

Taeyoung Lee: Curriculum Vitae

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Education

Ph. D	Department of Aerospace Engineering UNIVERSITY OF MICHIGAN, Ann Arbor, MI <i>Thesis: Computational Geometric Mechanics and Control of Rigid Bodies</i> <i>Advisors: N. Harris McClamroch, Melvin Leok (Mathematics)</i> <i>Committee: Daniel Scheeres, Anthony Bloch, Jessy Grizzle</i>	Sep 2004-Apr 2008
M. S	Department of Mathematics UNIVERSITY OF MICHIGAN, Ann Arbor, MI	Sep 2007-Apr 2008
M. S	Department of Aerospace Engineering SEOUL NATIONAL UNIVERSITY, Korea <i>Thesis: Nonlinear Adaptive and Robust Flight Control Using the Backstepping Algorithm</i> <i>Advisor: Youdan Kim</i>	1998-2000
B. S	Department of Aerospace Engineering SEOUL NATIONAL UNIVERSITY, Korea	1994-1998

Professional Experience

Professor	Department of Mechanical and Aerospace Engineering THE GEORGE WASHINGTON UNIVERSITY, Washington DC	2020-present
Associate Professor	Department of Mechanical and Aerospace Engineering THE GEORGE WASHINGTON UNIVERSITY, Washington DC	2015-2020
Assistant Professor	Department of Mechanical and Aerospace Engineering THE GEORGE WASHINGTON UNIVERSITY, Washington DC	2011-2015
Assistant Professor	Department of Mechanical and Aerospace Engineering FLORIDA INSTITUTE OF TECHNOLOGY, Melbourne FL	2008-2011
Military Service	Second Lieutenant, Tactical Control Officer The 3rd Air Defense Artillery Division, Republic of Korea Air Force	2001-2004

Research Interests

Geometric Control on Manifolds: Global, intrinsic formulation of control systems on nonlinear manifold

Machine Learning for Control and Estimation: Concurrent stochastic learning and Bayesian estimation; Supervised learning for control of periodic motion with Floquet stability; Safe reinforcement learning for medical application; Neural-network based adaptive control

Aerial Robotics: Geometric mechanics, control, optimization, planning, estimation, vision-based perception for autonomous aerial systems, including multirotor UAV and micro flapping-wing UAV

Flight Experiments: Indoor/outdoor flight experiments for agile maneuvering, aerial transportation, autonomous landing on a ship, and aerial mapping; Design and development of flight software and hardware for autonomous aerial systems

Stochastic Analysis on Manifolds: Uncertainty propagation and Bayesian estimation on a manifold

Geometric Numerical Integration: Structure-preserving numerical integration schemes for Hamiltonian systems

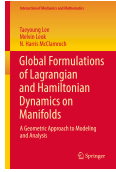
Research Grants (total award: over \$5.32M)

NSF CNS Computer and Network Systems #1837382 (\$1M, Co-PI) <i>CPS: Medium: Edge-Cloud Support for Predictable, Global Situational-Awareness for Autonomous Vehicle</i>	2019-2022
US Naval Academy (\$97K, PI) <i>Autonomous Landing on a Ship</i>	2019-2022
Air Force Office of Scientific Research (AFOSR) (\$600K, PI) <i>Uncertainty Quantification, Estimation, and Optimal Control for Stochastic Hybrid Systems on a Manifold</i>	2018-2022
NSF CMMI Dynamics, Control and Systems Diagnostics #1760928 (\$261K, PI) <i>Dynamics and Control of Long Range Micro Air Vehicles Inspired by Monarch Butterflies</i>	2018-2022
NASA Innovative Advanced Concepts (NIAC) Award (\$125K, co-PI) <i>Marsbee - Swarm of Flapping Wing Flyers for Enhanced Mars Exploration</i>	2018-2019
NSF IUCRC #1747760 (\$750K, co-PI) <i>Center for High Pressure Plasma Energy, Agriculture, and Biomedical Technologies</i>	2018-2023
Office of Naval Research (ONR) Grant #N00014-15-1-2043 (\$655K, co-PI) <i>Analysis of Ship Air Wakes</i>	2015-2018
Naval Research Laboratory (NRL) Contract #N00173-14-F-0584 (\$326K, PI) <i>Collaborative Autonomous Aerial Exploration</i>	2015-2017
NSF CMMI Control Systems #1335008 (\$220K, PI) <i>Stochastic Motion Planning and Estimation with Non-Gaussian Uncertainty Distributions on a Lie Group</i>	2013-2018
NSF CNS Major Research Instrumentation #1337722 (\$500K, co-PI) <i>Development of Large-Scale Dense Scene Capture and Tracking Instrument</i>	2013-2018
NSF CMMI Dynamic Systems #1029551 (\$150K, PI) <i>Computational Geometric Uncertainty Propagation for Hamiltonian Systems on a Lie Group</i>	2010-2014
GWU Institute For Biomedical Engineering Interdisciplinary Research Grant (PI) <i>Optimal Control of Anti-Tachycardia Pacing Therapy</i>	2011-2012
FIT Faculty Professional Development Grant (PI) <i>Development of an Autonomous Quadrotor UAV for Educational Research</i>	2010-2011

Honor & Awards

Air Force Summer Faculty Fellowship, Air Force Office of Scientific Research, Kirtland AFB, Albuquerque NM <i>Vision-Based Spacecraft Formation Control and Estimation Network</i>	2013
Air Force Summer Faculty Fellowship, Air Force Office of Scientific Research, Kirtland AFB, Albuquerque NM <i>Vision-Based Spacecraft Relative Attitude Control and Estimation</i>	2012
Best Student Course Evaluation, Mechanical and Aerospace Engineering, Florida Institute of Technology	2010
Distinguished Dissertation Award, honorable mention, University of Michigan	2009
Distinguished Achievement Award, College of Engineering, University of Michigan	2008
Ivor K. McIvor Award, College of Engineering, University of Michigan (outstanding research in applied mechanics)	2008
SIAM Conference on Computational Science and Engineering, BGCE Student Paper Prize, finalist	2007
Rackham Predoctoral Fellowship, University of Michigan	2006-2007
Rackham International Students Fellowship, University of Michigan	2006
Rackham Travel Grant, University of Michigan	Feb, Aug 2006
International Scholarship, Ministry of Education & Human Resources Development, Korea	2004

Book



- [1] T. Lee, M. Leok, and N.H. McClamroch. *Global Formulation of Lagrangian and Hamiltonian Dynamics on Manifolds*. Springer, 2018.

Computational Geometric Control

- *[1] T. C and T. Lee. Constrained imitation learning for a flapping wing unmanned aerial vehicle. In *Proceedings of IEEE International Conference on Intelligent Robots and Systems*, February 2022. submitted.
- [2] T. C and T. Lee. Geometric optimal controls for flapping wing UAV on a Lie group. In *IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control*, October 2021.
- [3] K. Gamagedara, T. Lee, and M. Snyder. Unscented Kalman filter for INS/GNSS data fusion with time delay. In *Proceedings of AIAA Aviation Forum*, August 2021. AIAA 2021-2486.
- [4] M. Snyder, K. Gamagedara, T. Lee, and J. Pritchard. In situ detection and analysis of ship air wakes from a US navy research vessel. In *Proceedings of AIAA Aviation Forum*, August 2021. AIAA 2021-2485.
- [5] M. Bisheban and T. Lee. Geometric adaptive control with neural networks for a quadrotor UAV in wind fields. *IEEE Transactions on Control Systems Technology*, 29(4):1533–1548, July 2021. doi:10.1109/TCST.2020.3006184.
- *[6] T. C and T. Lee. Iterative supervised learning for regression with constraints. In *International Conference on Ubiquitous Robots*, June 2021. submitted.
- [7] T. C, C. Kang, and T. Lee. Dynamics and control of a flapping wing UAV with abdomen undulation inspired by Monarch butterfly. In *Proceedings of the American Control Conference*, pages 66 – 71, May 2021.
- [8] B. Yu, K. Gamagedara, S. Kim, T. Lee, and J. Suk. Geometric control and experimental validation for a quadrotor UAV transporting a payload. In *Proceedings of IEEE Conference on Decision and Control*, pages 201–207, December 2020.
- [9] K. Gamagedara, M. Bisheban, E. Kaufman, and T. Lee. Geometric controls of a quadrotor with a decoupled yaw control. In *Proceedings of the American Control Conference*, June 2019.
- [10] M. Bisheban and T. Lee. Geometric adaptive control for a quadrotor UAV with wind disturbance rejection. In *Proceedings of IEEE Conference on Decision and Control*, pages 2816–2821, December 2018.
- [11] T. Lee, D. Chang, and Y. Eun. Semi-global non-memoryless attitude controls on the special orthogonal group. *ASME Journal of Dynamic Systems, Measurement, and Control*, 141(2):021005, October 2018. doi:10.1115/1.4041447.
- [12] Z. Zhao, G. Cruz, T. Lee, and D. Bernstein. Adaptive attitude control of a dual-rigid-body spacecraft with unmodeled nonminimum-phase dynamics. In *Proceedings of the American Control Conference*, pages 2503–2508, June 2018.
- [13] L. Simon, R. Agnes, K. Gamagedara, K. Takami, M. Snyder, and T. Lee. Studies on autonomous landing of an unmanned aerial vehicle on a vessel. In *Proceedings of AIAA Information Systems*, January 2018. AIAA 2018-1461.
- [14] T. Lee. Geometric control of quadrotor UAVs transporting a cable-suspended rigid body. *IEEE Transactions on Control Systems Technology*, 26(1):255–264, January 2018. doi:10.1109/TCST.2017.2656060.
- [15] S. Kulumani and T. Lee. Constrained geometric attitude control on $SO(3)$. *International Journal of Control, Automation, and Systems*, 15(6):2796–2809, December 2017. doi:10.1007/s12555-016-0607-4.

* pending

- [16] T. Wu, B. Flewelling, F. Leve, and T. Lee. Spacecraft attitude formation tracking using line-of-sight measurements. *AIAA Journal of Guidance, Control, and Dynamics*, 40(10):2616–2629, October 2017. doi:10.2514/1.G001727.
- [17] S. Kulumani, K. Takami, and T. Lee. Geometric control for autonomous landing on asteroid Itokawa using visual localization. In *Proceedings of the AAS/AIAA Astrodynamics Specialist Conference*, August 2017. AAS 17-720.
- [18] T. Lee, D. Chang, and Y. Eun. Attitude control strategies overcoming the topological obstruction on $SO(3)$. In *Proceedings of the American Control Conference*, pages 4942–4947, May 2017.
- [19] T. Lee. Optimal hybrid controls for global exponential tracking on the two-sphere. In *Proceedings of the IEEE Conference on Decision and Control*, pages 3331–3337, Las Vegas, NV, December 2016.
- [20] F. Goodarzi and T. Lee. Stabilization of a rigid body payload with multiple cooperative quadrotors. *ASME Journal of Dynamic Systems, Measurement, and Control*, 138(12):121001–121001–17, December 2016. doi:10.1115/1.4033945.
- [21] S. Kulumani, C. Poole, and T. Lee. Geometric adaptive control of attitude dynamics on $SO(3)$ with state inequality constraint. In *Proceedings of the American Control Conference*, pages 4936–4941, Boston, MA, July 2016.
- [22] K. Lee, C. Park, T. Lee, and S. Park. Spacecraft formation keeping via discrete-time Hamilton-Jacobi theory. In *Proceedings of the AIAA Guidance, Navigation and Control Conference*, January 2016. AIAA 2016-0874.
- [23] T. Lee. Geometric controls for a tethered quadrotor UAV. In *Proceedings of the IEEE Conference on Decision and Control*, pages 2749–2754, Osaka, Japan, December 2015.
- [24] F. Goodarzi, D. Lee, and T. Lee. Geometric control of a quadrotor UAV transporting a payload connected to a quadrotor UAV via flexible cable. *International Journal of Control, Automation, and Systems*, 13(6):1–13, December 2015. doi:10.1007/s12555-014-0304-0.
- [25] T. Lee. Global exponential attitude tracking controls on $SO(3)$. *IEEE Transactions on Automatic Control*, 60(10):2837–2842, October 2015. doi:10.1109/TAC.2015.2407452.
- [26] T. Lee. Geometric adaptive control for aerial transportation of a rigid body. In *Proceedings of the IMA Conference on Mathematics of Robotics*, September 2015.
- [27] F. Goodarzi, D. Lee, and T. Lee. Geometric adaptive tracking control of a quadrotor unmanned aerial vehicle on $SE(3)$. *ASME Journal of Dynamic Systems, Measurement, and Control*, 137(9), September 2015. doi:10.1115/1.4030419.
- [28] F. Goodarzi and T. Lee. Dynamics and control of quadrotor UAVs transporting a rigid body connected via flexible cables. In *Proceedings of the American Control Conference*, pages 4677–4682, July 2015.
- [29] T. Lee. Collision avoidance via Voronoi tessellation for quadrotor UAVs transporting a payload. In *Proceedings of the American Control Conference*, pages 1842–1848, July 2015.
- [30] E. Kaufman and T. Lee. Geometric adaptive control for aerial transportation of a rigid body. Presented at International Conference on Robotics and Automation, May 2015.
- [31] T. Wu and T. Lee. Spacecraft attitude formation stabilization using lines-of-sight without angular velocity measurements. In *Proceedings of the AAS/AIAA Space Flight Mechanics Meeting*, February 2015. AAS 15-441.
- [32] S. Dai, T. Lee, and D. Bernstein. Adaptive control of a quadrotor UAV transporting a cable-suspended load with unknown mass. In *Proceedings of the IEEE Conference on Decision and Control*, pages 6149–6154, December 2014.
- [33] T. Wu and T. Lee. Spacecraft position and attitude formation control using line-of-sight observations. In *Proceedings of the IEEE Conference on Decision and Control*, pages 970–975, December 2014.
- [34] T. Lee. Geometric control of multiple quadrotor UAVs transporting a cable-suspended rigid body. In *Proceedings of the IEEE Conference on Decision and Control*, pages 6155–6160, December 2014.
- [35] F. Goodarzi, D. Lee, and T. Lee. Geometric stabilization of a quadrotor UAV with a payload connected by flexible cable. In *Proceedings of the American Control Conference*, pages 4925–4930, June 2014.

- [36] J. Dougherty, D. Lee, and T. Lee. Laser-based guidance of a quadrotor UAV for precise landing on an inclined surface. In *Proceedings of the American Control Conference*, pages 1210–1215, June 2014.
- [37] E. Kaufman, K. Caldwell, D. Lee, and T. Lee. Design and development of a free-floating hexrotor UAV for 6-dof maneuvers. In *Proceedings of the IEEE Aerospace Conference*, March 2014.
- [38] T. Lee, K. Sreenath, and V. Kumar. Geometric control of cooperating multiple quadrotor UAVs with a suspended load. In *Proceedings of the IEEE Conference on Decision and Control*, volume 5510–5515, Florence, Italy, December 2013.
- [39] K. Sreenath, T. Lee, and V. Kumar. Geometric control and differential flatness of a quadrotor UAV with a cable-suspended load. In *Proceedings of the IEEE Conference on Decision and Control*, pages 2269–2274, Florence, Italy, December 2013.
- [40] T. Wu, T. Lee, and M. Keidar. Low-thrust attitude control for nano-satellite with micro-cathode thrusters. In *Proceedings of the International Electric Propulsion Conference*, Washington, DC, October 2013. IEPC-2013-366.
- [41] T. Lee. Robust adaptive tracking on $SO(3)$ with an application to the attitude dynamics of a quadrotor UAV. *IEEE Transactions on Control Systems Technology*, 21(5):1924–1930, September 2013. doi:10.1109/TCST.2012.2209887.
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- [44] T. Lee. Robust global exponential attitude tracking controls on $SO(3)$. In *Proceedings of the American Control Conference*, pages 2103–2108, Washington, DC, June 2013.
- [45] T. Wu, B. Flewelling, F. Leve, and T. Lee. Spacecraft relative attitude formation tracking on $SO(3)$ based on line-of-sight measurements. In *Proceedings of the American Control Conference*, pages 4827–4832, Washington, DC, June 2013.
- [46] T. Lee, M. Leok, and N.H. McClamroch. Nonlinear robust tracking control of a quadrotor UAV on $SE(3)$. *Asian Journal of Control*, 15(2):391–408, March 2013. doi:10.1002/asjc.567.
- [47] T. Lee, M. Leok, and N.H. McClamroch. Dynamics and control of a chain pendulum on a cart. In *Proceedings of the IEEE Conference on Decision and Control*, pages 2502–2508, Maui, HI, December 2012.
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- [49] T. Lee. Relative attitude control of two spacecraft on $SO(3)$ using line-of-sight observations. In *Proceedings of the American Control Conference*, pages 167–172, Montreal, Canada, June 2012.
- [50] T. Lee. Exponential stability of an attitude tracking control system on $SO(3)$ for large-angle rotational maneuvers. *Systems and Control Letters*, 61(1):231–237, January 2012. doi:10.1016/j.sysconle.2011.10.017.
- [51] T. Fernando, J. Chandiramani, T. Lee, and H. Gutierrez. Robust adaptive geometric tracking controls on $SO(3)$ with an application to the attitude dynamics of a quadrotor UAV. In *Proceedings of the IEEE Conference on Decision and Control*, pages 7380–7385, Orlando, FL, December 2011.
- [52] T. Lee, M. Leok, and N.H. McClamroch. Geometric tracking control of a quadrotor UAV for extreme maneuverability. In *Proceedings of the World Congress of the International Federation of Automatic Control*, pages 6337–6342, Milano, Italy, August 2011.
- [53] T. Lee. Geometric tracking control of the attitude dynamics of a rigid body on $SO(3)$. In *Proceedings of the American Control Conference*, pages 1200–1205, San Francisco, CA, June 2011.
- [54] T. Lee, M. Leok, and N.H. McClamroch. Geometric tracking control of a quadrotor UAV on $SE(3)$. In *Proceedings of the IEEE Conference on Decision and Control*, pages 5420–5425, Atlanta, GA, December 2010.

Computational Geometric Optimization

- [1] T. Lee, M. Tao, and M. Leok. Variational symplectic accelerated optimization on Lie groups. In *Proceedings of IEEE Conference on Decision and Control*, pages 233 – 240, 2021.
- [2] S. Kulumani and T. Lee. Bayesian shape reconstruction and optimal guidance for autonomous landing on asteroids. *Journal of the Astronautical Sciences*, 2021. accepted.
- [3] S. Kulumani and T. Lee. Systematic design of optimal low-thrust transfers for the three-body problem. *Journal of the Astronautical Sciences*, 66(1):1–31, March 2019. doi:10.1007/s40295-018-00139-y.
- [4] S. Kulumani and T. Lee. Low-thrust trajectory design using reachability sets near asteroid 4769 Castalia. In *Proceedings of the AIAA/AAS Astrodynamics Specialist Conference*, September 2016. AIAA 2016-5376.
- [5] S. Kulumani and T. Lee. Systematic design of optimal low-thrust transfers for the three-body problem. In *Proceedings of the AIAA/AAS Astrodynamics Specialist Conference*, August 2015. AAS 15-757.
- [6] T. Lee. Optimal control of partitioned hybrid systems via discrete-time Hamilton-Jacobi theory. *Automatica*, 50(8):2062–2069, August 2014. doi:10.1016/j.automatica.2014.05.024.
- [7] T. Lee. Discrete-time optimal feedback control via the discrete Hamilton-Jacobi theory with applications to hybrid systems. In *Proceedings of the IEEE Conference on Decision and Control*, pages 7055–7062, Maui, HI, December 2012.
- [8] T. Lee, M. Leok, and N.H. McClamroch. Computational geometric optimal control of connected rigid bodies in a perfect fluid. In *Proceedings of the American Control Conference*, pages 5985–5990, Baltimore, MD, June 2010. url:<http://arxiv.org/abs/0705.3868>.
- [9] T. Lee, M. Leok, and N.H. McClamroch. Discrete control systems. In *the Encyclopedia of Complexity and System Science*, pages 2002–2019. Springer, 2009.
- [10] T. Lee, M. Leok, and N.H. McClamroch. Optimal attitude control of a rigid body using geometrically exact computations on $SO(3)$. *Journal of Dynamical and Control Systems*, 14(4):465–487, October 2008. doi:10.1007/s10883-008-9047-7.
- [11] T. Lee, M. Leok, and N.H. McClamroch. Time optimal attitude control for a rigid body. In *Proceedings of the American Control Conference*, pages 5210–5215, Seattle, WA, June 2008.
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- [13] T. Lee, M. Leok, and N.H. McClamroch. A combinatorial optimal control problem for spacecraft formation reconfiguration. In *Proceedings of the IEEE Conference on Decision and Control*, pages 5370–5375, New Orleans, LA, December 2007.
- [14] T. Lee, M. Leok, and N.H. McClamroch. Optimal attitude control for a rigid body with symmetry. In *Proceedings of the American Control Conference*, pages 1073–1078, New York, NY, July 2007.
- [15] T. Lee, M. Leok, and N.H. McClamroch. Optimal control of a rigid body using geometrically exact computations on $SE(3)$. In *Proceedings of the IEEE Conference on Decision and Control*, pages 2170–2175, San Diego, CA, December 2006.
- [16] T. Lee, M. Leok, and N.H. McClamroch. Attitude maneuvers of a rigid spacecraft in a circular orbit. In *Proceedings of the American Control Conference*, pages 1742–1747, Minneapolis, MN, June 2006.

Computational Geometric Mechanics

- [1] T. Morris, M. Sridhar, T. Clark, F. Schulze, C. Kang, D. Landrum, K. Roh, T. Lee, and H. Aono. Experimental measurements of the wing deformation and force production of real and bioinspired artificial Monarch butterfly wings. In *Proceedings of the AIAA Scitech Forum*, January 2022. AIAA 2022-0308.
- [2] T. C. M. Sridhar, C. Kang, and T. Lee. Effects of abdomen undulation in energy consumption and stability for the flights of monarch butterfly. *Bioinspiration & Biomimetics*, 16(4):046003, May 2021. doi:10.1088/1748-3190/abce4d.

- [3] M. Sridhar, C. Kang, D. Landrum, H. Aono, S. Mathis, and T. Lee. Effects of flight altitude on the lift generation of monarch butterflies: from sea level to overwintering mountain. *Bioinspiration & Biomimetics*, 16:034002, March 2021. doi:<https://doi.org/10.1088/1748-3190/abe108>.
- [4] M. Sridhar, J. Pohly, C. Kang, T. Lee, and H. Aono. Effects of vein structures on fluid-structure interaction of flexible flapping wings at high altitudes. In *Proceedings of the AIAA Scitech Forum*, January 2021. AIAA 2021-0963.
- [5] H. Sharma, T. Lee, M. Patil, and C. Woolsey. Symplectic accelerated optimization on $SO(3)$ with Lie group variational integrators. In *Proceedings of the American Control Conference*, pages 2826–2831, July 2020.
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- [9] T. Lee, M. Leok, and N.H. McClamroch. Geometric formulations of Furuta pendulum control problems. *Mathematics in engineering, science and aerospace*, 7(1):69–81, 2016.
- [10] T. Lee, M. Leok, and N.H. McClamroch. Global formulations of Lagrangian and Hamiltonian mechanics on two-spheres. In *Proceedings of the IEEE Conference on Decision and Control*, pages 6010–6015, Osaka, Japan, December 2015.
- [11] T. Lee, M. Leok, and N.H. McClamroch. Global formulations of Lagrangian and Hamiltonian dynamics on embedded manifolds. In *Proceedings of the IMA Conference on Mathematics of Robotics*, September 2015.
- [12] T. Lee, F. Leve, M. Leok, and N.H. McClamroch. Lie group variational integrators for spacecraft with variable speed control moment gyros. In *Proceedings of the U.S. National Congress on Computational Mechanics*, July 2015.
- [13] T. Lee and F. Leve. Lagrangian mechanics and Lie group variational integrators for spacecraft with imbalanced reaction wheels. In *Proceedings of the American Control Conference*, pages 3122–3127, June 2014.
- [14] T. Lee, M. Leok, and N.H. McClamroch. High-fidelity numerical simulation of complex dynamics of tethered spacecraft. *Acta Astronautica*, 99(1):215–230, June 2014. doi:10.1016/j.actaastro.2014.02.021.
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- [16] T. Lee, M. Leok, and N.H. McClamroch. Stable manifolds of saddle points for pendulum dynamics on S^2 and $SO(3)$. In *Proceedings of the IEEE Conference on Decision and Control*, pages 3915–3921, Orlando, FL, December 2011.
- [17] T. Lee, M. Leok, and N.H. McClamroch. Geometric numerical integration for complex dynamics of tethered spacecraft. In *Proceedings of the American Control Conference*, pages 1885–1891, San Francisco, CA, June 2011.
- [18] T. Lee, M. Leok, and N.H. McClamroch. Computational dynamics of a 3D elastic string pendulum attached to a rigid body and an inertially fixed reel mechanism. *Nonlinear Dynamics*, 64(1-2):97–115, April 2011. doi:10.1007/s11071-010-9849-5.
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- [20] T. Lee, M. Leok, and N.H. McClamroch. Dynamics of a 3D elastic string pendulum. In *Proceedings of IEEE Conference on Decision and Control*, pages 3347–3352, Shanghai, China, December 2009.
- [21] T. Lee, M. Leok, and N.H. McClamroch. Lagrangian mechanics and variational integrators on two-spheres. *International Journal for Numerical Methods in Engineering*, 79(9):1147–1174, August 2009. doi:10.1002/nme.2603.
- [22] T. Lee, M. Leok, and N.H. McClamroch. Dynamics of connected rigid bodies in a perfect fluid. In *Proceedings of the American Control Conference*, pages 408–413, St. Louis, MO, June 2009.

- [23] T. Lee. *Computational Geometric Mechanics and Control of Rigid Bodies*. PhD thesis, University of Michigan, 2008.
- [24] T. Lee, M. Leok, and N.H. McClamroch. Lie group variational integrators for the full body problem in orbital mechanics. *Celestial Mechanics and Dynamical Astronomy*, 98(2):121–144, June 2007. doi:10.1007/s10569-007-9073-x.
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- [26] E. Fahnestock, T. Lee, M. Leok, N.H. McClamroch, and D. Scheeres. Polyhedral potential and variational integrator computation of the full two body problem. In *Proceedings of the AIAA/AAS Astrodynamics Specialist Conference and Exhibit*, Keystone, CO, August 2006. AIAA 2006-6289.
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Uncertainty Propagation / Estimation

- [1] W. Wang and T. Lee. Spacecraft attitude and gyro-bias estimation with a single magnetometer on $so(3) \times \mathbb{R}^n$. In *Proceedings of the AIAA Scitech Forum*, January 2022. AIAA 2022-0616.
- [2] K. Gamagedara, T. Lee, and M. Snyder. Quadrotor state estimation with IMU and delayed real-time kinematic GPS. *IEEE Transactions on Aerospace and Electronic Systems*, 57(5):2661 – 2673, October 2021. doi:10.1109/TAES.2021.3061795.
- [3] W. Wang and T. Lee. Bingham–gaussian distribution for unscented attitude estimation. In *Proceedings of IEEE International Conference on Multisensor Fusion and Integration*, September 2021.
- *[4] W. Wang and T. Lee. Uncertainty propagation for general stochastic hybrid systems on compact lie groups. *SIAM Journal on Applied Dynamical Systems*, August 2021. submitted.
- *[5] W. Wang, K. Gamagedara, and T. Lee. On the observability of attitude with single direction measurements. *IEEE Transactions on Automatic Control*, May 2021. submitted.
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- [48] T. Lee and M. Leok. Computational geometric uncertainty propagation and global estimation for Hamiltonian systems on a Lie group. *Proceedings of the NSF CMMI Research and Innovation Conference*, July 2012.
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Nonlinear Flight Control

- [1] N.H. McClamroch and T. Lee. Optimal flight planning for a jet aircraft mission. In K. Murty, editor, *Case Studies in Operations Research*, volume 212 of *International Series in Operations Research and Management Science*, , pages 355–390. Springer, 2015.
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Control of Biomedical Systems

- [1] L. Lin, D. Yan, T. Lee, and M. Keidar. Self-adaptive plasma chemistry and intelligent plasma medicine. *Advanced Intelligent Systems*, October 2021. doi:10.1002/aisy.202100112.
- [2] Z. Hou, T. Lee, and M. Keidar. Reinforcement learning with safe exploration for adaptive plasma cancer treatment. *IEEE Transactions on Radiation and Plasma Medical Sciences*, July 2021. accepted. doi:10.1109/TRPMS.2021.3094874.
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Open-Source Software Development

- [1] T. Lee. *Fast Fourier Transform on $SO(3)$* , <https://fdcl-gwu.github.io/FFTSO3>, 2018
- [2] T. Lee. *Matrix Fisher Distribution on $SO(3)$* , <https://github.com/tylee-fdcl/Matrix-Fisher-Distribution>, 2018
- [3] T. Lee. *Geometric Formulations for the Flapping Wing UAV*, <https://github.com/fdcl-gwu/FWUAV>, 2019

Invited Talks

- | | |
|--|----------|
| [1] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
Korea Aerospace University (virtual) | Jul 2021 |
| [2] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
University of Minnesota (virtual) | Nov 2020 |
| [3] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
Rutgers University, New Brunswick NJ | Oct 2019 |
| [4] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
University of Maryland, College Park MD | Oct 2019 |
| [5] <i>Stochastic Hybrid Systems on a Manifold</i>
Air Force Office of Scientific Research, Arlington VA | Aug 2019 |
| [6] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
University of Maryland, College Park MD | Oct 2018 |
| [7] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
Virginia Tech, Blacksburg VA | Apr 2018 |
| [8] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
University of Alabama, Huntsville, Huntsville AL | Mar 2018 |
| [9] <i>Intrinsic Formulation of Bayesian Estimation on a Lie Group</i>
Electrical Engineering, KAIST, Daejeon, South Korea | Aug 2017 |
| [10] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
Aerospace Engineering, KAIST, Daejeon, South Korea | Aug 2017 |
| [11] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
University of Michigan, Ann Arbor, MI | Mar 2016 |
| [12] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
MAE Seminar Series, Syracuse University, Syracuse, NY | Mar 2016 |
| [13] <i>Global Formulations of Stochastic Analysis on Manifolds</i>
NSF Workshop on Learning, Perception and Control in Robots and Humans, Arlington VA | Aug 2015 |
| [14] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
MAE Seminar Series, Seoul National University, South Korea | Sep 2014 |
| [15] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
Department Seminar Series, Yonsei University, South Korea | Sep 2014 |
| [16] <i>Stochastic Optimal Motion Planning and Estimation for the Attitude Kinematics on $SO(3)$</i>
AMS Eastern Sectional Meeting, Special Session on Mechanics and Control, Baltimore MD | Mar 2014 |
| [17] <i>Geometric Mechanics and Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
AFRL Seminar Series, Kirtland AFB, Albuquerque NM | Jul 2013 |
| [18] <i>Computational Geometric Mechanics and Controls for Complex Aerospace Systems</i>
ECE Seminar Series, University of Virginia | Mar 2013 |
| [19] <i>Computational Geometric Mechanics and Control on Nonlinear Manifolds</i>
Mathematics Colloquium Series, University of Maryland Baltimore County | Nov 2011 |
| [20] <i>Geometric Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
Physical Sciences Department Colloquium Series, Embry-Riddle Aeronautical University | Apr 2011 |
| [21] <i>Geometric Control on Nonlinear Manifolds for Complex Aerospace Systems</i>
MAE Seminar, George Washington University | Mar 2011 |
| [22] <i>Discrete Geometric Mechanics</i>
Young Researchers Workshop on Geometry, Mechanics and Control, University of La Laguna, Spain | Dec 2010 |
| [23] <i>Computational Geometric Mechanics and Control of Multibody Systems</i> | May 2010 |

University of Michigan

- [24] *Lie Group Variational Integrator for Dynamics and Control of Multibody Systems* Apr 2010
Structured Integrators Workshop, University of California, San Diego
- [25] *Computational Geometric Mechanics and Control of Rigid Bodies* Feb 2008
Florida Institute of Technology, Melbourne, Florida
- [26] *Computational Geometric Mechanics, Control, and Estimation of Rigid Bodies on Lie Groups* Feb 2007
SIAM Conference on Computational Science and Engineering, Costa Mesa, California
- [27] *Optimal Control of a Rigid Body using Geometrically Exact Computations on Lie Groups* Oct 2006
Flight Dynamics and Control Seminar, University of Michigan
- [28] *Attitude Maneuvers of a Rigid Spacecraft in a Circular Orbit* Nov 2005
Flight Dynamics and Control Seminar, University of Michigan
- [29] *Lie Group Variational Integrator for the Attitude dynamics of a Rigid body* Feb 2005
Flight Dynamics and Control Seminar, University of Michigan

Editorial Services

- Senior Editor:** Conference Editorial Board 2018-2022
International Conference on Ubiquitous Robotics
- Committee Member:** Technical Program Committee 2016, 2018
American Control Conference
- Associate Editor:** Conference Editorial Board, IEEE Robotics and Automation Society 2014-2020
2015, 2016, 2017, 2018, 2019 IEEE Conference on Robotics and Automation
- Associate Editor:** Conference Editorial Board, IEEE Control System Society 2013-2020
2014, 2015, 2016, 2017, 2018, 2019, 2020 American Control Conference
2014, 2015, 2016, 2017, 2018, 2019, 2020 IEEE Conference on Decision and Control
- Committee Member:** Program Committee, Conference Organization Board 2015, 2021
IMA Conference on Mathematics on Robotics

Conference Organization and Service

- Committee Member:** Local Arrangement Committee, Conference Organization Board 2013
American Control Conference
- Organizer, Chair:** Geometric Control on Nonlinear Manifolds 2010
Invited Session at IEEE Conference on Decision and Control, Atlanta
- Organizer, Chair:** Synergies and Interplay of Nonlinear Dynamics and Control 2010
Symposium in honor of Dr. Harris McClamroch, University of Michigan
“HarrisFest [Conference Report],” *IEEE Control System Magazine*, vol. 30, no. 5, pp. 81-83, 2010

Media Coverage

- Inquisitr:** GWU Engineer To Develop Robo Bees That Will Map The Surface Of Mars 2018
- Gizmodo:** Buzz Buzz, NASA Funds Project to Put Bee Robots on Mars 2018
- The engineer:** “Marsbees” chosen as potential pioneers of Martian exploration 2018
- Mars daily:** UAH gets NASA early-stage funding for “Marsbees” concept 2018

Professional Service and Review

Review Panelist: NASA	2019
Review Panelist: National Science Foundation (NSF)	2013, 2015
Reviewer: National Science Foundation (NSF); Air Force Office of Scientific Research (AFOSR); IEEE Transactions on Automatic Control; IEEE Transactions on Control Systems Technology; IEEE Transactions on Mechatronics; IEEE Transactions on Neural Networks; IEEE Transaction on Plasma Science; IEEE Transactions on Industrial Electronics; IEEE Transactions on Aerospace and Electronic Systems; IEEE Robotics and Automation Magazine; SIAM Journal on Control and Optimization; ASME Journal of Dynamics, Measurements, and Control; AIAA Journal of Guidance, Control, and Dynamics; International Journal of Aerospace Engineering; International Journal of Adaptive Control and Signal Processing; International Journal of Advanced Robotic Systems; International Journal of Control; International Journal of Control, Automation and Systems; International Journal of Robust and Nonlinear Control; Asian Journal of Control; Acta Astronautica; Aerospace Science & Technology; Automatica; Celestial Mechanics and Dynamical Astronomy; The Astronomical Journal; Control Engineering Practice; Computer Physics Communications; Chinese Journal of Aeronautics; The Astronomical Journal; Journal of Aerospace Engineering; Journal of Geometric Mechanics; Journal of Nonlinear Science; Mathematics of Control, Signals, and Systems; Transactions of the Japan Society for Aeronautical and Space Sciences, Aerospace Technology; Robotica; Symmetry, Integrability and Geometry: Methods and Applications; Systems and Control Letters; IEEE Conference on Decision and Control; IEEE Multi-conference on Systems and Control; IEEE International Conference on Robotics and Automation; IEEE International Conference on Intelligent Robots and Systems; AIAA Guidance, Navigation and Control Conference; American Control Conference; Applied Mathematical Modelling; European Control Conference; International Conference on Unmanned Aircraft Systems; IMA Conference on Mathematics of Robotics	
Assessment Coordinator: FIT University coordinator for Southern Association of Colleges and Schools (SACS) accreditation	2011
Judge: SSPI Mid-Atlantic Regional Chapter Scholarship Competition	2011
Judge: GWU SEAS Research and Development Showcase	2013, 2014
Judge: GWU Research Day	2017
Judge: GWU SEAS Pelton Senior Project Award	2017

University Service

Committee Member: Personnel Subcommittee, School of Engineering and Applied Science, GWU	2021-2022
Committee Chair: Personnel Subcommittee, Mechanical and Aerospace Engineering, GWU	2021-2022
Committee Member: Graduate Curriculum Committee, Mechanical and Aerospace Engineering, GWU	2021-2022
Committee Chair: Faculty Search Committee, Mechanical and Aerospace Engineering, GWU	2019-2020
Committee Member: Finance Committee, School of Engineering and Applied Science, GWU	2018-2019
Committee Member: Faculty Search Committee, Mechanical and Aerospace Engineering, GWU	2018-2019
Committee Member: Undergraduate Curriculum Committee, Mechanical and Aerospace Engineering, GWU	2018-2021
Committee Member: Research Committee, Faculty Senate, GWU	2013-2014
Committee Member: Graduate Curriculum Committee, Mechanical and Aerospace Engineering, GWU	2013-2015
Faculty secretary: Mechanical and Aerospace Engineering, GWU	2012-2013

Dissertation Directed

- [1] M. Bisheban, *Geometric Estimation and Control of Quadrotor UAVs in Wind Fields*, Ph.D Dissertation, The George Washington University, 2018
- [2] E. Kaufman, *Multi-Robot Probabilistic Mapping and Exploration*, Ph.D Dissertation, The George Washington University, 2018
- [3] S. Kulumani, *Geometric Mechanics and Control for Small Body Missions*, Ph.D Dissertation, The George Washington University, 2018

- [4] T. Wu, *Geometric Attitude Controls And Estimations On The Special Orthogonal Group*, Ph.D Dissertation, The George Washington University, 2016
- [5] F. Goodarzi, *Geometric Nonlinear Controls for Multiple Cooperative Quadrotor UAVs Transporting a Rigid Body*, Ph.D Dissertation, The George Washington University, 2015
- [6] J. Dougherty, *Laser-Guided Autonomous Landing of a Quadrotor UAV on an Inclined Surface*, MS Thesis, 2014
- [7] T. Wu, *Spacecraft Relative Attitude Formation Tracking on $SO(3)$ Based on Line-of-Sight Measurements*, MS Thesis, 2013

Mentoring Experiences

Postdoctoral Scientist	Dr. Kuya Takami: Autonomous aerial exploration	2016-2017
	Dr. Daewon Lee: Adaptive control of autonomous load transportation	2012-2014
Doctoral Students	Maneesha Wickramasuriya : Vision-based estimation	2021-present
	Beomyeon Yu : Reinforcement Learning for Quadrotor	2021-present
	Tejaswi K. C. : Flapping wing UAV	2020-present
	Zichao Hou : Autonomous cancer treatment	2019-present
	Weixin Wang : Hybrid systems on a manifold	2019-present
	Kanishke Gamagedar : Autonomous landing on a ship	2018-present
	Mahdis Bisheban : Geometric control of quadrotors under wind	2015-2018
	Shankar Kulamani : Low thrust optimal orbital maneuvers	2014-2018
	Evan Kaufman : Autonomous aerial exploration	2012-2018
	Tse-Huai Wu : Geometric control and estimation on $SO(3)$	2013-2015
Masters Students	Farhad Goodarzi : Geometric control of quadrotor UAV	2011-2015
	Tejaswi K. C. : Flapping wing UAV	2019-2020
	Zichao Hou : Autonomous exploration of Mars	2018-2019
	Kanishke Gamagedar : Development of telemetry for ship air wakes	2016-2017
	Kalpesh Patil : Development of telemetry for ship air wakes	2015-2017
	Kiren Caldwell : Outdoor flight of quadrotor UAV via differential GPS	2014-2015
	John A. Dougherty : Laser-based guidance of quadrotor UAV	2013-2014
Undergraduate Students	Tse-Huai Wu : Vision-based spacecraft formation control	2011-2013
	Allegra Farrar : Interaction between UAV and human	2018-2020
	Noah Curtiss : Development of multirotor UAV	2017-2019
	Carolyn Fisk : Cubesat mission analysis and design	2017-2019
	Chris Poole : Development of multirotor UAV	2015-2018
	Kiren Caldwell : Development of user interface for UAV control	2013-2014
	John Dougherty: Development of i2c interface circuit board	2012-2013
	Ryan Mossbarger: Development of thrust stand	2012-2013
Visiting Scholar	Prof. S. Kim (CNU South Korea) : Autonomous aerospace system	2019-2020
	Harsh Sharmar (VaTech) : Geometric numerical integration	2018, 2019

Student Recognition

<i>Most Innovative/Creative Project Award:</i> (Weixin Wang) Matrix Fisher–Gaussian Distribution for Spacecraft Attitude Estimation The 11th Annual Student Competition, Society for Satellite Professional Internationals (SSPI)	2021
<i>NSF Graduate Research Fellow:</i> (Allegra Farrar)	2020
<i>AFRL Scholar:</i> (Carolyn Fisk) Kirtland AFB, Albuquerque NM	2018
<i>Most Innovative/Creative Project Award:</i> (Shankar Kulumani) Spacecraft trajectory design near asteroid 4769 Castalia The 7th Annual Student Competition, Society for Satellite Professional Internationals (SSPI)	2017
<i>Mechanical and Aerospace Engineering – 1st Place:</i> (Shankar Kulumani) Spacecraft trajectory design near asteroid 4769 Castalia GWU Research Day	2017
<i>Best Theoretical Poster – Runner-up</i> (Shankar Kulumani) Spacecraft trajectory design near asteroid 4769 Castalia SEAS R&D Showcase, George Washington University	2017
<i>Entrepreneurship Prize</i> (Evan Kaufman) A robotic vacuuming software tool with autonomous exploration via exact occupancy grid mapping SEAS R&D Showcase, George Washington University	2017
<i>Best Theoretical Poster – 3rd Place</i> (Mahdis Bisheban) Computational geometric system identification SEAS R&D Showcase, George Washington University	2017
<i>Student Travel Award:</i> (Mahdis Bisheman), American Control Conference	2017
<i>Student Travel Award:</i> (Evan Kaufman, Shankar Kulumani), American Control Conference	2016
<i>Experimental Research Awards– 1st Place</i> (Shankar Kulumani, Christopher Poole) Geometric adaptive control of attitude dynamics on SO(3) with state inequality constraints SEAS R&D Showcase, George Washington University	2016
<i>Heatherington Family Annual Scholarship:</i> (Shankar Kulumani)	2016
<i>Most Innovative/Creative Project Award:</i> (Shankar Kulumani) Systematic design of optimal low-thrust orbital transfers in the three-body problem The 5th Annual Student Competition, Society for Satellite Professional Internationals (SSPI)	2015
<i>Second Prize:</i> (John Dougherty) Laser-based onboard sensing and estimation for precise landing of a quadrotor UAV on an inclined surface AIAA Region I Student Conference	2014
<i>Second Prize:</i> (Tse-Huai Wu), Vision-based spacecraft attitude formation control GWU Research Day	2014
<i>Student Travel Award:</i> (Farhad Goodarzi, John Dougherty), American Control Conference	2014
<i>AFRL Scholar:</i> (Evan Kaufman) Kirtland AFB, Albuquerque NM	2014
<i>AFRL Scholar:</i> (Evan Kaufman) Kirtland AFB, Albuquerque NM	2013
<i>Third Place Prize:</i> (Tse-Huai Wu), Vision-Based Spacecraft Formation Control and Estimation Network The 3rd Annual Student Competition, Society for Satellite Professional Internationals (SSPI)	2013
<i>SUPER Fellowship:</i> (Kiren Caldwell), Spacecraft Formation Control Testbed with Free-Floating Aerial Vehicles Summer Undergraduate Program in Engineering Research, The George Washington University	2013

Teaching Experience (average student evaluation: 4.8/5.0)

<i>MAE3145: Orbital Mechanics and Space Dynamics</i>	Fall 2011-2016
<i>MAE4182: Electromechanical Control Systems</i>	Fall 2018-2021
<i>MAE6254: Applied Nonlinear Control</i>	Spring 2012,2014,2016,2018,2019
<i>MAE6292: Special Topic: Robotics Vision and Perception</i>	Spring 2021, 2022
<i>MAE6292: Special Topic: Optimal Control and Estimation</i>	Spring 2015, 2020
<i>MAE6277: Spacecraft Attitude Control</i>	Spring 2013, 2017
<i>MAE6246: Electromechanical Control Systems (Linear Systems)</i>	Spring 2013, Fall 2013-2016
Department of Mechanical and Aerospace Engineering, The George Washington University	
<i>MAE5690: Special Topic: Spacecraft Dynamics and Control</i>	Spring 2011
<i>MAE5690: Special Topic: Nonlinear Systems</i>	Fall 2010
<i>MAE4600: Engineering Astrodynamics</i>	Fall 2009
<i>MAE4242: Aircraft Stability and Control</i>	Fall 2008-2010
<i>MAE4014: Control Systems</i>	Spring 2009-2011
<i>MAE2082: Dynamics</i>	Spring, Summer 2010
Department of Mechanical and Aerospace Engineering, Florida Institute of Technology	

Outreach

<i>Introduction to Control System Engineering</i>	May 2015
Workshop for Robotics Group at Bell Multicultural High School	
<i>Introduction to Control System Engineering</i>	May 2014
Workshop for Robotics Group at Bell Multicultural High School	
<i>Introduction to Control System Engineering</i>	Jul 2010
Engineering Summer Camp for K-12 Students, Florida Institute of Technology	