

Steven Waslander | Curriculum Vitae

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Research Interests

Perception, Planning and Coordination for Autonomous Vehicles
Autonomous Driving
Micro Air Vehicles
Simultaneous Localization and Mapping
Point Cloud Registration
Motion Planning
Multi-Camera Clusters
Multi-Robot Coordination

Education

Stanford University <i>Ph.D.</i> Department of Aeronautics & Astronautics, Supervisor: Prof. Claire J. Tomlin, Thesis Title: <i>Multi-Agent Systems Design for Aerospace Applications.</i>	Stanford, CA 2002–2007
Stanford University <i>M.S.</i> Department of Aeronautics & Astronautics, Supervisor: Prof. Stephen M. Rock.	Stanford, CA 2001–2002
Queen's University <i>B.Sc.E.</i> Applied Mathematics and Mechanical Engineering, Supervisor: Prof. Ron Hirschorn.	Kingston, ON 1994–1998

Work Experience

University of Toronto <i>Associate Professor</i> Institute of Aerospace Studies	Toronto, ON <i>starting May 2018</i>
University of Waterloo <i>Associate Professor</i> Department of Mechanical and Mechatronics Engineering	Waterloo, ON 2015–2018
Stanford University <i>Visiting Scholar</i> Department of Aeronautics & Astronautics, Sponsor: Prof. Mac Schwager	Waterloo, ON 2016–2017
University of Waterloo <i>Assistant Professor</i>	Waterloo, ON 2008–2015

Department of Mechanical and Mechatronics Engineering

Stanford University

Postdoctoral Scholar

Department of Aeronautics & Astronautics, Supervisor: Prof. Claire Tomlin.

Stanford, CA

2007–2008

Massachusetts Institute of Technology

Exchange Scholar

Department of Aeronautics & Astronautics, Supervisor: Prof. Jonathan How.

Cambridge, MA

2003–2004

Pratt & Whitney Canada

Controls Analyst

Turbofan Controls Department

Toronto, ON

1998–2001

Syncrude Canada

Mechanical Engineering Student

Hydrotreater Plant

Fort McMurray, AB

1997–1997

Awards

2015: 1st overall, 1st in design, drag race and circuit race, International Autonomous Robot Racing Competition, Waterloo, ON, Canada.

2014: Control Engineering Practice Best Paper award 2011-2013, for “Precision flight control for a multi-vehicle quadrotor helicopter testbed.”

2012: OCE Mind to Market Award for best Industry/Academia collaboration with Aeryon Labs

2011: 1st overall, 1st in design, drag race and circuit race, International Autonomous Robot Racing Competition, Vancouver, BC, Canada.

2011: 4th overall, International Ground Vehicle Competition, Rochester, MI, USA.

2008: Best Demonstration Video, Twenty-Third AAAI Conference on Artificial Intelligence 2008, July 13-17, Chicago, Illinois, USA

Publications

Citations.....

	Count	Citation Count
Refereed Journal Articles	20 (+2 submitted)	487
Refereed Conference Articles	64 (+3 submitted)	2668
Refereed Abstract Conference Articles	3	87
Book Chapters	3	58
Total	88 (+5)	3300

Citation count as recorded on Google Scholar, December 12th, 2017.

Journal Articles

- [1] N. Mohajerin and S. L. Waslander, "Modeling transient response of nonlinear dynamic systems using recurrent neural networks," *Submitted to IEEE Transactions on Neural Networks and Learning Systems*, Feb. 2018.
- [2] M. Atia and S. L. Waslander, "Map-constrained adaptive GNSS/IMU fusion scheme for robust urban navigation," *Submitted to Measurement*, Jun. 2017.
- [3] J. Servos and S. L. Waslander, "Multi-channel generalized-ICP: A robust framework for multi-channel scan registration," *Robotics and Autonomous Systems*, vol. 87, pp. 247–257, Jan. 2017. DOI: 10.1016/j.robot.2016.10.016.
- [4] S. Ahuja, P. Iles, and S. L. Waslander, "Three-dimensional scan registration using curvelet features in planetary environments," *Journal of Field Robotics*, vol. 33, no. 2, pp. 243–259, Mar. 2016. DOI: 10.1002/rob.21616.
- [5] M. Gharibi, R. Boutaba, and S. L. Waslander, "Internet of drones," *IEEE Access*, vol. 4, pp. 1148–1162, Mar. 2016. DOI: 10.1109/ACCESS.2016.2537208.
- [6] M. J. Tribou, D. W. Wang, and S. L. Waslander, "Degenerate motions in multicamera cluster SLAM with non-overlapping fields of view," *Image and Vision Computing*, vol. 50, pp. 27–41, 2016. DOI: 10.1016/j.imavis.2016.01.005.
- [7] N. Mathew, S. L. Smith, and S. L. Waslander, "Planning paths for package delivery in heterogeneous multi-robot teams," *IEEE Transactions on Automation Science and Engineering*, vol. 12, no. 4, pp. 1298–1308, Oct. 2015. DOI: 10.1109/TASE.2015.2461213.
- [8] M. J. Tribou, A. Harmat, D. Wang, I. Sharf, and S. L. Waslander, "Multi-camera parallel tracking and mapping with non-overlapping fields of view," *International Journal of Robotics Research*, vol. 34, no. 12, pp. 1480–1500, Oct. 2015. DOI: 10.1177/0278364915571429.
- [9] A. Akhtar, C. Nielsen, and S. L. Waslander, "Path following using dynamic transverse feedback linearization for car-like robots," *IEEE Transactions on Robotics*, vol. 31, no. 2, pp. 269–279, Apr. 2015. DOI: 10.1109/TR0.2015.2395711.
- [10] J. Daly, Y. Ma, and S. L. Waslander, "Coordinated landing of a quadrotor on a skid-steered ground vehicle in the presence of time delays," *Autonomous Robots*, vol. 38, no. 2, pp. 179–191, Feb. 2015. DOI: 10.1007/s10514-014-9400-5.
- [11] N. Mathew, S. L. Smith, and S. L. Waslander, "Multi-robot rendezvous for recharging in persistent tasks," *IEEE Transactions on Robotics*, vol. 31, no. 1, pp. 128–142, Feb. 2015. DOI: 10.1109/TR0.2014.2380593.
- [12] S. L. Waslander, A. Das, and M. Haley, "3d mapping in tunnel environments: Maximizing mission range," *Progress and Communication in Sciences*, vol. 1, no. 2, pp. 46–51, Dec. 2014.
- [13] A. Das and S. L. Waslander, "Scan registration using segmented region growing NDT," *International Journal of Robotics Research*, vol. 33, no. 13, pp. 1645–1663, Nov. 2014. DOI: 10.1177/0278364914539404.
- [14] M. J. Tribou, S. L. Waslander, and D. Wang, "Scale recovery in multicamera cluster SLAM with non-overlapping fields of view," *Computer Vision and Image Understanding*, vol. 126, pp. 53–66, Sep. 2014. DOI: 10.1016/j.cviu.2014.06.001.
- [15] M. G. Twynstra, K. J. Daun, and S. L. Waslander, "Line-of-sight-attenuation chemical species tomography through the level set method," *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 143, pp. 25–34, Aug. 2014. DOI: 10.1016/j.jqsrt.2013.09.015.

- [16] A. Kasaiezadeh, A. Khajepour, and W. S. L., "Spiral bacterial foraging optimization method: Algorithm, evaluation and convergence analysis," *Engineering Optimization*, vol. 46, no. 4, pp. 439–464, May 2014. DOI: 10.1080/0305215X.2013.776550.
- [17] A. Das, M. Diu, N. Mathew, C. Scharfenberger, J. Servos, A. Wong, J. S. Zelek, D. A. Clausi, and S. L. Waslander, "Mapping, planning and detection strategies for autonomous exploration," *Journal Of Field Robotics*, vol. 31, no. 1, pp. 75–106, Jan. 2014. DOI: 10.1002/rob.21490.
- [18] M. Bristow, K. Erkorkmaz, J. P. Huissoon, S. Jeon, W. S. Owen, S. L. Waslander, and G. D. Stubbley, "A control systems concept inventory test design and assessment," *IEEE Transactions on Education*, vol. 55, no. 2, pp. 203–212, May 2012. DOI: 10.1109/TE.2011.2160946.
- [19] G. M. Hoffmann, H. Huang, S. L. Waslander, and C. J. Tomlin, "Precision flight control for a multi-vehicle quadrotor helicopter testbed," *Control Engineering Practice*, vol. 19, no. 9, pp. 1023–1036, Sep. 2011. DOI: 10.1016/j.conengprac.2011.04.005.
- [20] K. J. Daun, S. L. Waslander, and B. B. Tulloch, "Infrared species tomography of a transient flow field using kalman filtering," *Applied Optics*, vol. 50, no. 6, pp. 891–900, Feb. 2011. DOI: 10.1364/AO.50.000891.
- [21] S. L. Waslander, K. Roy, R. Johari, and C. J. Tomlin, "Lump sum markets for air traffic flow control with competitive airlines," *IEEE Special Issue on Aviation Information Systems*, vol. 96, no. 12, pp. 2113–2130, Dec. 2008. DOI: 10.1109/JPROC.2008.2006197.
- [22] S. L. Waslander, R. L. Raffard, and C. J. Tomlin, "Market-based air traffic flow control with competing airlines," *AIAA Journal of Guidance, Control and Dynamics*, vol. 31, no. 1, pp. 148–161, Jan. 2008. DOI: 10.2514/1.30595.

Book Chapters.....

- [23] S. L. Waslander, "Unmanned aerial and ground vehicle teams: Recent work and open problems," in *Autonomous Control Systems and Vehicles*, K. Nonami, M. Kartidjo, K.-J. Yoon, and A. Budiyo, Eds., Springer JP, 2013, ch. 2, pp. 21–36, ISBN: 978-4431542759.
- [24] M. A. Javed, J. Spike, S. Waslander, W. W. Melek, and W. Owen, "Argo vehicle simulation of motion driven 3d LIDAR detection and environment awareness," in *Autonomous and Intelligent Systems*, ser. Lecture Notes in Computer Science Volume 6752, Springer, Jan. 2011, pp. 284–293. DOI: 10.1007/978-3-642-21538-4_28.
- [25] S. L. Waslander, G. Inalhan, and C. J. Tomlin, "Decentralized optimization via Nash bargaining," in *Theory and Algorithms for Cooperative Systems*, D. Grundel, R. Murphy, and P. Pardalos, Eds., World Scientific, Jan. 2004, ch. 25, pp. 565–584, ISBN: ISBN-10: 981-2560203.

Conference Papers.....

- [26] J. Ku, M. Mozifian, J. S. Jang, A. Harakeh, and S. L. Waslander, "Avod: Aggregate view object detection for autonomous driving," in *Submitted to Computer Vision and Pattern Recognition, arXiv:1712.02294*, Jun. 2018.
- [27] C. L. Choi, J. Rebello, L. Koppel, P. Ganti, A. Das, and S. L. Waslander, "Encoderless gimbal calibration of dynamic multi-camera clusters," in *IEEE International Conference on Robotics and Automation (ICRA)*, to appear, May 2018.
- [28] N. Mohajerin, M. Mozifian, and S. L. Waslander, "Deep learning a quadrotor dynamic model for multi-step prediction," in *IEEE International Conference on Robotics and Automation (ICRA)*, to appear, May 2018.

- [29] A. Dakibay and S. L. Waslander, "Aggressive vehicle control using polynomial spiral curves," in *20th International Conference on Intelligent Transportation Systems*, Yokohama, Japan, Oct. 2017.
- [30] A. Sarkar, K. Czarnecki, M. Angus, C. Li, and S. L. Waslander, "Trajectory prediction of traffic agents at urban intersections through learned interactions," in *20th International Conference on Intelligent Transportation Systems*, Yokohama, Japan, Oct. 2017.
- [31] J. Rebello, A. Das, and S. L. Waslander, "Autonomous active calibration of a dynamic camera cluster using next-best-view," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Vancouver, Canada, Sep. 2017.
- [32] N. Mohajerin and S. L. Waslander, "A state initialization for recurrent neural network modeling of time-series data," in *International Joint Conference on Neural Networks (IJCNN)*, Anchorage, AL, USA, May 2017.
- [33] D. Yoon, K. Lee, P. Molina, and S. L. Waslander, "Wall-following motion primitives for a three-wheeled cleaning robot," in *27th Canadian Congress of Applied Mechanics (CANCAM)*, May 2017.
- [34] A. Das and S. L. Waslander, "Calibration of a dynamic camera cluster for multi-camera visual SLAM," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Daejeon, South Korea, Oct. 2016.
- [35] ———, "Entropy based keyframe selection for multi-camera visual SLAM," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Hamburg, Germany, Oct. 2015, pp. 3676–3681.
- [36] N. Mohajerin and S. L. Waslander, "Modelling a quadrotor vehicle using a modular deep recurrent neural network," in *IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, Hong Kong, China, Oct. 2015.
- [37] M. Smart and S. L. Waslander, "Stereo augmented detection of lane marking boundaries," in *IEEE Intelligent Transportation Systems Conference (ITSC)*, Canary Islands, Spain, Sep. 2015.
- [38] S. Song, A. Wong, J. Huissoon, and S. L. Waslander, "Autonomous vehicle control near the limit of friction," in *IEEE Intelligent Transportation Systems Conference (ITSC)*, Canary Islands, Spain, Sep. 2015.
- [39] A. Das, D. Kumar, A. El Bably, and S. L. Waslander, "Taming the north: Multi-camera parallel tracking and mapping in snow-laden environments," in *10th Conference on Field and Service Robotics (FSR)*, Toronto, ON, Canada, Jun. 2015.
- [40] D. Abeywardena, Z. Wang, G. Dissanayake, S. L. Waslander, and S. Kodagoda, "Model-aided state estimation for quadrotor micro air vehicles amidst wind disturbances," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Chicago, IL, USA, Oct. 2014.
- [41] N. Mohajerin and S. L. Waslander, "Modular deep recurrent neural network: Application to quadrotors," in *IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, San Diego, CA, USA, Oct. 2014.
- [42] J. Servos and S. L. Waslander, "Using RGB information to improve NDT distribution generation and registration convergence," in *International Conference on Intelligent Unmanned Systems (ICIUS)*, Montreal, QC, Canada, Sep. 2014.
- [43] N. Mathew, S. L. Smith, and S. L. Waslander, "Optimal path planning in cooperative heterogeneous multi-robot delivery systems," in *11th International Workshop on the Algorithmic Foundations of Robotics (WAFR)*, Istanbul, Turkey, Aug. 2014.

- [44] S. Ahuja, P. Iles, and S. L. Waslander, "3d scan registration using curvelet features in planetary environments," in *12th International Symposium on Artificial Intelligence, Robotics and Automation in Space (i-SAIRAS)*, Montreal, QC, Jun. 2014.
- [45] A. Das and S. L. Waslander, "Outlier rejection for visual odometry using parity space methods," in *IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong, China, Jun. 2014.
- [46] F. E. Sancar, B. Fidan, J. P. Huissoon, and S. L. Waslander, "MPC based collaborative adaptive cruise control with rear end collision avoidance," in *IEEE Intelligent Vehicles Symposium (IV)*, Dearborn, MI, USA, Jun. 2014.
- [47] J. Servos and S. L. Waslander, "Multi-channel generalized ICP," in *IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong, China, Jun. 2014.
- [48] S. Song, M. Chi Kam Chun, J. P. Huissoon, and S. L. Waslander, "Pneumatic trail based slip angle observer with dugoff tire model," in *IEEE Intelligent Vehicles Symposium (IV)*, Dearborn, MI, USA, Jun. 2014.
- [49] S. Ahuja and S. L. Waslander, "3d scan registration using curvelet features," in *11th Conference on Computer and Robot Vision (CRV)*, Montreal, QC, May 2014.
- [50] K. Ling, D. Chow, A. Das, and S. L. Waslander, "Autonomous maritime landings for low-cost VTOL aerial vehicles," in *11th Conference on Computer and Robot Vision (CRV)*, Montreal, QC, May 2014.
- [51] N. Mohajerin, J. Histon, R. Dizaji, and S. L. Waslander, "Feature extraction and radar track classification for detecting UAVs in civilian airspace," in *IEEE RADAR Conference*, Cincinnati, OH, USA, May 2014.
- [52] S. Ahuja and S. L. Waslander, "Scan registration using the normal distributions transform with region growing clustering," in *AIAA Scitech 2014 Conference*, National Harbor, MD, United States, Jan. 2014.
- [53] A. Akhtar, C. Nielsen, and S. L. Waslander, "Fault tolerant path following for a quadrotor," in *52nd IEEE Conference on Decision and Control (CDC)*, Firenze, Italy, Dec. 2013.
- [54] J. Servos, M. Smart, and S. L. Waslander, "Underwater stereo localization and mapping with refraction correction," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Tokyo, Japan, Oct. 2013.
- [55] A. Das, J. Servos, and S. L. Waslander, "3d scan registration using the normal distributions transform with ground segmentation and point cloud clustering," in *IEEE International Conference on Robotics and Automation (ICRA)*, Karlsruhe, Germany, May 2013.
- [56] N. Mathew, S. L. Smith, and S. L. Waslander, "A graph-based approach to multi-robot rendezvous for recharging in persistent tasks," in *2013 IEEE International Conference on Robotics and Automation (ICRA)*, Karlsruhe, Germany, May 2013.
- [57] C. Scharfenberger, S. L. Waslander, and D. Zelek John and Clausi, "Existence detection of objects in images for robot vision using saliency histogram features," in *10th Conference on Computer and Robot Vision (CRV)*, Regina, Saskatchewan, Canada, May 2013.
- [58] X. Yuan, J. Histon, C. Burns, S. L. Waslander, and R. Dizaji, "Controller-pilot communications in the presence of asynchronous UAS radar surveillance data," in *17th International Symposium on Aviation Psychology (ISAP)*, Dayton, OH, USA, May 2013.
- [59] A. Akhtar, S. L. Waslander, and C. Nielsen, "Path following for a quadrotor using dynamic extension and transverse feedback linearization," in *51st IEEE Conference on Decision and Control (CDC)*, Maui, Hawaii, USA, Dec. 2012.

- [60] J. Daly, M. Tribou, and S. L. Waslander, "A nonlinear path following controller for an underactuated unmanned surface vessel," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Villamoura, Portugal, Oct. 2012.
- [61] A. Das and S. L. Waslander, "Scan registration with multi-scale k-means normal distributions transform," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Villamoura, Portugal, Oct. 2012.
- [62] P. Mukherjee and S. L. Waslander, "Direct adaptive feedback linearization for quadrotor control," in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Minneapolis, MN, USA, Aug. 2012.
- [63] M. J. Tribou, A. Akhtar, and S. L. Waslander, "Relative position-based visual servoing control for quadrotors," in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Minneapolis, MN, USA, Aug. 2012.
- [64] L. He, S. Phillips, S. L. Waslander, and S. Melek, "Task based pose optimization of modular mobile manipulators," in *ASME 2012 11th Biennial Conference on Engineering Systems Design and Analysis (ESDA)*, Nantes, France, Jul. 2012.
- [65] X. Yuan, J. Histon, S. Waslander, R. Dizaji, and C. Schneider, "Distributing non-cooperative surveillance data: A preliminary model and evaluation of potential use cases," in *IEEE Integrated Communications, Navigation and Surveillance Conference (ICNS), 2012*, Herndon, Virginia, USA, Apr. 2012.
- [66] P. Chen, A. Das, P. Mukherjee, and S. L. Waslander, "Way-point navigation for a skid-steer vehicle in unknown environments," in *Proceedings of the SPIE*, vol. 8301, 2012, DOI: 10.1117/12.910074.
- [67] A. Das and S. L. Waslander, "Initialization of the normal distributions transform registration optimization using the iterative closest point algorithm," in *Symposium on Advanced Intelligent Systems (SAIS)*, Waterloo, ON, Canada, Dec. 2011.
- [68] J. Daly, Y. Ma, and S. L. Waslander, "Coordinated landing of a quadrotor on a skid-steered ground vehicle in the presence of time delays," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, San Francisco, CA, USA, Sep. 2011.
- [69] P. Mukherjee and S. L. Waslander, "Modeling and multivariable control techniques for small coaxial helicopters," in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Portland, OR, USA, Aug. 2011.
- [70] A. Das, P. Mukherjee, C. Wang, G. Salas, S. Bedi, and S. L. Waslander, "Graph based path planning in unknown environments using voronoi diagrams," in *23rd Canadian Congress of Applied Mechanics (CANCAM)*, Vancouver, BC, Canada, Jun. 2011.
- [71] S. Phillip, V. Muniappan, S. L. Waslander, J. Huissoon, and H. Karbasi, "Modular mobile robotics: Obstacle management through reconfiguration," in *23rd Canadian Congress of Applied Mechanics (CANCAM)*, Vancouver, BC, Canada, Jun. 2011.
- [72] Y. Rizwan, S. L. Waslander, and C. Nielsen, "Nonlinear aircraft modeling and controller design for target tracking," in *AACC American Control Conference (ACC)*, San Francisco, CA, USA, Jun. 2011.
- [73] P. Chen and S. L. Waslander, "Kinodynamic motion planning for holonomic UAVs in complex 3d environments," in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Toronto, ON, Canada, Aug. 2010.
- [74] R. Gariepy and S. L. Waslander, "UAV motion estimation using low quality image features," in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Toronto, ON, Canada, Aug. 2010.

- [75] ———, “Position control of a 6X6 ATV using a MIMO fuzzy controller,” in *AACC American Control Conference (ACC)*, Baltimore, Maryland, USA, Jun. 2010.
- [76] A. Kasaiezadeh, A. Khajepour, and S. L. Waslander, “Spiral bacterial foraging optimization method,” in *AACC American Control Conference (ACC)*, Baltimore, Maryland, USA, Jun. 2010.
- [77] P. Bouffard and S. L. Waslander, “A hybrid randomized/nonlinear programming technique for small aerial vehicle trajectory planning in 3d,” in *3rd Workshop: Planning, Perception and Navigation for Intelligent Vehicles at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, St. Louis, MO, USA, Oct. 2009.
- [78] G. Hoffmann, S. L. Waslander, M. Vitus, H. Huang, J. Gillula, V. Pradeep, and C. J. Tomlin, “Stanford testbed of autonomous rotorcraft for multi-agent control: Video submission,” in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, St. Louis, MO, USA, Oct. 2009.
- [79] H. Huang, G. Hoffmann, S. L. Waslander, and C. J. Tomlin, “Aerodynamics and control of autonomous quadrotor helicopters in aggressive maneuvering,” in *IEEE International Conference on Robotics and Automation (ICRA)*, Kobe, Japan, May 2009.
- [80] S. L. Waslander and C. Wang, “Wind disturbance estimation and rejection for quadrotor position control,” in *AIAA Infotech@Aerospace Conference and AIAA Unmanned...Unlimited Conference*, Seattle, WA, Apr. 2009.
- [81] M. Vitus, S. L. Waslander, and C. J. Tomlin, “Locally optimal decomposition for autonomous obstacle avoidance with the tunnel-MILP algorithm,” in *47th IEEE Conference on Decision and Control (CDC)*, Cancun, Mexico, Dec. 2008.
- [82] G. M. Hoffmann, S. L. Waslander, and C. J. Tomlin, “Quadrotor helicopter trajectory tracking control,” in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Honolulu, Hawaii, USA, Aug. 2008.
- [83] M. Vitus, V. Pradeep, G. M. Hoffmann, S. L. Waslander, and C. J. Tomlin, “Tunnel-MILP: Path planning with sequential convex polytopes,” in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Honolulu, Hawaii, USA, Aug. 2008.
- [84] G. Hoffmann, S. L. Waslander, H. Huang, V. Pradeep, M. P. Vitus, J. Gillula, and C. J. Tomlin, “Starmac: Stanford testbed of autonomous vehicles for multi-agent control, AAAI best demonstration video,” in *Twenty-Third AAAI Conference on Artificial Intelligence*, Chicago, Illinois, USA, Jul. 2008.
- [85] G. M. Hoffmann, H. Huang, S. L. Waslander, and C. J. Tomlin, “Quadrotor helicopter flight dynamics and control: Theory and experiment,” in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, Hilton Head, South Carolina, Aug. 2007.
- [86] S. L. Waslander and C. J. Tomlin, “Convergence of lump-sum markets with price-anticipating agents,” in *AACC American Control Conference (ACC)*, New York, NY, Jun. 2007.
- [87] G. M. Hoffmann, S. L. Waslander, and C. J. Tomlin, “Mutual information methods with particle filters for mobile sensor network control,” in *45th IEEE Conference on Decision and Control (CDC)*, San Diego, CA, Dec. 2006.
- [88] S. L. Waslander and C. J. Tomlin, “Efficient market-based air traffic flow control with competing airlines,” in *45th IEEE Conference on Decision and Control (CDC)*, San Diego, CA, Dec. 2006.
- [89] G. M. Hoffmann, S. L. Waslander, and C. J. Tomlin, “Distributed cooperative search using information-theoretic costs for particle filters with quadrotor applications,” in *AIAA Guidance, Navigation, and Control Conference and Exhibit (GNC)*, Keystone, CO, Aug. 2006.

- [90] S. L. Waslander, R. L. Raffard, and C. J. Tomlin, "Toward efficient and equitable air traffic flow control," in *AACC American Control Conference (ACC)*, Minneapolis, MN, Aug. 2006.
- [91] R. L. Raffard, S. L. Waslander, and C. J. Bayen Alexandre and Tomlin, "A cooperative distributed approach to multi-agent eulerian network control: Application to air traffic management," in *AIAA Guidance, Navigation and Control Conference and Exhibit (GNC)*, San Francisco, CA, Aug. 2005.
- [92] S. L. Waslander, G. M. Hoffmann, J. S. Jang, and C. J. Tomlin, "Multi-agent X4-flyer testbed design: Integral sliding mode vs. reinforcement learning," in *IEEE/RSJ Conference on Intelligent Robots and Systems (IROS)*, IEEE, Edmonton, AB, Canada, Aug. 2005.
- [93] G. M. Hoffmann, D. G. Rajnarayan, S. L. Waslander, D. Dostal, J. S. Jang, and C. J. Tomlin, "The stanford testbed of autonomous rotorcraft for multi-agent control," in *Digital Avionics System Conference (DASC)*, Salt Lake City, UT, Nov. 2004.

Recent Invited Talks

February 15th, 2018: "Canada Takes a Big Stake in the Driver-less Future", Bacon and Eggheads Seminar for Canadian Ministers of Parliament

October 18th, 2017: "From Zero to Autonomy in Three Months", Automotive Megatrends Webinar

September 26th, 2017: "Static and Dynamic Camera Clusters for Localization and Mapping", Keynote, IEEE/RSJ International Conference on Intelligent Robots and Systems, Vancouver, BC, Canada

April 27th, 2017: "Gimballed Multi-Camera Localization and Mapping for Aerial Vehicles", University of Southern California, Computer Science Dept., Los Angeles, CA, USA

March 3rd, 2017: "Multi-camera localization and mapping for Autonomous Driving", University of California Berkeley, Dept. of Electrical Engineering and Computer Science, Berkeley, CA, USA

August 22nd, 2016: "Multi-camera localization and mapping for quadrotors", Stanford University, Dept. of Aeronautics and Astronautics, Stanford, CA, USA

December 4th, 2015: "A DriverLess Future: The State Of And Path to Fully Autonomous Vehicles" Institute of Transportation Engineers Annual General Meeting, Toronto, ON, Canada

September 29th, 2015: "Using Small Rotorcraft UAVs for Inspection Tasks", Inside GNSS Webinar

September 10th, 2015: "Robotics Research in the Waterloo Autonomous Vehicles Laboratory", KW Retired Professionals and Business Men's Club, Waterloo, ON, Canada

June 10th, 2015: "Multirotor UAV Autonomy Near Obstacles and In Wind", University of Toronto Institute of Aerospace Studies, Toronto, ON, Canada

May, 21st, 2015: "Driverless Cars: The Future of MVA Cases", Ontario Trial Lawyers Association Annual Conference, Toronto, ON, Canada

December 1st, 2014: "Vision-Based Outdoor Autonomy for Quadrotor UAVs", University of Illinois and Urbana Champaign (UIUC), Urbana, IL, USA

Research Funding

Applied for.....

Years	Source	Role	Title	Total amount (% allocated)
2018-2024	ORF-RE	PI	SafeAuto: Safety Assurance for All-Weather Autonomy	\$ 4,000,000 (30%)
Total allocation pending				\$1,200,000

Awarded.....

Years	Source	Role	Title	Allocated amount (% allocated)
2017-2023	CFI-IF & ORF-RI	PI	RoboDrive: Waterloo Autonomous Vehicle Research and Test Facility	\$ 5,420,952 (30%)
2017-2018	Partner Contribution	PI	Autonomous Driving Demonstrator for Functional Safety V2 - Renesas Electronics America	\$1,620,071 (40%)
2017-2018	NSERC CRD	Co-I	Robust Perception Strategies for Autonomous Driving - Denso USA	\$323,253 (25%)
2016-2019	NSERC SPG	Co-I	Shared Decision Making and Progressive Automation for Manufacturing Assembly	\$ 618,500 (20%)
2016-2017	Partner Contribution	PI	All-Weather Autonomous Driving - Huawei	\$ 3,048,000 (50%)
2016-2021	CFI-IF & ORF-RI	Co-I	The Robohub: A robotic test facility for multi-robot systems	\$ 4,563,312 (20%)
2015-2017	Partner Contribution	PI	Robust Perception Strategies for Autonomous Driving - Denso USA	\$159,000 (100%)
2015-2017	Partner Contribution	PI	Autonomous Driving Demonstrator for Functional Safety - Renesas Electronics America	\$788,000 (35%)
2015-2016	OCE VIP II	PI	Low-cost Robotic Autonomy with Multi-camera Clusters	\$ 55,366 (100%)
2015-2016	Partner Contribution	PI	Low-cost Robotic Autonomy with Multi-camera Clusters - Clearpath Robotics	\$ 38,000 (100%)
2015-2019	NSERC CRD	PI	Quadrotor Perception and Planning in Confined Spaces	\$ 240,000 (100%)

Years	Source	Role	Title	Allocated amount (% allocated)
2015-2016	OCE VIP II	PI	Rapid Modeling and Control Design for New Rotorcraft Configurations	\$ 120,000 (65%)
2015-2018	Partner Contribution	PI	Quadrotor Perception and Modeling - Aeryon Labs	\$ 156,000 (90%)
2015-2020	NSERC CREATE	Co-I	Research and Training Program in Unmanned Aerial Vehicles	\$45,000 (4%)
2014-2019	NSERC - Discovery	PI	Autonomous Aerial Vehicle Navigation without Reliance on GPS	\$ 110,000 (100%)
2014-2015	NSERC - Engage	PI	Visual SLAM for Indoor Navigation	\$ 25,000 (100%)
2014	NSERC - Engage	PI	Real-Time Camera Tracking for Integrated CG Live-Action Videography	\$ 25,000 (100%)
2013-2017	Partner Contribution	PI	Autonomous Driving - Nuvation Engineering	\$ 110,000 (50%)
2013-2017	NSERC - CRD	Co-I	Autonomous Driving Strategies for Urban and Highway Environments	\$ 169,220 (50%)
2013-2016	MRI ORF-RE	Co-I	Green Intelligent Transportation Systems	\$ 150,000 (50%)
2012-2017	NSERC - SNG	PI	NSERC Canadian Field Robotics Network	\$ 236,100 (5%)
2012-2012	NSERC - Engage	PI	Iceberg Tracking Beacon Deployment with UAVs	\$ 25,000 (100%)
2012-2013	FedDev - ARC	PI	Underwater Localization and Mapping with the 2G Robotics Laser Scanner	\$ 50,000 (100%)
2011-2012	FedDev - ARC	PI	Product Definition, Testing and Validation of PelvAssist Surgical Navigation Technology	\$ 49,500 (100%)
2011-2012	FedDev - ARC	PI	Development of an Autonomous UAV/UGV Team for Inspection and Mapping in Remote Environments	\$ 50,000 (100%)
2011-2011	OCE - TPS	Co-I	Modeling and control of a differential thrust unmanned surface vehicle for hydrological data acquisition	\$ 28,472 (100%)
2010-2014	Partner Contribution	Co-I	Radar Track Classification - Raytheon Canada	\$ 94,500 (50%)
2010-2014	NSERC - CRD	PI	Anomaly Detection, Classification, and Distribution in Next Generation Radar-based Monitoring and Control Systems	\$ 115,350 (50%)

Years	Source	Role	Title	Allocated amount (% allocated)
2010-2014	Partner Contribution	PI	Quadrotor Autonomy - Aeryon Labs	\$ 94,500 (90%)
2010-2013	NSERC - CRD	PI	Enhanced Safety for Quadrotor Operation in Unknown Environments	\$ 218,070 (90%)
2010-2013	OCE - CR	PI	Positioning and Obstacle Detection for Quadrotor Helicopters	\$ 285,232 (90%)
2010	NSERC - Engage	PI	Coordinated Operation of Autonomous Aerial and Ground Vehicles (G)	\$ 25,000 (100%)
2009 - 2014	NSERC - Discovery	PI	Cooperative Control of Multiple Small Aerial Vehicles in Three Dimensions	\$ 95,000 (100%)
2009	OCE - Interact	PI	Wind Estimation and Rejection for Precision Quadrotor Trajectory Control	\$ 13,500 (100%)
Total allocated				\$7,473,204

Graduate Student Supervision - Ongoing

Waterloo Autonomous Vehicles Laboratory Student Members			
	Current Supervised	Current Co-Supervised	Total
Undergraduate	3	3	6
Masters	9	1	10
PhD	6	1	7
Postdoc	2	0	2
Engineer	5	1	6
Total	25	6	31

Graduate Student Supervision - Complete

Post-doctoral.....

2016-2016: Mohamed Atia, "GPS, INS and Vision Sensor Fusion for Robotics Applications", Assistant Professor at Carleton University

2014-2015: Michael Tribou, "Relative Motion Estimation with Multi-Camera Clusters", Lead Control System Developer at Aeryon Labs

2010-2011: John Daly, "Nonlinear Control Methods for Robotics", Senior Software Engineer at Quanergy

Doctoral.....

2012-2017: Nima Mohajerin, PhD Thesis: "Modeling Dynamic Systems for Multi-Step Prediction with Recurrent Neural Networks"

2009-2014: Michael Tribou, PhD Thesis: "Relative Motion Estimation with Multi-Camera Clusters", co-supervised with David Wang (ECE)

Masters.....

2014-2017: Stanley Brown, M.S. Thesis: "Coverage Path Planning and Room Segmentation in Indoor Environments using the Constriction Decomposition Method"

2013-2017: Assylbek Dakibay, M.S. Thesis: "Autonomous Driving: Baseline Autonomy", co-supervised with Jan Huissoon

2014-2016: Devinder Kumar, M.S. Thesis: "Deep learning based place recognition for challenging environments", co-supervised with David Clausi

2013-2016: Michael Smart, M.S. Thesis: "Robust Bayesian Detection and Tracking of Lane Boundary Markings for Autonomous Driving"

2013-2015: Sirui Song, M.S. Thesis: "Towards Autonomous Driving at the Limit of Friction", co-supervised with Jan Huissoon

2012-2014: Kevin Ling, M.S. Thesis: "Precision Landing of a Quadrotor UAV on a Moving Target Using Low-cost Sensors"

2012-2014: James Servos, M.S. Thesis: "Improving Scan Registration Methods Using Secondary Point Data Channels"

2011-2013: Neil Mathew, M.S. Thesis: "Discrete Path Planning Strategies for Coverage and Multi-Robot Rendezvous", co-supervised with Stephen Smith (ECE)

2010-2013: Arun Das, M.S. Thesis: "Scan Registration Using the Normal Distributions Transform and Point Cloud Clustering Techniques", co-supervised with Jan Huissoon

2010-2012: Michael Karpinski-Leydier, M.S. Thesis: "Optimal Control of Li-Ion Hydrogen Fuel Cell Hybrid Vehicles", co-supervised with Roydon Fraser

2010-2012: Yan Ma, M.S. Thesis: "Coordinated Landing and Mapping with Aerial and Ground Vehicle Teams"

2010-2012: Prasenjit Mukherjee, M.S. Thesis: "Robust and Adaptive Control Methods for Small Aerial Vehicles"

2009-2011: Peiyi Chen, M.S. Thesis: "3D Motion Planning using Kinodynamically Feasible Motion Primitives in Unknown Environments"

2009-2011: Ryan Gariepy, M.S. Thesis: "Quadrotor Position Estimation using Low Quality Images"

2009-2011: Yassir Rizwan, M.S. Thesis: "Towards High Speed Aerial Tracking of Agile Targets", co-supervised with Sebastian Fischmeister (ECE)

2009-2011: Carlos Wang, M.S. Thesis: "Monocular Vision-Based Obstacle Detection for Unmanned Systems"

Teaching Experience

Up to two most recent teaching ratings are included, based on student course critiques.

ME 640: Autonomous Mobile Robotics

2009–present

Graduate Course Instructor

Teaching Ratings: 2014 - 89, 2013 - 86

MTE 544: Autonomous Mobile Robotics

2009–present

4th Year Technical Elective Course Instructor

Teaching Ratings: 2017 - 91, 2015 - 93

ME 561: Fluid Power Systems	2009–present
<i>4th Year Technical Elective Course Instructor</i>	<i>Teaching Ratings: 2014 - 90, 2013 - 86</i>
ME 481/482: Fourth Year Design	2008–present
<i>4th Year Core Course Project Supervisor</i>	
MTE 360: Introduction to Control Systems	2014–present
<i>3rd Year Core Course Instructor</i>	<i>Teaching Ratings: 2014 - 87</i>
ME 360: Introduction to Controls	2008–2012
<i>3rd Year Core Course Instructor</i>	<i>Teaching Ratings: 2012 - 83, 2011 - 72</i>
ME 262: Introduction to Microprocessors and Digital Logic	2012–present
<i>2nd Year Core Course Instructor</i>	<i>Teaching Ratings: 2014 - 82, 2013 - 83</i>
University of Waterloo Robotics Team	2009–present
<i>Student Team Academic Advisor</i>	
University of Waterloo Micro-Air Vehicle Team	2008–2015
<i>Student Team Academic Advisor</i>	
University of Waterloo Alternative Fuels Team	2009–2012
<i>Student Team Academic Advisor</i>	
Waterloo Aerial Robotics Group	2008–2012
<i>Student Team Academic Advisor</i>	

Professional Activities

Professional Memberships.....

2008–present: Professional Engineer of Ontario (2008)

2006–present: IEEE Senior Member (2017), Member (2006)

2005–present: AIAA Senior Member (2014), Member (2005)

Professional Service.....

2018–present: Canadian Image Processing and Pattern Recognition Society, Treasurer

2017–present: IEEE Transactions on Aerospace and Electronics Systems, Associate Editor

2016–present: IEEE/RSJ International Conference on Intelligent Robots and Systems, Competition Co-Chair

2015–2017: Canadian Conference on Computer and Robot Vision, Program Co-Chair

2013–present: International Autonomous Robot Racing Competition, General Chair

2012–2016: International Journal of Intelligent Unmanned Systems Associate Editor, Emerald Publishing

2012–2016: AIAA Guidance, Navigation and Control Conference and Exhibit Technical Area Co-chair, Mini and Micro Aerial Vehicles

2011–2016: AACC American Control Conference Associate Editor, AIAA

2010–2013: AIAA Guidance, Navigation and Control Conference and Exhibit Technical Committee Member