Kumar, **Y. Mulgaonkar**, S. Liu, “The future of flying robots,” Drones for Good, Dubai, UAE. February 2015.
- [TS3] G. Loianno, **Y. Mulgaonkar** and V. Kumar, “Smartphones Control Flying Robots,” International Consumer Electronics Show (CES2015), Las Vegas, Nevada. January 2015.
- [TS2] V. Kumar and **Y. Mulgaonkar**, “Aerial Robot Swarms,” TEDxGateway, Mumbai, India. November 2014.
- [TS1] **Y. Mulgaonkar** and V. Kumar, “Open-Source, Printable Pico-Quadrotor,” Robot Makers, Robotics Science and Systems (RSS), Berkeley, California. July 2014.

## Certifications / Licenses

- [L2] FAA Remote Pilot Certification (14 CFR Part 107)
- [L1] FCC H.A.M. Radio Technician License

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