EDUCATION

Doctorate of Philosophy, Mechanical Engineering
Michigan State University, East Lansing, MI, '00
- Design and Control of Robotic Mechanisms for Enhanced Dexterity and Superior Mobility.

Master of Science, Mechanical Engineering
Michigan State University, East Lansing, MI, '96
- Hierarchical Modeling Tools Applied to Automobile Powertrain and Rigid Body Kinematics.

Bachelor of Science, Mechanical Engineering
University of Michigan, Ann Arbor, MI, '93
- Concentrations in dynamic systems modeling and design theory.

PROFESSIONAL EXPERIENCE

Associate Professor
Department of Mechanical Engineering, University of Utah, Salt Lake City, UT. July '07 - current
- *Research focused on wearable robotics:*
  - *Smart Helmet.* This research focuses on methods of mitigating traumatic brain injury using novel helmets featuring controllable bladders to mitigate impact forces, tracking systems to predict impending blindside collisions, advanced warning systems to trigger protective clenching reflexes, and tissue mechanics models to better characterize potential brain injury.
  - *Smart Shoes.* Examining novel footwear capable of changing terrain felt by the user and correlating these perceptions with the 3D graphical terrain display.
- *Research activities focusing on virtual reality:*
  - *Large Workspace Haptic Manipulation* research examines devices and algorithms to allow users to physically interact with simulations of graphical objects from daily life, such as walkers, canes, carts, luggage, boxes, doors, etc., as they walk and interact with their virtual worlds.
  - *Terrain Display.* Graphical and physical rendering of terrain features such as slope, uneven/broken surfaces, and different surface materials.
  - *Environmental Effects in Virtual Environments.* Virtual reality systems combining wind, radiant heat, olfactory display, treadmill locomotion, urban wind models, and graphical simulation to create rich environmental display. Dr. Minor's research involves design and control of the Tread Port Active Wind Tunnel (TPAWT) as well as inclusion of olfactory and heat display.
- *Research activities focusing on mobile robot adaptability, mobility, and deployment:*
  - *Autonomous Vehicles.* Design and control of automated vehicles for operation in urban environments. Emphasis on modeling, planning, identification, sensor fusion, and control.
  - *Flying and Perching Aerial Robotics.* Research focuses on design and control of aerial robots with the ability to fly and perch on cables, branches, and rods. Emphasis is on perching mechanism design optimization and sensor-based planning and control.
  - *Hybrid Locomotion Robots.* Climbing and walking robots hybridizing rolling, walking, and climbing locomotion for improved adaptability and efficiency. Research involves mechanical design, motion planning, and control.

Assistant Professor
Department of Mechanical Engineering, University of Utah, Salt Lake City, UT. Aug. '00 – June 07

NASA-ASEE Faculty Fellow

NASA Johnson Space Center, Automation, Robotics, and Simulation Division, Houston, TX, '01 and '02

- Smart tools for extravehicular activities: Automated Tether Management System for Improved Crewmember Efficiency. Design, manufacture, air bearing test evaluation, and dynamic analysis.

Postdoctoral Research Associate

Departments of Mechanical and Electrical Engineering, Michigan State University, East Lansing, MI, '00

- Responsible for the design, integration, and manufacture of the Reconfigurable Adaptable Miniature Robot (RAMR2) for urban reconnaissance.
  - Unique underactuated structure improves autonomous operability via weight reduction, space savings, and power conservation. Three motors actuate five joints. Kinematics structure customized for climbing walls and ceilings, walking on floors, and traversing between such inclined surfaces.
  - Reconfigurability provides two separate modes of locomotion customized to confined spaces (small ventilation ducts) and open environments (the exterior of a building).
  - Sensors, actuators, and circuitry integrated with mechanical structure to streamline prototype and manufacturing processes.

Instructor

Department of Mechanical Engineering, Michigan State University, East Lansing, MI. '96- '00.

Engineering Equal Opportunity Program, Michigan State University, East Lansing, MI. Summer '95

- College Algebra, Detroit Area Pre-College Engineering Program.

Research Assistant

Department of Mechanical Engineering, Michigan State University, East Lansing, MI. '96 – '99

- Design and Manufacturing:
  - *Adaptable Reconfigurable Micro Robots*. Design and construction of a biped wall-climbing micro-robot for reconnaissance in urban environments. The meso-scale robot uses a two-legged design and coupled DOF to minimize weight and power consumption. Funded by DARPA.
  - *Development of a Flexible Surgical Robotic Arm*. Design of a minimally invasive surgical mechanism capable of reaching around obstructions (±180° articulation) and grasping and driving a suture needle through tissue. Constraints include 10mm abdominal port and limited maneuvering space. Optimized for maximum dexterous and reachable workspace, maximum load capacity, maximum life, and minimum backlash. Funded by ARPA.
- Controls Research: *Non-holonomic control and motion planning*. Derivation of practical control strategies for complete reorientation of a sphere (ball-plate problem) exploiting inherent geometric properties of the system where traditional differential geometric and feedback linearization techniques are not applicable.   A motion planner has been developed that is readily applied in a real-time situation. Funded by NSF.
- Proposals Written: Collaborated with medical doctors and major professor to submit proposals to the National Institute of Health, Whitaker Foundation, National Medical Technology Testbed, and the MSU AURIG fund.

Teaching Assistant

Department of Mechanical Engineering, Michigan State University, East Lansing, MI.

- Computer Aided Optimal Design (ME 465), Spring '97
- Computer Aided Design of Automotive Structures (ME 475), Fall '96
- Laboratory Manager: Mechanical Vibrations (ME 461), Fall '95, Spring '96, Fall '96
- Control Systems Laboratory (ME 451), Summer '95
- Mechanical Vibrations Laboratory (ME 461), Fall '94, Spring '95, Fall '96

Mechanical Research Engineer
NTN Technical Center (USA), Ann Arbor, MI (2/94-7/94)
- Bearing application and product development research.

JOURNAL PUBLICATIONS

Underlining: Graduate Students, Undergraduate Students

Under review/revision:

1. Xin, M., **Minor, M.A.**, "Integrating Vehicle Slip and Yaw in Overarching Multi-Tiered Automated Vehicle Steering Control to Balance Path Following Accuracy, Gracefulness, and Safety," Revised and resubmitted to the *IEEE Transactions on Robotics.* Under revision. http://arxiv.org/abs/2207.05523

2. Luttmer, N. G., Truong, T. E., Boynton, A. M., Merryweather, A. S., Carrier, D., **Minor, M.A.**, "Impactful Robots: Evaluating Visual and Audio Warnings with a Parallel Tether Robot to Help Users Brace for Impact," submitted to the *IEEE Robotics and Automation Magazine.* Revised and resubmitted. https://doi.org/10.48550/arXiv.2207.13835

3. Eshte, E., Truong, T.E., Luttmer, N., Greer, D., Zaki, A. D., Stern, B., Gregory, C., **Minor, M.A.**, "Physical Presence – The Effect of Audio and Environmental Display on Immersion, Involvement, and Presence in the MS.TPAWT Virtual Environment", submitted to *IEEE Robotics and Automation Magazine.* Under revision.

4. Leng, Z., **Minor, M. A.**, "Online Vehicle-Trailer Kinematic Parameter Identification Considering Sideslip for Trailer Backing Control," submitted to *Control Engineering Practice*. Under revision.

5. Boynton, A., Truong, T.E., Luttmer, N.G., Merryweather, A.S., **Minor, M.A.**, Carrier, D.R., "Axial muscle activation provides stabilization against perturbations while running," submitted to Human Movement Science.

In preparation:

6. Luttmer, N.G., Baum, N.I., Flores-Gonzalez, J., Hollerbach, J.M., and Minor, M.A, "Characterizing One and Two-Handed Manipulation of Large Objects in Everyday Living: A Foundation for Roboticists and Virtual Reality and Gaming Engineers", abstract submitted to *Bioengineering: Biomechanics-Based Motion Analysis* special issue accepted. Preparing final manuscript.

7. Xin, M., **Minor, M.A.**, "On-Road Parameter and State Estimation for Ground Vehicles Using Multi-Stage On-Line Algorithms," to be submitted to the *ASME Transactions on Dynamic Systems, Measurement, and Control*.

8. Xin, M., Zhang, K., Lackner, D., **Minor, M.A.**, "Slip-Based Nonlinear Recursive Backstepping Path Following Controller for Autonomous Ground Vehicles," to be submitted to the *IEEE Trans. on Intelligent Transportation Systems*.

9. Aston, J., Truong,T., Eshete, E., Olsen, N., Zaki, A., Benko, N., Luttmer, N.G., Coats, B., **Minor, M.A.**, "Optimization of a Soft Robotic Bladder Array for Dissipating High Impact Loads: an Initial Study in Designing a Smart Helmet," to be submitted to *Soft Robotics*.

10. Miller, J., Mitchel, A., Sabbagh, R., Merryweather, M., **Minor, M.A.**, "A Gantry Type 6-DOF Robot for Ankle-Foot Gait Simulation", to be submitted to the *ASME Journal of Mechanisms and Robotics*.

Published:

1. Leng. Z., Wang, Y., Xin, M., **Minor, M.A.**, "The Effect of Sideslip on Jackknife Limits During Low Speed Trailer Operation," *Robotics,* vol. 11, no. 6, pp 133 (28 pages), Nov. 2022, *https://doi.org/10.3390/robotics11060133*.

2. Baum, N. I., **Minor, M.A.**, "Identification and Control of a Soft-Robotic Bladder Towards Impedance-Style Haptic Terrain Display," *IEEE Robotics and Automation Letters*, vol. 7, no 4, pp 12355-12362, Oct. 2022, https://doi.org/10.1109/LRA.2022.3216251.

3. Truong, T.E., Luttmer, N.G., Eshete, E. R., Zaki, A. B. M., Greer, D. D., Hirschi T. J., Stewart, B.R., Gregory, C.A., **Minor, M.A.**, "Evaluating the Effect of Multi-sensory Stimulation on Startle Response using the Virtual Reality Locomotion Interface MS.TPAWT," *Virtual Worlds*, vol 1, no 1, p 62-81, Sept. 2022. https://doi.org/10.3390/virtualworlds1010005

4. E. De Momi, Tavakoli, M., Delmerico, J., Frisoli, A., **Minor, M.A.**, Rossini, G., Chippendale, P., "Extended Reality in Robotics [From the Guest Editors]," in IEEE Robotics & Automation Magazine, vol. 29, no. 1, pp. 8-9, https://doi.org/10.1109/MRA.2022.3143186, March 2022.

5. Dunlop, D. J, **Minor, M. A.**, "Modelling and Simulation of Perching with a Quadrotor Aerial Robot With Passive Bio-Inspired Legs And Feet", *Letters Dyn. Sys. Control., Paper No. ALDSC-19-1157,* https://doi.org/10.1115/1.4046778, Apr. 2021.

6. Wang, Y, Truong, T. E., Chesebrough, S., Willemsen, P., Foreman, K. B., Merryweather, A.S., Hollerbach, J. M., and **Minor, M.A.**, "Augmenting Virtual Reality Terrain Display with Smart Shoe Physical Rendering: A Pilot Study", *IEEE Trans. Haptics*, https://doi.org/10.1109/TOH.2020.3029896, Oct. 2020.

7. Kakkar, S., **Minor, M. A.**, "Fast and Reliable Motion Model for Articulated Wheeled Mobile Robots on Extremely Rough and Rocky Terrains," *IEEE Robotics and Automation Letters*, 4(3), p2252-2259, February 20, 2019. http://dx.doi.org/10.1109/LRA.2019.2900523

8. Wang, Y., **Minor, M.A.**, "Design and Evaluation of a Soft Robotic Smart Shoe for Haptic Terrain Rendering," *ASME/IEEE Trans. Mechatronics*, 23(6), p 2974-2979, December 2018. https://doi.org/10.1109/TMECH.2018.2871631

9. Wang, Y., Gregory, C., **Minor, M.A.**, "Improving Mechanical Properties of Molded Silicone Rubber for Soft Robotics via Fabric Compositing," *Soft Robotics*, 5(3), p 272-290, June 2018. https://doi.org/10.1089/soro.2017.0035

10. Zhe, L., **Minor, M.A.**, "Curvature Based Ground Vehicle Control of Trailer Path Following Considering Sideslip and Limited Steering Actuation," *IEEE Trans. Intel. Trans Systems, (18)2, 332-348, July 2016.* https://doi.org/10.1109/TITS.2016.2572208.

11. Burroughs, M.L., Freckleton, K.B., Abbott, J.J., **Minor, M.A.**, "A Sarrus-Based Passive Mechanism for Rotorcraft Perching," *ASME J. Mechanisms Robotics, (8)1, 11pp, JMR-14-1314, Aug 2015.* https://doi.org/10.1115/1.4030672

12. Kulkarni, S., Fisher, C., Lefler, P., Desai, A., Chakravarthy, S., **Minor, M.A.**, Pardyjak, E., Hollerbach, J.M., "A Full-Body Steerable Wind Display for a Locomotion Interface", *IEEE Transactions on Visualization and Computer Graphics*, v. 21, no. 10, 1146-1159, 2015. https://doi.org/10.1109/TVCG.2015.2424862

13. Zhu, X., Qiu. C., **Minor, M.A.**, "Terrain Inclination Based Three-dimensional Localization for Mobile Robot in Outdoor Environments," *Journal of Field Robots*, v. 31, no 3, p 477-492, 2014. https://doi.org/10.1002/rob.21515

14. Doyle, C. E.; Bird, J. J., Isom, T. A., Kallman, J. C., Bareiss, D. F., Dunlop, D. J., King, R. J., Abbott, J. J., **Minor, M.A.**, "An Avian-Inspired Passive Mechanism for Quadrotor Perching" *IEEE/ASME Transactions on Mechatronics*, v 18, no 2, p 506-517, April 2013. https://doi.org/10.1109/TMECH.2012.2211081

15. Zhu, X., Qiu, C., **Minor, M.A.**, "Terrain inclination aided three-dimensional localization and mapping for an outdoor mobile robot," *Int. J. Adv. Robotic Systems*, v 10, January 29, 2013. https://doi.org/10.5772%2F54957

16. Kulkarni, S.K., Chakravarthy, S., **Minor, M.A.**, Pardyjak, E.R., and Hollerbach, J.M., "Control of a Duct Flow Network for Wind Display in a Virtual Environment," *ASME/IEEE Transactions on Mechatronics,* v 17, n 6, p 1021-1030, 2012. https://doi.org/10.1109/TMECH.2011.2157973

17. Kulkarni, S.D., **Minor, M.A.**, Deaver, M.W., Pardyjak, E.R., Hollerbach, J.M., "Design, sensing, and control of a scaled wind tunnel for atmospheric display*," IEEE/ASME Transactions on Mechatronics*, v 17, n 4, p 635-645, 2012. https://doi.org/10.1109/TMECH.2011.2113353

18. Kulkarni, S.K., Deaver, M.W., Pardyjak, E.R., **Minor, M.A.**, Hollerbach, J.M, "Design Elements of a Novel Atmospheric Flow Simulator," *Journal of Fluid Engineering*, Tran. ASME, v 133, n 12, 2011. https://doi.org/10.1115/1.4005345

19. Kim, Y., **Minor, M.A.**, "Coordinated kinematic control of compliantly coupled multirobot systems in an array format," *IEEE Trans. Robotics,* Vol. 26, No. 1, pp173-180, Feb. 2010. https://doi.org/10.1109/TRO.2009.2035739

20. Kim, Y., **Minor, M.A.**, "Distributed kinematic motion control of multi-robot coordination subject to physical constraints," *International Journal of Robotics Research,* Vol. 29, No. 1, pp92-109, Jan. 2010. https://doi.org/10.1177%2F0278364909343217

21. Phipps, C., Shores, B., **Minor, M.A.**, "Design, Control, and Characterization of Quasi Steady Hybrid Locomotion in a Rolling Disk Biped," *IEEE Trans. Robotics,* Vol. 24, No. 6, pp1302-1314, Dec. 2008. https://doi.org/10.1109/ROBOT.2005.1570525

22. Engeberg, E., **Minor, M.A.**, Meek, S.G. "Hybrid Force-Velocity Control of a Prosthetic Hand," *IEEE Transactions on Biomedical Engineering*, Vol 55, No 5, pp 1572-81, May 2008. https://doi.org/10.1109/TBME.2007.914672

23. Kim, Y., **Minor, M. A.**, "Path Manifold Based Kinematic Control of Wheeled Mobile Robots Considering Physical Constraints," *International Journal of Robotics Research*, Vol 26, No 9, pp 755-75, 2007. https://doi.org/10.1177%2F0278364907081231

24. **Minor, M.A.**, Merrell, R., "Instrumentation and Algorithms for Posture Estimation in Compliant Framed Modular Mobile Robotic Systems," *International Journal of Robotics Research*, Vol. 26, No. 5, pp 491-512, May 2007. https://doi.org/10.1177%2F0278364907077899

25. **Minor, M.A.**, Hirschi, C.R., "Design and Evaluation of an Automated Tether Management System for Extravehicular Activities," *Journal of Field Robotics*, Vol. 24, No 4, pp 311-337, April 2007. https://doi.org/10.1002/rob.20188

26. Zhu, X., Kim, Y., Merrell, R., **Minor, M.A.**, "Cooperative Motion Control and Sensing Architecture in Compliant Framed Modular Mobile Robots," *IEEE Trans. Rob.,* Vol 23, No. 5, pp 1095-1101, October 2007. https://doi.org/10.1109/TRO.2007.903815

27. Zhu, X., **Minor, M.A.**, Park, S-Y., "Distributed Robust Control of Compliant Framed Wheeled Modular Mobile Robots," *ASME Journal of Dynamic Systems, Measurement, and Control*, Vol. 128, No. 3, pp 489-498, September 2006. https://doi.org/10.1115/1.2229254

28. **Minor, M.A.**, Albiston, B.W., Schwensen, C.L., "Simplified Motion Control for Compliant Framed Wheeled Mobile Robots," *IEEE Transactions on Robotics,* Vol 22, No. 3, pp 491-506, June 2006. https://doi.org/10.1109/TRO.2006.875503

29. Norton, A., **Minor, M.A.**, "Pneumatic Microactuator Powered by the Deflagration of Sodium Azide," *IEEE/ASME Journal of Microelectromechanical Systems,* Vol 15, No 2, pp. 344-354, April 2006. https://doi.org/10.1109/JMEMS.2005.863735

30. Arora, D., **Minor. M.A.**, Skliar, M. Roemer, R. B., "Control of Thermal Therapies With Moving Power Deposition Field," *Physics in Medicine and Biology*, Vol. 51, pp. 1201–1219, 2006. https://doi.org/10.1088/0031-9155/51/5/011

31. Krosuri, S., **Minor, M.A.**, "Design, Modeling, Control, and Evaluation of a Miniature Hybrid Hip Climbing Robot," *International Journal of Robotics Research,* Vol. 24, No. 12, p1033-1053, *Dec. 2005. https://doi.org/10.1177%2F0278364905057854*

32. Xiao, J., Xi, N., Dulimarta, H., Tummala, R.L., **Minor, M.A.**, Mukherjee, R., "Modeling, Control, and Motion Planning of a Climbing Microrobot," *Integrated Computer-Aided Engineering*, Vol. 11, No. 4, pp. 289-307, 2004

33. **Minor, M.A.**, Mukherjee, R., "Underactuated Kinematic Structures for Miniature Climbing Robots," *ASME Journal of Mechanical Design*, Vol.125, No.2, pp.281-91, 2003. https://doi.org/10.1115/1.1564075

34. Tummala, R.L., Mukherjee, M., Xi, N., Aslam, D., Dulimarta, H., Xiao, J., **Minor, M.A.**, Dangi, G., "Climbing the Walls," *IEEE Robotics and Automation Magazine*, Vol.9, No.4, pp.10-20, December 2002. https://doi.org/10.1109/MRA.2002.1160067

35. Mukherjee, R, **Minor, M.A.**, Pukrushpan, J., "Motion Planning for a Spherical Mobile Robot: Revisiting the Classical Ball-Plate Problem," *ASME Journal of Dynamic Systems Measurement and Control*, Vol. 124, No.4, pp 502-511, 2002. https://doi.org/10.1115/1.1513177

36. **Minor, M.A.**, Mukherjee, R. "A Mechanism for Dexterous End-Effector Placement During Minimally Invasive Surgery," *ASME Journal of Mechanical Design*, Vol.124, No.4, pp. 472-479, 1999. https://doi.org/10.1115/1.2829485

37. Mukherjee, R., **Minor, M.A.**, Song, G., Satava, R. "Optimization of an Articulated Instrument for Enhanced Dexterity in Minimally Invasive Therapy," *Journal of Minimally Invasive Therapy and Allied Technologies*, Vol.7, No.4, pp.335-42, 1998. https://doi.org/10.3109/13645709809152877

REFEREED CONFERENCE PUBLICATIONS

Underlining: Graduate Students, Undergraduate Students

Under Review/Revision:

1. Baum, N.I., Luttmer, N., Hirschi, T., Greer, D.D., McKee, S.M., Cookson, C., Hardy, K., Jue, A., Loveless, T., Salzeti, M., Labon, E., Hollerbach, J.M., and **Minor, M.A.**, "Large Workspace Haptic Manipulators for Two-Armed Manipulation," Under revision. To be submitted to the *2023 IEEE/RSJ Int'l Conf. on Intelligent Robots and Systems (IROS 23).*

Published:

1. Pollard, C., Truong, T.E., Aston, J., and **Minor, M.A.**, "Estimation of Soft Robotic Bladder Compression for Smart Helmets using Hall Effect Magnetic Sensing with Neural Networks,"

2022 IEEE/RSJ Int'l Conf. Intel. Robots and Systems (IROS 2022), https://doi.org/10.1109/IROS47612.2022.9981160.

2. Xin, Ming, Yin, Y., Zhang, K., Lackner, D., **Minor, M.A.**, "Continuous Robust Trajectory Tracking Control for Autonomous Ground Vehicles Considering Lateral and Longitudinal Kinematics and Dynamics via Recursive Backstepping," *2021 IEEE/RSJ Int'l Conf. Intel. Robots and Systems (IROS 2021),* https://doi.org/10.1109/IROS51168.2021.9635920.

3. Kitchen, R., Bierwolf, N., Harbertson, S., Platt, B., Owen, D., Griessmann, K., **Minor, M.A.**, "Design and Evaluation of a Perching Hexacopter Drone for Energy Harvesting from Power Lines", *2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020), October 25-29, 2020, Las Vegas, NV, USA (Virtual), https://doi.org/10.1109/IROS45743.2020.9341100.*

4. Aston, J., Truong,T., Eshete, E., Olsen, N., Zaki, A., Benko, N., Luttmer, N.G., Coats, B., **Minor, M.A.**, "Optimization of a Soft Robotic Bladder Array for Dissipating High Impact Loads: an Initial Study in Designing a Smart Helmet," *2020 3rd IEEE International Conference on Soft Robotics (RoboSoft)*, New Haven, CT, USA, June 2020, pp. 607-614, https://doi.org/10.1109/RoboSoft48309.2020.9116034.

5. Xin, M., Zhang, K., Lackner, D., **Minor, M.A.**, "Slip-Based Nonlinear Recursive Backstepping Path Following Controller for Autonomous Ground Vehicles," *2020 IEEE Int'l Conf. Robotics and Automation (ICRA 2020)*, Paris, France, May 2020, pp. 6169-6175, https://doi.org/10.1109/ICRA40945.2020.9197165 .

6. Luttmer, N. G., Truong, T.E., Boynton, A.M., Carrier, D., **Minor, M.A.**, "Treadmill Based Three Tether Parallel Robot for Evaluating Auditory Warnings While Running," *2020 IEEE Int'l Conf. Robotics and Automation (ICRA 2020)*, Paris, France, May 2020, pp. 9135-9142, https://doi.org10.1109/ICRA40945.2020.9196600.

7. Dunlop, D. J, **Minor, M.A.**, "Modelling and Simulation of Perching with a Quadrotor Aerial Robot With Passive Bio-Inspired Legs And Feet", *2019 ASME Dynamic Systems and Control Conference*, Oct 9-11, Park City, UT, 8 pages, DSCC2019-9241, 2019. https://doi.org/10.1115/DSCC2019-9241

8. Freckleton, K. B., **Minor, M.A.**, "Modeling and Characterization of a Potential Bladder Based Orthotic Device to Mitigate Shoe Slip," *2018 IEEE Int'l Conf. Robotics and Automation (ICRA 2018)*, p. 1496 – 1503, May 21-25, 2018. https://doi.org/10.1109/ICRA.2018.8460791

9. Crandall, K., **Minor, M.A.**, "UAV Fall Detection from a Dynamic Perch using Instantaneous Centers of Rotation and Inertial Sensing", *2015 IEEE Int'l Conf. Robotics and Automation (ICRA 2015)*, p. 4675-9, May 26-20, 2015. https://doi.org/10.1109/ICRA.2015.7139847

10. Merryweather, A., Hunt, M., Smith, L., Foreman, B., **Minor, M.A.**, "Gait Alterations on Irregular Terrain in Older Adults with and without Parkinson Disease: Fall Risk Implications", *Proceedings 19th Triennial Congress of the IEA*, Melbourne 9-14 August, 8 pages, 2015

11. Wang, Y., **Minor, M.A.**, "Design of a bladder based elastomeric Smart Shoe for haptic terrain display," *2014 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2014),* p 1236-41, Sept. 14-18, 2014. https://doi.org/10.1109/IROS.2014.6942715

12. Xin, M., **Minor, M.A.**, "Backstepping Variable Structure Controls of Slip-Based Kinematics and Dynamics for Improved AGV Cornering Performance," *2014 IEEE International Conference on Robotics and Automation*, ICRA 2014, p 5286-91. 10.1109/ICRA.2014.6907636. https://doi.org/10.1109/ICRA.2014.6907636

13. Xin, M., **Minor, M.A.**, "Variable Structure Backstepping Control via Hierarchal Manifolds Set for Graceful Ground Vehicle Path Following," *2013 IEEE International Conference on Robotics and Automation*, ICRA 2013, 7 pages, p 2826-32, 2013.
https://doi.org/10.1109/ICRA.2013.6630968

14. Xin, M., **Minor, M.A.**, "Backstepping vehicle steering controller using integral and robust control based on dynamic state estimation", *2012 IEEE/RSJ International Conference on Intelligent Robots and Systems*, IROS 2012, p 3132-37, 2012.
https://doi.org/10.1109/IROS.2012.6386199

15. Doyle, C., Bird, J., Isom, T., Johnson, C., Kallman, J., Simpson, J., King, R., Abbott, J., **Minor, M.A.**, "Avian-Inspired Passive Perching Mechanism for Robotic Rotorcraft," *2011 IEEE Conference on Intelligent Robots and Systems*, p 4975-80, 2011.
https://doi.org/10.1109/IROS.2011.6094487

16. Xin, M., **Minor, M.A.**, "A Multi-Tiered Robust Steering Controller Based on Yaw Rate and Side Slip Estimation," *2011 IEEE Conference on Intelligent Robots and Systems*, p292-7, 2011.
https://doi.org/10.1109/IROS.2011.6095117

17. Leng, Z., **Minor, M.A.**, "A Simple Tractor-Trailer Backing Control Law for Path Following with Side Slope Compensation," *2011 IEEE International Conference on Robotics and Automation,*p2386-91, 2011. https://doi.org/10.1109/ICRA.2011.5979918

18. Floyd, M., **Minor, M.A.**, "Impulse Based Rolling in the Rolling Disk Biped," *2010 3rd IEEE RAS and EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob 2010)*, p 498-503, 2010. https://doi.org/10.1109/BIOROB.2010.5625978

19. Leng, Z., **Minor, M.A.**, "A Simple Trailer Backing Control Law for Path Following," *IEEE/RSJ 2010 International Conference on Intelligent Robots and Systems (IROS 2010),* p5538-5542, 2010. https://doi.org/10.1109/IROS.2010.5650489

20. Vogt, A.P, Lincoln, L., Bamberg, S.J., **Minor, M.A.**, "Traction Force Characterization of Human Locomotion," *IEEE/RSJ 2010 International Conference on Intelligent Robots and Systems (IROS 2010),* p 5511-5516, 2010*. https://doi.org/10.1109/IROS.2010.5648950*

21. Kulkarni, S.K., Fisher, C., Pardyjak, E.R., **Minor, M.A.**, Hollerbach, J.M., "Wind display device for locomotion interface in a virtual environment," *3rd Joint Euro Haptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (World Haptics 2009)*, p 184-189, 2009. https://doi.org/10.1109/WHC.2009.4810855

22. Vogt, A.P, **Minor, M.A.**, "Localization for Multi-Axle Train Configured CFMMRs," *2009 IEEE/RSJ International Conference on Intelligent Robots and Systems*, St. Louis, Missouri, USA, Oct 11-15, p 5567-5572, 2009. https://doi.org/10.1109/IROS.2009.5354125

23. Zhu, X., **Minor, M.A.**, "Terrain feature localization for mobile robots in outdoor environments," *2009 IEEE International Conference on Information and Automation, ICIA 2009*, p 1074-1080, 2009. https://doi.org/10.1109/ICINFA.2009.5205077

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41. Park, S., **Minor, M.A.**, "Modeling and Dynamic Control of Compliant Framed Wheeled Modular Mobile Robots," *Proc. 2004 IEEE International Conference on Robotics and Automation,* April 26-May 1, New Orleans, LA, USA, pp. 3937-43, 2004. https://doi.org/10.1109/ROBOT.2004.1308884

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BOOKS

1. Xiaorui Zhu, Youngshik Kim, **Mark A. Minor**, Chunxin Qiu, "Autonomous Mobile Robots in Unknown Outdoor Environments," 1st Edition, CRC Press, ISBN-13: 978-1498740555, ISBN-10: 1498740553, 256 pages, December 22, 2017.

In preparation:

2. Marshall D. Floyd and **Minor, M. A.**, "Steering-Plane Bipeds: Characterization, Motion Planning and Gait Optimization."

OTHER PUBLICATIONS

1. Yue Wang, Christopher Wilson, Sam Chesebrough, Pete Willemsen, K. Bo Foreman, Andrew Merryweather, John Hollerbach, and **Mark A. Minor**, "Towards Terrain-Enabled Gait Therapy using Immersive VR with Physical Terrain Display for Parkinson's Disease", 4th Neurological Disorders Summit, Los Angles, CA. Abstract and Podium Presentation. July 2018.
2. Wang, Y., **Minor, M.A.**, "Improving Mechanical Properties of Molded Silicone Rubber for Soft Robotics Through Fabric Compositing," SATEC 2018, May 2018, 22 pages.

3. Xin, M., **Minor, M.A.**, "Graceful and Robust Steering of Automated Ground Vehicles (AGV) through bioinspired sensing and control", SATEC 2016, 9 pages.

4. Miller, J., Merryweather, A., **Minor, M.A.**, "Design and Simulation of an Ankle Foot Simulator", Extended Abstract, SB3C, June 2015.

5. Johnson, D., Flickinger, D., Stack, T., Ricci, R., Stoller L., Fish, R., Webb, K., **Minor, M.A.**, Lepreau, J. Poster Abstract: "Robot Couriers: Precise Mobility in a Wireless Network Testbed," in *Proc. of ACM SenSys 2005*, San Diego, CA, Nov 2-4 2005. https://doi.org/10.1145/1098918.1098971

6. Johnson, D., Flickinger, D., Stack, T., Ricci, R., Stoller, L., Fish, R., Webb, K., **Minor, M.A.**, Lepreau, J., Demo Abstract: "Emulab's Wireless Sensor Net Testbed: True Mobility, Location Precision, and Remote Access," in *Proc. of ACM SenSys 2005*, San Diego, CA, Nov 2-4 2005. https://doi.org/10.1145/1098918.1098971

7. Jensen, K., **Minor, M.A.**, "An Interactive Robot for Educating Pre-College Students About Engineering Disciplines," *ASEE Rocky Mountain Chapter Proceedings*, April 2001.

PATENTS

1. **Minor, M.A.**, Wang, Y., Merryweather, A.M., "Haptic Device for Terrain Feedback and Control", requested patent, 16/993,682. Aug. 14, 2020.

2. Xin, M., **Minor, M.A.**, U-6792 Provisional Patent Application, "GRACEFUL AND ROBUST PROPRIOCEPTIVE STEERING AND PARAMETER ESTIMATION OF AUTOMATED GROUND VEHICLES" 62/861,222, June 2019.

3. Johnson, E.A., **Minor, M.A.**, Morris-Bamberg, S.J., "Systems, methods, and apparatus for calibration of and three-dimensional tracking of intermittent motion with an inertial measurement unit," Patent No. 9,810,549, November 7, 2017

4. **Minor, M.A.**, Johnson, E.A., Morris-Bamberg, S.J., "State estimator for rejecting noise and tracking and updating bias in inertial sensors and associated methods," Patent No. 9,127,947, August 9, 2015.

5. **Minor, M.A.**, Schwensen, C. , "System And Method For Controlling Modular Robots," Patent No. 7,400,108 B2. July 15, 2008.

6. **Minor, M.A.**, Mukherjee, R.M., "Dexterous articulated linkage for surgical applications," US Patent No. 6,309,403. October 30, 2001.

INVENTION DISCLOSURE

7. **Minor, M.A.**, Wang, Y., Merryweather, A., "Orthotic Smart Shoe for Modulating Foot-Ground Interaction," Invention disclosure U-5772, April, 28, 2014. Patent application submitted 2020.

8. **Minor, M.A.**, Hollerbach, J.M, "Large workspace haptic manipulators for mixed reality locomotion interfaces", U-7212, March 25, 2021.

INVITED PRESENTATIONS

1. "Extended Reality and its Applications in the Multi-Sensory TreadPort Active Wind-Tunnel Virtual Reality Locomotion Interface," Workshop on Extended Reality and Robotics, IEEE/RSJ Int'l Conf on Intelligent Robot and Systems (IROS) 2022, Kyoto, Japan.

2. "FIRST Utah Regional and Robotics in Utah," Robofest, Salt Lake City, UT. November 5, 2016.

3. "Bioinspired Design, Sensing, and Control: Inherently Smart Robotic Systems," 2016 Northeastern University Artificial Intelligence & Robotics International Graduate Summer School, Shenyang, China. July 25, 2016.

4. "Graceful and Robust Steering of Automated Ground Vehicles (AGV) through Bioinspired Sensing and Control," Sino-American-Technology-Engineering-Conference (SATEC), Shenyang, China. May 18, 2016.

5. "Inspiring children to pursue science, technology, engineering and math (STEM) studies and careers", Robotfest, November 3, 2015.

6. "Atmostpheric Display with a Virtual Environment Locomotion Interface," Harbin Institute of Technology Graduate School. Shenzen, China, May 16, 2011

7. "Passive and Active Techniques for Resilient Control of Ground Vehicles," International Symposium on Resilient Control Systems, Aug 10, 2011.

8. "2007 DARPA Urban Challenge," Aerospace Control and Guidance Systems Committee Meeting, Salt Lake City, UT, March 5, 2007.

9. "Design, Modeling, Control, and Evaluation of a Miniature Hybrid Hip Climbing Robot," Dept. of Electrical Engineering, Brigham Young University, July 13, 2006.

10. "Design, Modeling, Control, and Evaluation of a Miniature Hybrid Hip Climbing Robot," Dept. of Aerospace and Mechanical Engineering, University of Notre Dame, November 15, 2005.

11. "Reconfigurable Adaptable Micro-Robots," ICRA 2002 Workshop on Distributed Micro-Robotics, IEEE Conference on Robotics and Automation, Washington, DC, 2002.

12. "Automated Tether Management System," NASA Johnson Space Center, Automation, Robotics, and Simulation Division, Robotic Systems Technology Branch, 2001.

HONORS AND AWARDS

1. Volunteer of the Decade, Utah FIRST Robotics, 2020

2. Department Service Award, Department of Mechanical Engineering, University of Utah, 2019

3. Keynote speaker, 2016 Northeastern University Artificial Intelligence & Robotics International Graduate Summer School, Shenyang, China. July 24, 2016.

4. Volunteer of the Year, Utah FIRST Robotics Competition Regional Event, 2011

5. Dean's List: Top 15% of college of engineering instructors, '07-'08

6. Professor of the Year, Mechanical Engineering, University of Utah, '04

Following are competitive fellowships. During the 2002 cycle there were 144 applicants for 24 faculty fellowship positions, and only 6 of those produced student positions. Items 5 and 6 are also listed under work experience.

7. Fellowship: NASA/ASEE Summer Faculty Fellowship Program. Title: "Automated Tether Management System: Testing, Evaluation, and Microgravity Mobility," Amount: $13,500. Duration: 5/23/02-7/31/02.

8. Fellowship: NASA/ASEE Faculty Fellowship Program. Title: "Smart Tools: Automated Tether Management System for Microgravity Extravehicular Activities," Amount: $11,500. Duration: 5/31/01-8/10/02.

As part of the above NASA fellowship opportunities, I was also able to sponsor a student, Chris Hirschi, to attend the program and work on this research with me. Following is a brief description:

9. Fellowship Student: NASA/ASEE Summer Faculty Fellowship Program. Title: "Automated Tether Management System: Testing, Evaluation, and Microgravity Mobility," Amount: $6,500. Duration: 5/23/02-7/31/02. Student: Christopher Hirschi.

10. Fellowship Student: NASA/ASEE Faculty Fellowship Program. Title: "Smart Tools: Automated Tether Management System for Microgravity Extravehicular Activities," Amount: $5,750. Duration: 5/31/01-8/10/01. Student: Christopher Hirschi.

GRANTS

Proposals under revision:

1. *"Collaborative Research: NRI: Adapt-o-Walk: Design and Integration of Robotic Systems to Improve Mobility through Adaptable Terrain Rendering, Mobile Haptic Support, and AR," Agency: NSF NRI – National Robotics Initiative, PI and Co-PI: Mark Minor (PI), ~~Andrew Merryweather (Utah)~~, Bo Foreman (Utah), Keith Green (Cornell), Pete Willemsen (Minnesota Duluth), Edward Downs (Minnesota Duluth). Amount: $1.5M (Minor/UU: $861k). Duration: 9/1/2022-8/31/2026*

Active grants:

1. "Robotics Certificates and Graduate Degree Programs", Agency: State of Utah System of Higher Education, PI and Co-PIs: Mark Minor (PI), Jake Abbott, Edoardo Battaglia, Daniel Drew, Jacob George, John Hollerbach, Alan Kuntz, Kam Leang, Tomasso Lenzi, Steve Mascaro, Sanford Meek, Haohan Zhang, Amount: $413,973 ($545,460 with third year extension). Should turn into ongoing state funding. Duration: 9/1/2022-8/31/24.

2. *"CHS: Small: Large Workspace Haptic Interaction for Mixed Reality Locomotion Interfaces,"* Agency: NSF-CISE Core Programs, PI and Co-PI: Mark Minor (PI) and John Hollerbach, Total Amount: $499,998 (Minor: $267k), Duration: 9/1/2019-8/30/2023.

3. "SCH: INT: Reducing Traumatic Brain Injury Risk with Impact Compensation," Agency: NSF. PI and co-PIs: Mark Minor (PI), David Carrier, Brittany Coats, Andrew Merryweather, Neal Patwari, David Schurig, Colby Hansen. Total Amount: $1.747M (Minor: $429k), Duration: 9/1/2016-8/31/2020.

4. REU Supplement to *"CHS: Small: Large Workspace Haptic Interaction for Mixed Reality Locomotion Interfaces,"* Agency: NSF, PI, Mark Minor. $48,000. Duration: 5/1/20-5/30/23.

5. REU Supplement to "SCH: INT: Reducing Traumatic Brain Injury Risk with Impact Compensation," Agency: NSF, PI, Mark Minor. $80,000. Duration: 5/1/17-5/30/22.

Completed research grants:

1. "HCC: Medium: Collaborative Research: Haptic Display Of Terrain Characteristics And Its Application In Virtual And Physical Worlds," Agency: NSF, PI and Co-PIs: Mark Minor, Kenneth Foreman, John Hollerbach, Andrew Merryweather, ~~David Johnson~~, Amount: $1,052,554 (Minor: $278k), Duration: 10/1/12-9/30/19.

2. "Rapidly Modulated Hydraulic Supply and Control Policies for XOS-2" PI and Co-PI: John Hollerbach (PI), Mark Minor, Agency: DoD US Special Operations Command, Amount: $300k (Minor: $150k), Duration: 2/28/17-5/30/18.

3. REU Supplement to "HCC: Medium: Collaborative Research: Haptic Display Of Terrain Characteristics And Its Application In Virtual And Physical Worlds," Agency: NSF, PI: Mark Minor. $16,000. Duration: 5/1/16-4/30/17.

4. "2016 NASA RASC-AL Rover Competition," Agency: National Aerospace Institute, Amount $10,000, Duration: 12/15/15-12/31/16.

5. REU Supplement to "HCC: Medium: Collaborative Research: Haptic Display Of Terrain Characteristics And Its Application In Virtual And Physical Worlds," Agency: NSF, PI: Mark Minor. $16,000. Duration: 5/1/15-4/30/16.

6. REU Supplement to "HCC: Medium: Collaborative Research: Haptic Display Of Terrain Characteristics And Its Application In Virtual And Physical Worlds," Agency: NSF, PI: Mark Minor. $16,000. Duration: 5/1/14-4/30/15.

7. "2015 NASA RASC-AL Rover Competition," Agency: National Aerospace Institute, Amount $10,000, Duration: 12/15/14-12/31/15.

8. REU Supplement to "HCC: Medium: Collaborative Research: Haptic Display Of Terrain Characteristics And Its Application In Virtual And Physical Worlds," Agency: NSF, PI: Mark Minor. $16,000. Duration: 5/1/13-4/30/14.

9. "2014 NASA RASC-AL Rover Competition," Agency: National Aerospace Institute/NASA, Amount $10,000, Duration: 1/1/14-12/31/14.

10. "2013 NASA RASC-AL Rover Competition," Agency: National Aerospace Institute/NASA, Amount $10,000, Duration: 1/1/13-12/31/13.

11. "2012 NASA RASC-AL Rover Competition," Agency: National Aerospace Institute/NASA, Amount $10,000, Duration: 1/1/12-12/31/12

12. "2011 NASA RASC-AL Rover Competition," Agency: National Aerospace Institute/NASA, Amount $10,000, Duration: 3/15/11-12/31/11

13. "IGERT: Interdisciplinary Research Training in Biocentric Robotics," Agency: NSF, Proj. No. 654414. Amount: $3,158,171. Duration: 9/1/07-8/31/11. PI and co-PIs: John Hollerbach (PI), Stacy Bamberg, Stephen Mascaro, Mark Minor, Will Provancher

14. "ITR: Generation of Complex Environmental Flow Patterns for Virtual Environments," Agency: National Science Foundation (Information Technology Research for National Priorities (ITR). Proj. No. 428856. Amount: $1,119,000, Minor: ~$450k. Duration: 10/1/04-9/30/09. PI and co-PIs: John Hollerbach, Merideth Metzger, Mark Minor, Erik Pardyjak, Peter Willemsen.

15. "Evaluation Of Vehicle Heading Filter, Runtime Steering Bias, Correction, And Automated Trailer Parking Algorithms," Agency: Kairos Autonomi, Amount: $20,894. Summer '08. PI: Mark Minor.

16. "Rocket Control Strategy," Sponsor: ATK Launch Systems, Amount: $53,000, Duration: 6/1/07-3/15/08.

17. "Seed Grant: Urban Challenge," Agency: University of Utah Seed Grant Foundation. Amount, $29,000, 1/15/07-7/30/07, Investigators: Thomas Henderson (50%) and Mark Minor (50%)

18. "Urban Challenge," Agency: Kairos Autonomi, Amount: $89,000, 1/1/07-8/1/07. PI's: Thomas Henderson (50%), Mark Minor (50%).

19. "Urban Challenge," Agency: University support (VP offices, COE Dean, ME, CS), Amount: $43,000, 8/1/07-8/1/08, PI's: Mark Minor (50%) and Thomas Henderson (50%).

20. "Unifying Data Acquisition and Control. Part II: Discrete Systems Laboratories," Agency: College of Engineering BEEF Fund. Amount: $50,919. Duration: 7/30/2003-7/30/2004. PIs: Mark Minor and Sanford Meek.

21. "NRT: Collaborative Research: A Unified Experimental Environment for Diverse Network Technologies", Agency: National Science Foundation (CSE/COMPUTER AND NETWORK SYSTEMS, ADVANCED NET INFRA & RSCH). Proj. No. 0335296. Amount: $3,592,248 (Minor: ~$300k). Duration: 10/1/03-9/30/06. PI and co-PIs: Jay Lepreau, Sneha Kasera, Steven Parker, Mark Minor.

22. "Compliant Frame Modular Mobile Robotic Systems," Agency: National Science Foundation (CSE/IIS/Robotics). Proj. No. 0308056. Amount: $249,853. Duration: 7/1/2003-6/30/2007 PI/Co-PI: Mark Minor.

23. REU Supplement to "Compliant Frame Modular Mobile Robotic Systems," Agency: National Science Foundation (CSI/IIS/Robotics), Proj. No. 0524003. Amount: $10,000. Duration 4/15/2005-6/30/2007 PI: Mark Minor

24. "Mechatronics Computer Upgrade," University of Utah Student Computing Advisory Committee (SCAC). Amount: $47,945. Duration: 9/2001-8/2002. PIs: Mark Minor and Sandy Meek.

GRADUATE ADVISOR

Current PhD. students:

1. Dunlop, David, "Autonomous Bioinspired Perching of small unmanned aerial vehicles," Qualifying exams completed. Thesis proposal completed. Jan 2013-current. Defending Spring 2023. Support: NSF, Self. Products with advisor:

   - Dunlop, D.J, **Minor, M. A.**, "Design and Autonomous Perching with a Micro-UAV using bioinspired legs and feet", in preparation. To be submitted to ASME/IEEE Trans. Mechatronics.

   - Dunlop, D.J, **Minor, M. A.**, "Modelling and Simulation of Perching with a Quadrotor Aerial Robot With Passive Bio-Inspired Legs And Feet", *Letters Dyn. Sys. Control., Paper No. ALDSC-19-1157,* https://doi.org/10.1115/1.4046778, Apr. 2021.

   - Dunlop, D. J, **Minor, M.A.**, "Modelling and Simulation of Perching with a Quadrotor Aerial Robot With Passive Bio-Inspired Legs And Feet", *2019 ASME Dynamic Systems and Control Conference*, Oct 9-11, Park City, UT, 8 pages, DSCC2019-9241, 2019. https://doi.org/10.1115/DSCC2019-9241

   - Doyle, C. E.; Bird, J. J., Isom, T. A., Kallman, J. C., Bareiss, D. F., Dunlop, D. J., King, R. J., Abbott, J. J., **Minor, M.A.**, "An Avian-Inspired Passive Mechanism for Quadrotor Perching" *IEEE/ASME Transactions on Mechatronics*, v 18, no 2, p 506-517, April 2013. https://doi.org/10.1109/TMECH.2012.2211081

2. Aston, Jonathan, "Design and control of a Smart Helmet for reducing collision forces leading to traumatic brain injury". Qualifying exam and thesis proposal completed. Start January 2017. Expected defense Fall 2022. Products with advisor:

   - Aston, J., Truong,T., Eshete, E., Olsen, N., Zaki, A., Benko, N., Luttmer, N.G., Coats, B., **Minor, M.A.**, "Optimization of a Soft Robotic Bladder Array for Dissipating High Impact Loads: an Initial Study in Designing a Smart Helmet," in preparation. To be submitted to *Soft Robotics*.

- Pollard, C., Aston, J., and **Minor, M.A.**, "Estimation of Soft Robotic Bladder Compression for Smart Helmets using Hall Effect Magnetic Sensing with Neural Networks," to appear in the *2022 IEEE/RSJ Int'l Conf. Intel. Robots and Systems (IROS 2022)*. http://arxiv.org/abs/2207.06530

- Aston, J., Truong,T., Eshete, E., Olsen, N., Zaki, A., Benko, N., Luttmer, N.G., Coats, B., **Minor, M.A.**, "Optimization of a Soft Robotic Bladder Array for Dissipating High Impact Loads: an Initial Study in Designing a Smart Helmet," *2020 3rd IEEE International Conference on Soft Robotics (RoboSoft)*, New Haven, CT, USA, June 2020, pp. 607-614, https://doi.org/10.1109/RoboSoft48309.2020.9116034.

3. Luttmer, Nate, "Large Workspace Haptic Manipulation", Qualifying exam completed. Thesis proposal Summer 2022. Start January 2020, Expected graduation August 2023. Support: NSF. Co-advised with John Hollerbach. Products with advisor:

   - Luttmer, N. G., Truong, T. E., Boynton, A. M., Merryweather, A. S., Carrier, D., **Minor, M.A.**, "Impactful Robots: Evaluating Visual and Audio Warnings with a Parallel Tether Robot to Help Users Brace for Impact," Under revision.

   - Truong, T.E., Luttmer, N.G., Eshete, E. R., Zaki, A. B. M., Greer, D. D., Hirschi T. J., Stewart, B.R., Gregory, C.A., **Minor, M.A.**, "Evaluating the Effect of Multi-sensory Stimulation on Startle Response using the Virtual Reality Locomotion Interface MS.TPAWT," *Virtual Worlds*, Vol 1, no 1, p 62-81, Sept. 2022.

   - Baum, N.I., Luttmer, N., Hirschi, T., Greer, D.D., McKee, S.M., Cookson, C., Hardy, K., Jue, A., Loveless, T., Salzeti, M., Labon, E., Hollerbach, J.M., and **Minor, M.A.**, "Large Workspace Haptic Manipulators for Two-Armed Manipulation," submitted to the *2022 IEEE/RSJ Int'l Conf. Intel. Robots and Systems (IROS 2022)*.

   - Aston, J., Truong,T., Eshete, E., Olsen, N., Zaki, A., Benko, N., Luttmer, N.G., Coats, B., **Minor, M.A.**, "Optimization of a Soft Robotic Bladder Array for Dissipating High Impact Loads: an Initial Study in Designing a Smart Helmet," *2020 3rd IEEE International Conference on Soft Robotics (RoboSoft)*, New Haven, CT, USA, June 2020, pp. 607-614, https://doi.org/10.1109/RoboSoft48309.2020.9116034.

4. Baum, Nate, "Large workspace haptic manipulation", Start January 2020, Qualifying exam completed. Expected graduation August 2023. Support: NSF. Co-advised with John Hollerbach. Products:

   - Baum, N.I., Luttmer, N., Hirschi, T., Greer, D.D., McKee, S.M., Cookson, C., Hardy, K., Jue, A., Loveless, T., Salzeti, M., Labon, E., Hollerbach, J.M., and **Minor, M.A.**, "Large Workspace Haptic Manipulators for Two-Armed Manipulation," Under revision. To be submitted to the *2023 IEEE Int'l Conf. on Robotics and Automation (ICRA 2023)*.

   - Baum, N. I., **Minor, M.A.**, "Identification and Control of a Soft-Robotic Bladder Towards Impedance-Style Haptic Terrain Display," submitted to *IEEE Robotics and Automation Letters*. Under review. http://arxiv.org/abs/2207.05537

PhD Students Graduated:

1. Zhu, Xiaorui (Rachel), "Robust Motion Control Strategies for Cooperative Wheeled Mobile Robots," August 2002 - December 2006, Support: NSF, Occupation: Professor of Robotics, Harbin Institute of Technology, Guandong, China. Products with advisor:

- Xiaorui Zhu, Youngshik Kim, **Mark A. Minor**, Chunxin Qiu, "Autonomous Mobile Robots in Unknown Outdoor Environments," 1st Edition, CRC Press, ISBN-13: 978-1498740555, ISBN-10: 1498740553, 256 pages, December 22, 2017.

- Zhu, X., Qiu. C., **Minor, M.A.**, "Terrain Inclination Based Three-dimensional Localization for Mobile Robot in Outdoor Environments," *Journal of Field Robots*, v. 31, no 3, p 477-492, 2014. https://doi.org/10.1002/rob.21515

- Zhu, X., Qiu, C., **Minor, M.A.**, "Terrain inclination aided three-dimensional localization and mapping for an outdoor mobile robot," *Int. J. Adv. Robotic Systems*, v 10, January 29, 2013. https://doi.org/10.5772%2F54957

- Zhu, X., Kim, Y., Merrell, R., **Minor, M.A.**, "Cooperative Motion Control and Sensing Architecture in Compliant Framed Modular Mobile Robots," *IEEE Trans. Rob.,* Vol 23, No. 5, pp 1095-1101, October 2007. https://doi.org/10.1109/TRO.2007.903815

- Zhu, X., **Minor, M.A.**, Park, S-Y., "Distributed Robust Control of Compliant Framed Wheeled Modular Mobile Robots," *ASME Journal of Dynamic Systems, Measurement, and Control*, Vol. 128, No. 3, pp 489-498, September 2006. https://doi.org/10.1115/1.2229254

- Zhu, X., **Minor, M.A.**, "Terrain feature localization for mobile robots in outdoor environments," *2009 IEEE International Conference on Information and Automation, ICIA 2009*, p 1074-1080, 2009. https://doi.org/10.1109/ICINFA.2009.5205077

- Zhu, X., Kim, Y., Merrell, R., **Minor, M.A.**, "Cooperative Motion Control and Sensing Architecture in Compliant Framed Modular Mobile Robots," *IEEE Trans. Rob.,* Vol 23, No. 5, pp 1095-1101, October 2007. https://doi.org/10.1109/TRO.2007.903815

- Zhu, X., **Minor, M.A.**, "Motion Control and Sensing Strategy for a Two-axle Compliant Framed Wheeled Modular Mobile Robot," *2006 IEEE International Conference on Robotics and Automation*, Orlando, Florida, May 15-19, pp. 3526-31, 2006. https://doi.org/10.1109/ROBOT.2006.1642240

- Zhu, X., Kim, Y., **Minor, M.A.**, "Cooperative Distributed Robust Control of Modular Mobile Robots with Bounded Curvature and Velocity," *Proc. 2005 IEEE/ASME Int'l Conference on Advanced Intelligent Mechatronics*, July 24-28, Monterey, CA, USA, pp 1151-57, 2005. https://doi.org/10.1109/AIM.2005.1511165

2. Kim, Youngshik, "Motion Planning and Kinematic Control of Cooperative Wheeled Mobile Robots Subject to Physical Constraints," January 2003-August 2008. Support: NSF, University of Utah, Occupation: Associate Professor, Hanbat National University, Yusong, South Korea, Products with advisor:

- Kim, Y., **Minor, M.A.**, "Coordinated kinematic control of compliantly coupled multirobot systems in an array format," *IEEE Trans. Robotics,* Vol. 26, No. 1, pp173-180, Feb. 2010. https://doi.org/10.1109/TRO.2009.2035739

- Kim, Y., **Minor, M.A.**, "Distributed kinematic motion control of multi-robot coordination subject to physical constraints," *International Journal of Robotics Research,* Vol. 29, No. 1, pp92-109, Jan. 2010. https://doi.org/10.1177%2F0278364909343217

- Kim, Y., **Minor, M. A.**, "Path Manifold Based Kinematic Control of Wheeled Mobile Robots Considering Physical Constraints," *International Journal of Robotics Research*, Vol 26, No 9, pp 755-75, 2007. https://doi.org/10.1177%2F0278364907081231

- Kim, Y., **Minor, M.A.**, "Coordinated Kinematic Motion Control of Compliant Framed Wheeled Modular Mobile Robots," *2008 IEEE/RSJ International Conference on Intelligent Robots and Systems*, Nice, France, Sept 22-26, 6 pages, 2008. https://doi.org/10.1109/IROS.2008.4650683

- Kim, Y., **Minor, M.A.**, "Kinematic Motion Control of Wheeled Mobile Robots Considering Curvature Constraints*," 2008 IEEE International Conference on Robotics and Automation,* Pasadena, CA, May 19-23, pp 2527-32, 2008. https://doi.org/10.1109/ROBOT.2008.4543593

- Kim, Y., **Minor, M.A.**, "Decentralized Motion Control for Multiple-Axle Compliant Framed Modular Mobile Robots," *2006 IEEE/RSJ Int'l Conf. on Intelligent Systems and Robots*, October 9-15, Beijing, China, pp 392-397, 2006. https://doi.org/10.1109/IROS.2006.281838

- Kim, Y., **Minor, M.A.**, "Bounded Smooth Time Invariant Motion Control of Unicycle Kinematic Models," *2005 IEEE International Conference on Robotics and Automation*, Barcelona, Spain, April 18-22, pp. 3687-92 , 2005. https://doi.org/10.1109/ROBOT.2005.1570680

- Zhu, X., Kim, Y., **Minor, M.A.**, "Cooperative Distributed Robust Control of Modular Mobile Robots with Bounded Curvature and Velocity," *Proc. 2005 IEEE/ASME Int'l Conference on Advanced Intelligent Mechatronics*, July 24-28, Monterey, CA, USA, pp 1151-57, 2005. https://doi.org/10.1109/AIM.2005.1511165

3. Kulkarni, Sandip, " Underactuated control and characterization of wind flow in a virtual environment," August 2004-August 2009, Occupation: Senior Applied AI Engineer, Microsoft, Products with advisor:

- Kulkarni, S., Fisher, C., Lefler, P., Desai, A., Chakravarthy, S., **Minor, M.A.**, Pardyjak, E., Hollerbach, J.M., "A Full-Body Steerable Wind Display for a Locomotion Interface", *IEEE Transactions on Visualization and Computer Graphics*, v. 21, no. 10, 1146-1159, 2015.   https://doi.org/10.1109/TVCG.2015.2424862

- Kulkarni, S.K., Chakravarthy, S., **Minor, M.A.**, Pardyjak, E.R., and Hollerbach, J.M., "Control of a Duct Flow Network for Wind Display in a Virtual Environment," *IEEE/ASME Transactions on Mechatronics,* v 17, n 6, p 1021-1030, 2012. https://doi.org/10.1109/TMECH.2011.2157973

- Kulkarni, S.D., **Minor, M.A.**, Deaver, M.W., Pardyjak, E.R., Hollerbach, J.M., "Design, sensing, and control of a scaled wind tunnel for atmospheric display*," IEEE/ASME Transactions on Mechatronics*, v 17, n 4, p 635-645, 2012. https://doi.org/10.1109/TMECH.2011.2113353

- Kulkarni, S.K., Deaver, M.W., Pardyjak, E.R., **Minor, M.A.**, Hollerbach, J.M, "Design Elements of a Novel Atmospheric Flow Simulator," *Journal of Fluid Engineering*, Tran. ASME, v 133, n 12, 2011. https://doi.org/10.1115/1.4005345

- Kulkarni, S.K., Fisher, C., Pardyjak, E.R., **Minor, M.A.**, Hollerbach, J.M., "Wind display device for locomotion interface in a virtual environment," *3rd Joint Euro Haptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (World Haptics 2009)*, p 184-189, 2009. https://doi.org/10.1109/WHC.2009.4810855

- Kulkarni, S.D., **Minor, M.A**., Pardyjak, E., Hollerbach, J.M, "Combined Wind Speed and Angle Control in a Virtual Environment Using a Static Observer," *2008 IEEE/RSJ International Conference on Intelligent Robots and Systems*, Nice, France, Sept 22-26, 7 pages, 2008. https://doi.org/10.1109/IROS.2008.4651066

- Kulkarni, S., **Minor, M.A.**, Deaver, M., Pardyjak , E., Hollerbach, J. "Steady Headwind Display with Conditional Angular Rate-Switching Control," *2008 IEEE International Conference on Robotics and Automation,* Pasadena, CA, May 19-23, pp 1118-24, 2008. https://doi.org/10.1109/ROBOT.2008.4543354

4. Floyd, Marshall, "Formalization of Steering-Plane Bipeds: Characterization, Motion Planning and Gait Optimization," September 2008-August 2017, Occupation: Robotics Engineer, SARCOS Robotics, Products with advisor:

    - Floyd, M., **Minor, M.A.**, "Impulse Based Rolling in the Rolling Disk Biped," *2010 3rd IEEE RAS and EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob 2010)*, p 498-503, 2010. https://doi.org/10.1109/BIOROB.2010.5625978

    - Marshall D. Floyd and **Minor, M. A.**, "Steering-Plane Bipeds: Characterization, Motion Planning and Gait Optimization.", Book in preparation

5. Wang, Yue, "Design and control of a Smart Shoe for displaying terrain features," August 2012-August 2018. Support: NSF. Occupation: Robotic Algorithms and Control Systems Engineer , Intuitive Surgical, Products with advisor:

    - Leng. Z., Wang, Y., Xin, M., **Minor, M.A.**, "The Effect of Sideslip on Jackknife Limits During Low Speed Trailer Operation," *Robotics,* vol. 11, no. 6, pp 133 (28 pages), Nov. 2022, *https://doi.org/10.3390/robotics11060133.*

    - **Minor, M.A.**, Wang, Y., Merryweather, A.M., "Haptic Device for Terrain Feedback and Control", requested patent, 16/993,682. Aug. 14, 2020.

    - Wang, Y, Truong, T. E., Chesebrough, S., Willemsen, P., Foreman, K. B., Merryweather, A.S., Hollerbach, J. M., and **Minor, M.A.**, "Augmenting Virtual Reality Terrain Display with Smart Shoe Physical Rendering: A Pilot Study", *IEEE Trans. Haptics*, https://doi.org/10.1109/TOH.2020.3029896, Oct. 2020

    - Wang, Y., **Minor, M.A.**, "Design and Evaluation of a Soft Robotic Smart Shoe for Haptic Terrain Rendering," *ASME/IEEE Trans. Mechatronics*, 23(6), p 2974-2979, December 2018. https://doi.org/10.1109/TMECH.2018.2871631

    - Wang, Y., Gregory, C., **Minor, M.A.**, "Improving Mechanical Properties of Molded Silicone Rubber for Soft Robotics via Fabric Compositing," *Soft Robotics*, 5(3), p 272-290, June 2018. https://doi.org/10.1089/soro.2017.0035

    - Yue Wang, Christopher Wilson, Sam Chesebrough, Pete Willemsen, K. Bo Foreman, Andrew Merryweather, John Hollerbach, and **Mark A. Minor**, "Towards Terrain-Enabled Gait Therapy using Immersive VR with Physical Terrain Display for Parkinson's Disease", 4th Neurological Disorders Summit, Los Angeles, CA. Abstract and Podium Presentation. July 2018.

    - Wang, Y., **Minor, M.A.**, "Improving Mechanical Properties of Molded Silicone Rubber for Soft Robotics Through Fabric Compositing," SATEC 2018, May 2018, 22 pages.

    - Wang, Y., **Minor, M.A.**, "Design of a bladder based elastomeric Smart Shoe for haptic terrain display," *2014 IEEE/RSJ International Conference on Intelligent Robots and*

Systems (IROS 2014), p 1236-41, Sept. 14-18, 2014.
https://doi.org/10.1109/IROS.2014.6942715

6. Xin, Ming, "Sensor based model identification in unmanned ground vehicles," Support: Kairos Autonomi, University of Utah. Sept 2008-December 2018. Occupation: Director of Control System, x-motor. Products with advisor:

- Xin, M., **Minor, M.A.**, "Integrating Vehicle Slip and Yaw in Overarching Multi-Tiered Automated Vehicle Steering Control to Balance Path Following Accuracy, Gracefulness, and Safety," Submitted to the *IEEE Transactions on Robotics.* Under Revision.

- Xin, M., **Minor, M.A.**, "On-Road Parameter and State Estimation for Ground Vehicles Using Multi-Stage On-Line Algorithms," to be submitted to the *ASME Transactions on Dynamic Systems, Measurement, and Control.*

- Xin, M., Zhang, K., Lackner, D., **Minor, M.A.**, "Slip-Based Nonlinear Recursive Backstepping Path Following Controller for Autonomous Ground Vehicles," to be submitted to the *IEEE Trans. on Intelligent Transportation Systems.*

- Leng. Z., Wang, Y., Xin, M., **Minor, M.A.**, "The Effect of Sideslip on Jackknife Limits During Low Speed Trailer Operation," *Robotics,* vol. 11, no. 6, pp 133 (28 pages), Nov. 2022, *https://doi.org/10.3390/robotics11060133.*

- Xin, Ming, Yin, Y., Zhang, K., Lackner, D., **Minor, M.A.**, "Continuous Robust Trajectory Tracking Control for Autonomous Ground Vehicles Considering Lateral and Longitudinal Kinematics and Dynamics via Recursive Backstepping," *2021 IEEE/RSJ Int'l Conf. Intel. Robots and Systems (IROS 2021),* https://doi.org/*10.1109/IROS51168.2021.9635920.*

- Xin, M., Zhang, K., Lackner, D., **Minor, M.A.**, "Slip-Based Nonlinear Recursive Backstepping Path Following Controller for Autonomous Ground Vehicles," *2020 IEEE Int'l Conf. Robotics and Automation (ICRA 2020)*, Paris, France, May 2020, pp. 6169-6175, https://doi.org/10.1109/ICRA40945.2020.9197165 .

- Xin, M., **Minor, M.A.**, U-6792 Provisional Patent Application, "GRACEFUL AND ROBUST PROPRIOCEPTIVE STEERING AND PARAMETER ESTIMATION OF AUTOMATED GROUND VEHICLES" 62/861,222, June 2019.

- Xin, M., **Minor, M.A.**, "Graceful and Robust Steering of Automated Ground Vehicles (AGV) through bioinspired sensing and control", SATEC 2016, 9 pages.

- Xin, M., **Minor, M.A.**, "Backstepping Variable Structure Controls of Slip-Based Kinematics and Dynamics for Improved AGV Cornering Performance," *2014 IEEE International Conference on Robotics and Automation*, ICRA 2014, p 5286-91. 10.1109/ICRA.2014.6907636. https://doi.org/10.1109/ICRA.2014.6907636

- Xin, M., **Minor, M.A.**, "Variable Structure Backstepping Control via Hierarchal Manifolds Set for Graceful Ground Vehicle Path Following," *2013 IEEE International Conference on Robotics and Automation*, ICRA 2013, 7 pages, p 2826-32, 2013. https://doi.org/10.1109/ICRA.2013.6630968

- Xin, M., **Minor, M.A.**, "Backstepping vehicle steering controller using integral and robust control based on dynamic state estimation", *2012 IEEE/RSJ International Conference on Intelligent Robots and Systems*, IROS 2012, p 3132-37, 2012. https://doi.org/10.1109/IROS.2012.6386199

- Xin, M., **Minor, M.A.**, "A Multi-Tiered Robust Steering Controller Based on Yaw Rate and Side Slip Estimation," *2011 IEEE Conference on Intelligent Robots and Systems*, p292-7, 2011. https://doi.org/10.1109/IROS.2011.6095117

7. Zhe, Leng, "Dynamic control of autonomous ground vehicles," Support: Kairos Autonomi, University of Utah, Sept 2007-December 2018. Co-founder, Hongan Robotics, Products with advisor:

- Leng, Z., **Minor, M. A.**, "Vehicle-Trailer Kinematic Parameter Identification Considering Sideslip for Trailer Backing Control," submitted to Control Engineering Practice.

- Leng. Z., Wang, Y., Xin, M., **Minor, M.A.**, "The Effect of Sideslip on Jackknife Limits During Low Speed Trailer Operation," *Robotics,* vol. 11, no. 6, pp 133 (28 pages), Nov. 2022, *https://doi.org/10.3390/robotics11060133*.

- Zhe, L., **Minor, M.A.**, "Curvature Based Ground Vehicle Control of Trailer Path Following Considering Sideslip and Limited Steering Actuation," *IEEE Trans. Intel. Trans Systems, (18)2, 332-348, July 2016.* https://doi.org/10.1109/TITS.2016.2572208.

- Leng, Z., **Minor, M.A.**, "A Simple Tractor-Trailer Backing Control Law for Path Following with Side Slope Compensation," *2011 IEEE International Conference on Robotics and Automation,*p2386-91, 2011. https://doi.org/10.1109/ICRA.2011.5979918

- Leng, Z., **Minor, M.A.**, "A Simple Trailer Backing Control Law for Path Following," *IEEE/RSJ 2010 International Conference on Intelligent Robots and Systems (IROS 2010),* p5538-42, 2010. https://doi.org/10.1109/IROS.2010.5650489

Current MS students:

1. Pollard, Colin, "Embedded sensing for a Smart Helmet," ECE Project, Expected graduation: Spring 2023.

2. Short, Tanner, "Comparison of real and virtual cane usage," MS Project, Jan 2022-current.

3. Singh, Prabhupal, "Identification and characterization of brushless motor driven harmonic drives for large workspace haptic manipulators", ME MS project, Fall 2022.

Masters Students Graduated:

1. Baum, Nate, "An Evaluation of the Closed-Loop, Active Smart Shoe (C.L.A.S.S.) Bladder as an Impedance-Style Haptic Device Using Indirect And Direct Force Control", August 2017-August 2021. Support: DoD US Special Operations Command, NSF

2. Luttmer, Nate, "Development, Validation, And Testing of a Treadmill Based Three-Tether Parallel Robot for Evaluating Warnings While Running", Start May 2018-December 2020. Support: NSF, ME Department.

3. Mitchell, Alexander, "Realistic Biped Gait Simulation Using Double Computed-Torque Control," Masters Project in CS, May 2019-December 2019.

4. Shantnu Kakkar, "Fast And Reliable Motion Model For Articulated Wheeled Mobile Robots On Extremely Rough And Rocky Terrains," January 2016-December 2018.

5. K. Beau Freckleton, "A Preliminary Analysis Of The Ability Of A Potential Orthotic Device To Reduce And Mitigate Shoe Slip," January 2015-May 2017

6. Travis Hainsworth, "Quadrupedal Emotive Gaits in Robots", January 2016-May 2017.

7. Miller, Jonathan, (co-advised with A. Merryweather) "Design and control of a gait robot for evaluating smart shoes", Sept 2012-Aug 2016.

8. Ott, Michael, "Sonar based navigation of aerial robots among vineyard rows," Visiting MS student, September 2013-March 2014.

9. Crandall, Kyle, "Detecting and compensating perching stabilization of Aerial Robots," Start August 2013-August 2014.

10. Burroughs, Michelle. "Miniature Bio-inspired Perching for Unmanned Air Vehicles", Co-advised with Jake Abbott. Jan 2012 – August 2013.

11. Doyle, Courtney, "Underactuated Bio-inspired Robotic Graspers", Co-advised with Jake Abbott, August 2009 – August 2011.

12. Lefler, Price, "Olfactory Display in the TreadPort Active Wind Tunnel", May 2009 - August 2011.

13. Steigerwaldt, Bret, "Active Shoe Sole Capable Of Providing A Level Walking Surface On Low-Angled Terrain", Start: August 2008, Expected Graduation: May 2011

14. Fisher, Charles, "Design and construction of an atmospheric display wind tunnel for virtual reality use", May 2006 – August 2009.

15. Hetrick, Andrew, "Implementation of kinematic control for a DARPA Urban Challenge vehicle," August 2006-May 2010.

16. Bandaru, Ramya, "Constrained Ground Vehicle Path Specification", Jan 2007-May 2009.

17. Chakravarthy, Shanthanu, "Modeling and control for simulated wind in immersive virtual environment," Jan 2008-August 2009.

18. Desai, Aditya, "Design of vents for the incorporation of wind effects to a virtual environment," Jan 2008-December 2009.

19. Terry, Jared, "Prediction and Control of Terrain Interaction in Wheeled Mobile Robots," July 2004-August 2008, Guidance and Control Engineer, ATK.

20. Flickinger, Dan, "Planning and Coordination of mobile robot behavior for medium scale distributed wireless network experiments," August 2004-May 2007. PhD University of Texas Arlington., Postdoc RPI.

21. Phipps, Cristian, "Quasi Steady Rolling Locomotion in Hybrid Mobility Robots," July 2004-May 2007.

22. Shigeoka, Katie, "Stabilization and tracking control of ornithopter flight locomotion," Aug 2004 - May 2007.

23. Parker, Craig, "Energetic and Biomechanical Comparisons of Treadmill Slope Display Using Tilt Versus Torso Forces," Master of Science, May 2002 – Aug. 2005. Co-advised with John Hollerbach, Occupation: L-3 Communications.

24. Shores, Benjamin, "Hybrid Climbing and Rolling Mobility for Mobile Robotic Systems," Master of Science, Aug. 2002 – Aug. 2005. Occupation: Guidance, Navigation, and Controls Engineer, Orbital Sciences, Corporation, Phoenix, AZ.

25. Merrell, Roy, "Compliant Framed Modular Mobile Robots: Sensor Fusion for Self-Sensing and Global Localization," Master of Science, Aug. 2001 – Aug. 2005. Occupation: Guidance, Navigation, and Controls Engineer, Orbital Sciences Corporation, Phoenix, AZ.

26. Mohammidi, Amir, "Pneumatic Microactuator Powered by the Deflagration of Sodium Azide," Master of Science, Aug. 2002 – Dec. 2004, Occupation: Principal Mechanical Engineer, 1" Mobile Hard Drive Servo Development, Western Digital Corporation.

27. Krosuri, Satya, "Design, Modeling, Control, and Evaluation of a Hybrid Hip Miniature Climbing Robot," Master of Science, Jan. 2001 – Dec 2004. Occupation: Automation Engineer, Boston Scientific, Salt Lake City, UT

28. Park, Sungyong, "Compliant Framed Modular Mobile Robots: Control Techniques for Dynamic Stabilization," Master of Science, Jan. 2002 – May 2004. Occupation: Doctoral Student, University California Los Angeles, Los Angeles, CA.

29. Hirschi, Chris, "Automated Tether System for Microgravity Extravehicular Activities," Master of Science, May 2001 – Dec. 2003. Occupation: Research Engineer, Sarcos Research, Salt Lake City, UT

30. Albiston, Brian, "Compliant Framed Modular Mobile Robots: Motion Planning for Point Stabilization and Path Following," Master of Science, Jan. 2002-May 2003. Occupation: Senior Controls Engineer, Sagetech, Inc, Hood River, OR.

31. Kim, Youngshik, "Control System Prototyping: From DSP to Micro-Controller," Master of Science, Aug. 2001-Jan. 2003. Occupation: Associate Professor, Hanbat National University, Daejon, South Korea.

32. Schwensen, Corey, "Control Of A Compliant Fixed-Wheeled Vehicle Via Independent Wheel Control," Master of Science, Aug. 2000 - Aug. 2002, Occupation: Integration Developer, Lincoln Electric Systems, Lincoln, NE..

33. Jensen, Kent, "An Interactive Robot for Educating College Bound Student about Engineering Disciplines," Master of Engineering, Aug. 2000 - Aug. 2001, Occupation: Ret. Lt. Col US Air Force.

UNDERGRADUATE RESEARCHERS

Current Undergraduate Researchers:

1. Boynton, Milo, "Design and Manufacturing of Large Workspace Haptic Manipulators", May 2022-current. NSF REU Funded.

2. Flores-Gonzalez, Josue, "Characterization of user interaction with real-world objects for virtual environments", June 2022-current. NSF REU funded.

Past Undergraduate Researchers:

1. Short, Tanner, "Instrumentation of a cain for characterization of user interaction in a virtual environment." January 2022-Fall 2022. UROP Funded

2. Gill, Stefen, "Embedded Sensing for a Smart Helmet", May 2022-Aug 2022.

3. Eshete, Ebsa, "Startle Response in Virtual Reality", "Design and characterization of Bladders for a Smart Helmet to Dissipate Impact Forces", NSF REU, NSF funded hourly research assistant, September 2018-May 2022

4. Hirschi, Tren, "Improved harness design for the TreadPort", NSF REU, Fall 2019-May 2022

5. Pollard, Colin, "Embedded sensing for a Smart Helmet", NSF REU, NSF funded hourly research assistant, January 2020-May 2022.

6. Olson, Julia, "Modeling and Characterization of User Interaction with Real World Objects for Large Workspace Haptic Interaction", NSF REU, Summer 2021-May 2022.

7. Steur, Arthur, "Development of a Hybrid Aerial-Aquatic Vehicle dynamic model and Testing," volunteer working with Ali Almiskeen, January 2021-January 2022

8. Simpson, Rian, "Characterization of Helmet Bladder Compression Forces", NSF REU, Summer 2021

9. Almiskeen, Ali, "Development of a Hybrid Aerial-Aquatic Vehicle dynamic model and Testing," UROP, December 2020-January 2022.

10. Salzetti, Maria, "Design of large workspace haptic manipulators", Merril Scholar, Fall 2020-Spring 2021.

11. McKee, Sasha, "Design of and Interaction with Large Workspace Haptic Manipulators," Summer 2020-Spring 2021

12. Greer, Derek, "Startle Response in Virtual Reality", NSF REU, UROP, volunteer, December 2017-May 2021

13. Labon, Emerson, "Characterizing cane dynamics for large workspace virtual haptic interaction," UROP, December 2020-May 2021.

14. Moss, Ella, "Embedded sensing and control of a Smart Helmet", Merrill Scholar, Fall 2020.

15. Truong, Takara, "Startle Response in Virtual Reality", "Design and Manufacturing of a Smart Helmet" NSF REU, May 2017-Spring 2020

16. Mohd Zaki, Alia Binti, "Startle Response in Virtual Reality" and "Smart Helmet Sensing and Control", NSF funded hourly research assistant, UROP supported, November 2017-May 2020

17. Garcia, Thornton, "Pressure regulating system for evaluation of elastomeric bladders", Independent Study, Fall 2019

18. Olsen, Nathan, "Estimating helmet acceleration using embedded sensors", UROP, Fall 2019.

19. Yang, Jiayu, "Startle Response in Virtual Reality", student volunteer, September 2018-May 2019.

20. Stewart, Ben, "Startle Response in Virtual Reality", NSF REU, June 2017-May 2018.

21. Luttmer, Nate, "Startle Response in Virtual Reality", NSF REU, June 2017-May 2018.

22. Gregory, Cherry, "Improving realism in virtual reality terrain display" NSF REU student, May 2016-April 2017.

23. Stewart, Ben. "Improving realism in virtual reality terrain display" NSF REU student, May 2016-April 2017.

24. Posselli, Nick, "Feedforward control of wind display in the Treadport Active Wind Tunnel", NSF REU student, Summer 2014-Spring 2015.

25. Bruns, Jonathan, "Anthropomorphic Ankle Design for a Gait Simulator," NSF REU Student co-advised with Andrew Merryweather. Summer 2014-Spring 2015

26. Freckleton, Beau. "Directionally compliant footwear for reduced slips." MEEN 5960, Fall 2014.

27. Bonham, Alec, "Increasing Robotic Platform Mobility through a Compliant Chassis Articulation System", UROP, Spring 2015.

28. Bruns, Jonathan, "Enhancing The Performance Of Light Telerobotic Systems With Compliant Composite Wheel Designs For Use In Extraterrestrial Mobility Applications", UROP, Spring 2015.

29. Michael Bills "Design of bio-inspired hands," UROP, August 2013-August 2014

30. Aaron Wernerhal "Design of bio-inspired hands," UROP, August 2013-August 2014

31. Matthew Monahan, "Virtual Reality Based Tele-operation of a mobile manipulator," MEEN 5920, August 2013-August 2014.

32. Boppana, Abhijit, "Control allocation for a wind control system for a virtual environment," NSF REU Student, November 2013-May 2014.

33. Hainsworth, Travis, "Gaiting and control of legged mobile robots," MEEN 5920, December 2013-May 2014.

34. Freckelton, Beau, "Design and Manufacture of Sarrus Based Perching Mechanism," January 2012-August 2014.

35. Stevens, Robert, "Integrating wind display and TreadPort locomotion," NSF REU Student, Summer 2013.

36. Crandall, Kyle, "Serial Data Communications for Real Time Control," NSF REU Student, August 2009-August 2013

37. Crocker, Nicholas, "Embedded Microcontroller Integration for a Hybrid Mobility Robot", Spring 2011, Merrill Scholar

38. Rees, Dallin, "Design and Construction of a Snakeboard Robot", Spring 2011, Merrill Scholar

39. Vowles, Marty, "Embedded control and autonomy of compliant framed wheeled modular mobile robots," Start: May 2005-August 2005.

40. Fischer, Charles, "Terrain sensing and odometric compensation in wheeled mobile robots," Start: May 2005-May 2006

41. Lefler, Price, "Olfactory display in virtual environments," July 2008-May 2009

42. Sani, Hamid, "Vision based stop line detection for Autonomous Vehicles," Independent Study, Spring 2007

43. Roberts, Jared, "Autonomous Vehicle System Integration," Independent Study, Spring 2007.

44. Roberts, Jared, "Sonar system for Autonomous Vehicle," Independent Study, Summer 2007.

45. Scott, Jacob, "Miniature Suction Foot for Climbing Robots," Independent Study, Fall 2002.

46. Truscott, Tadd, "Selection and Characterization of Inertial Instrumentation Hardware," Independent Study, Spring 2001, Fall 2002.

47. Fox, Arthur, "Boundary Condition Characterization of a Flexible Frame Element," Independent Study, Summer 2002.

48. Allison, James, "Instructional Tutorials for Lessons in Particle Dynamics using a Serial Link Manipulator," UROP, Spring – Summer 2002.

49. Hoffman, Chad, "Selection and Characterization of a Global Positioning System," UROP, Spring 2002.

50. Merrell, Roy, "Micro-controller Interface Programming for a Serial Link Manipulator," Independent Study, Summer 2001.

51. Anderson, Julia, "Encoder Interfacing for a Serial Link Manipulator," Independent Study, Spring 2001.

52. Blanchard, Danny, "Instrumentation of a Serial Link Manipulator," UROP, Spring-Summer 2001.

GRADUATE THESIS COMMITTEE MEMBER

Current:
1. Aarti Singh, PhD, Washington University St. Louis, Electrical Engineering
2. Ali Filsoofi, PhD, Mechanical Engineering

Past:
1. Jake Abbot, MS, Mechanical Engineering
2. Mike Anderson, MS, Mechanical Engineering
3. Shawn Archer, MS, Mechanical Engineering
4. Dhiraj Aurora, PhD, Mechanical Engineering
5. Adam Blanksepoor, MS, Mechanical Engineering
6. Adam Blanksepoor, PhD, Mechanical Engineering
7. Clief Castleton, MS, Mechanical Engineering
8. Clinton Cathey, MS, Mechanical Engineering
9. Garrett Colton, ME, Mechanical Engineering
10. Mark Colton, PhD, Mechanical Engineering
11. Parker Conroy, MS, Mechanical Engineering
12. Joe Doubek, MS, Mechanical Engineering
13. Erik Engeberg, PhD, Mechanical Engineering
14. Scott Fields, MS, Mechanical Engineering
15. Les Flemming, PhD, Mechanical Engineering
16. Matt Frey, MS, Mechanical Engineering
17. Lisa Fountain, PhD, Biomedical Engineering
18. Jongwong Kim, MS, Mechanical Engineering
19. Scott Pigg, PhD, Electrical Engineering
20. Craig Parker, MS, Mechanical Engineering
21. Matt Pierce, MS, Mechanical Engineering
22. Sarah Peddicord, MS, Mechanical Engineering
23. Brandon Peterson, MS, College of Mines
24. Daniel Petersen, MS, Mechanical Engineering
25. John Petersen, PhD, Electrical Engineering
26. Ravikumar Sakalikar, MS, Mechanical Engineering
27. Yu Sun, PhD, School of Computing
28. Steve Virost, MS, Mechanical Engineering
29. Trent Wall, ME, Mechanical Engineering
30. Andrew Wilder, PhD, Computer Science.
31. Huichai Zhang, PhD, Chemical Engineering
32. Narong, Boonsirisumpun, PhD, Computing
33. Thomas Grieve, PhD, Mechanical Engineering
34. Matthew Beall, MSNT Chair, Mechanical Engineering
35. Mathew Lyon, MSNT Chair, Mechanical Engineering

36. Bryce Wilson, MSNT Chair, Mechanical Engineering
37. Brady Bradshaw, MSNT Chair, Mechanical Engineering
38. Nathan Donahue, MSNT Chair, Mechanical Engineering
39. Katharin Jensen, MS, Mechanical Engineering
40. Kelton Gruebler, MS, Mechanical Engineering
41. John Mortensen, PhD, Mechanical Engineering
42. Sam Chesebrough, PhD, Mechanical Engineering
43. Pouya Sabetian, PhD, Mechanical Engineering
44. Hunter Brown, MS, Mechanical Engineering
45. Jackson Pontsler, MSNT, Mechanical Engineering
46. James Watson, MS, Mechanical Engineering
47. Clinton Fernandez, MS, Mechanical Engineering
48. Benko, Nik, PhD, Mechanical Engineering
49. Mohammad Homayounpour, PhD, Mechanical Engineering
50. Eric McClain, PhD, Mechanical Engineering

TEACHING

Curriculum development activities:

1. *University of Utah Graduate Robotics Program* http://robotics.coe.utah.edu/
   – Worked with John Hollerbach (Program Director) to establish the second Graduate Robotics Program in the US as a joint effort between School of Computing and Mechanical Engineering.
   – Curriculum covers the fundamental elements of robotics (mechanics, control, and geometry) in three core courses. Students also select one course each from Perception (such as Computer Vision or Image Processing), Cognition (such as Artificial Intelligence or Machine Learning), and Action (such as Advanced Manipulation and Locomotion or System Identification for Robotics). Remaining courses selected by student and advisory committee.
   – Developed core course "Introduction to Robot Control." Prerequisite: Introduction to Robotics. 3 credits. Course establishes foundation level understanding of control systems in order to rigorously develop independent joint level controllers, feed forward computed torque controllers, centralized controllers, and robust controllers. Operational space and interaction control are also examined. Includes final project focusing on a three link serial manipulator throwing a ball at a target. Students must design trajectories, select and design a dynamic controller, simulate the system, and then evaluate their algorithms on an actual robot.
   – Developed course on "Advanced Manipulation and Locomotion" as part of Action Focus of the Robotics Track. Course description below under instruction activities.
   – Program faculty include Jake Abbot (ME), Tucker Hermans (CS), Thomas Henderson (CS), John Hollerbach (CS/ME), Tommaso Lenzi (ME), Stephen Mascaro (ME), Sanford Meek (ME), Mark Minor (ME) and Srikumar Ramalingam (CS).
   – University of Utah Graduate Robotics Program is a founding member of the *Association of Graduate Robotics Programs*, an association of international Ph.D. Programs in Robotics, in collaboration with Carnegie Mellon University, Georgia Institute of Technology, and SSSA/IMT (Scuola Superiore Santa Anna, Pisa).

2. *Graduate Mechatronics Certificate*. Developed graduate curriculum/certificate aimed at mechatronic system modeling, control, prototyping techniques, and platform implementation. Intended for industrial audiences as well as traditional matriculated students.

3. *2002. Advanced Controls and Robotics Lab.* Refurbished experimental resources in lab to include state-of-the-art data acquisition and control hardware for rapid control prototyping, plant synthesis, and experimental validation. Lab supports all graduate courses listed above as well as the graduate robotics and mechatronics programs. Students now apply design theory using prototyping tools critical to rapid product development and evaluation. Impacts all graduate level controls and robotics courses.

4. *Undergraduate Mechatronics Lab and Project:*

   a. 2000-2004. Refurbished all experiments, installed all new computational and instrumentation resources, and rewrote all labs. Labs now include an instructional introduction, clear procedures, and key summarizing questions to ensure understanding. Two in-depth and encompassing lab reports per semester now require the students to tie relevant material together. Impacts ME EN 3200 and 3210.

   b. *2000-2004. Undergraduate Mechatronics Project.* Improved project structure with mandatory milestones and advisor meetings. Project is now tightly integrated throughout both semesters and ensures the use of a methodical design approach necessary for designing and manufacturing mechatronic systems. Impacts ME EN 3200 and 3210.

   c. *2010 Undergraduate Mechatronics Project.* Separated project from lab such that all lab activities take place in 3200 and all project activities take place in 3210. This provides a more focused pedagogy during 3200 while allowing the students to apply those skills in 3210 to their project.

   d. *2016 Mechatronics Lab Class (MEEN 3230).* Developed new lab class with Steve Mascaro to allow students to better focus on learning mechatronics in pedagogical lab activities and then applying them in a term length design project.

   e. *2016 Dynamic Systems and Control Class (MEEN 3220).* Developed new system dynamics and control class based upon lecture content of Mech II (MEEN 3210), but without the project and lab.

Instruction Activities at the University of Utah Department of Mechanical Engineering:

1. *Mechatronics I & II (ME EN 3200 & 3210).* Fall 2000-Spring 2001, Fall 2001-Spring 2002, Fall 2003-Spring 2004, Spring 2008, Spring 2010, Spring 2011, Spring 2012, Spring 2013, Spring 2015, Spring 2017. Course focuses on integrated design of mechanisms, actuators, instrumentation, modeling, and control. Laboratory assignments focus on practical aspects of instrumentation, modeling, and control. Yearlong mobile robotics project (e.g. walking sumo robots) directed towards a final competition culminates concepts in a mentored team environment with progressive milestones to assure judicious design methodology.

2. *Mechatronics Lab Class (MEEN 3230). Spring 2018, Spring 2019, Spring 2020, Spring 2021, Spring 2022.* Course focuses on pedagogical and applied aspects of mechatronics. Lectures provide a foundation and background for lab activities. Pedagogical lab activities teach students fundamentals of data acquisitions, signal processing, active and passive filters, sensing, and actuation. These concepts are applied in open ended team based mechatronics projects where students typically design a robot for a year end competition.

3. *Classical Controls (ME EN 5200/6200).* Fall 2002, 2004, and 2007. Students learn modeling and advanced control techniques in the time and frequency domains. The theory and application of techniques and tools used for the design of feedback control systems, including root locus, Bode, and Nyquist techniques are studied.

4. *State Space Controls (ME EN 5210/6210).* Spring 2003. Develop state space system models, determine and analyze transition matrices, evaluate conditions for controllability and observability, and design state feedback controllers, observers, and output feedback controllers.

5. *Nonlinear Controls (ME EN 7200).* Spring 2003 & 2005, Fall 2008 & 2010, Fall 2012, Fall 2014, Fall 2016, Fall 2018, Fall 2020, Fall 2022. Includes modeling, analysis, and control of nonlinear systems. Specific topics include phase portraits, Lyapunov stability, input/output stability, linearized controllers, gain scheduling, output feedback linearizing controllers, sliding mode control, and backstepping control.

6. *Nonlinear Controls II.* Fall 2003. In depth study of nonlinear control systems focusing on advanced state feedback linearizing controllers, sliding mode control, Lyapunov redesign, and backstepping.

7. *System Identification for Robotics (ME EN 7220).* Fall 2021. In depth study of identification techniques for determining kinematic parameters of serial link manipulators.

8. *Introduction to Robot Control (ME EN 5960/6960, Section 4).* Spring 2005, 2006, 2014. Control of manipulation robots is studied. Topics include control system fundamentals, sensors and actuators, and manipulator control techniques. Projects provide hands-on experience controlling a basic serial manipulator.

9. *Advanced Locomotion and Manipulation (ME EN 7230).* Spring 2007, Fall 2009, Fall 2011, Fall 2013, Fall 2015, Fall 2017, Fall 2019. Examines grasping, rolling, and sliding manipulation from two perspectives; (1) manipulating the pose of an object with an end-effector via grasping, rolling, and sliding manipulation, and, (2) manipulating the trajectory of a mobile robot via the rolling and sliding contact of wheels, feet, or curved exoskeletons and the ground.

10. *Vibrations (ME EN 5400/6400).* Spring 2008, Spring 2011. Examines free and forced vibrations of discrete linear systems with and without damping; matrix methods for multiple-degree-of-freedom systems; isolation of shock and vibration; and applications.

Capstone Design Teams Advised:

1. *NGC Guide By Wire Life.* Fall 2022-Spring 2023. Six student team (Trevor Johnson, Colby Lynch, Skyler Little, Caleb Norman, Derrick Moss) is evaluating the life of the guide wire used by Northrup Grumman Corp to navigate mobile robot transport units hauling heavy materials to manufacturing sites.

2. *Mining Excavator Testbed.* Fall 2021-Spring 2022. Six students (Steffen Gill, Kenzie Hoggan, Charlie Lambert, Justin Lord, Emma Stillings, Vivian Su) team is developing a testbed to characterize bucket wheel excavator forces and torques during mining in simulated lunar regolith.

3. *Perching Hexacopter Drone.* Fall 2020-Spring 2021. Seven students (Adam Lundgren, Cody Ashdown, Glen Greager, Ali Almiskeen, David Robinson, Jesse Crossley, Tyler Jackson) team is researching and developing the next generation of drone to perch on powerlines and harvest energy to recharge batteries and power onboard systems.

4. *Haptic Interfaces for Real World Objects,* Fall 2020-Spring 2021, Seven students (Courtney Cookson, Derek Greer, Kevin Hardy, Andrew Jue, Emerson Labon, Timmanee Loveless, Sasha McKee). The team is developing interfaces for the Large Workspace Haptic Manipulator project based upon real-world objects. This has included developing a tool changer to allow the interfaces to be switched quickly as well as instrumenting interfaces on real-world objects to forces to evaluate forced exerted on those objects.

5. *Aerial Robot Perching Power Harvesting.* Spring 2019-Fall 2019. Six students (Nick Bierwolf, Sean Harbertson, Brage Platt, Ryan Kitchen, Dean Owen, Klauss Griesman) researching and designing a perching mechanism for an aerial robot to harvest energy from power transmission lines.

6. *Seaforce.* Spring 2017-Fall 2017. Six students (Devon Martinez, John McAllister, Nathan Mikulski, Juan Uribe, Davison Wille, Kyle Woods) worked with an industry sponsor to design a system for creating waves for surfing.

7. *Ballistic Darts.* Fall 2015-Spring 2016. Advised five students (Chancey Bailey, Scott Downard, Jedediah Knight, Joseph Leeman, Brian Martinez) regarding design of a shooting based dart game. Project included design of metal targets, scorekeeping system, and support mechatronics. Sponsored by Center Mass Targets.

8. *Night Fury.* Fall 2015-Spring 2016. Co-advised four students (JP Thomas, Alex Bailey, Nick Arbanas, and Carl Condas) with Ken Stevens (ECE) regarding a mechatronics approach to ultimate frisby for night usage.

9. *Robotic Testbed.* Fall 2012-Spring 2013. Co-advised five students (Jessica Johnson, Josh Perschon, Ken Openshaw, Mike Porter, Anthony Chyr) with Andrew Merryweather toward design of a robotic test bed for evaluating footwear response during human gait.

10. *Saharan Rolling Spider.* Fall 2012-Spring 2013. Four students (Wenson Kwan, David Tripi, Ian Thomas, Jeremy Sharp) designed a robot inspired by the Saharan rolling spider in order to provide flipping and walking locomotion.

11. *Powered Paraglider UAV.* Fall 2011-Spring 2012. Five students (Kirk Davenport, Marcos Pozo, Dannie Bradley, Michael Price, Colton Woodman) designed and built a tele-operated robot based upon a miniature paraglider using android 3G phones for onboard sensing and control as well as the remote user interface.

12. *Saharan Rolling Spider.* Fall 2011-Spring 2012, Four students (Benito Suriano, Raphael Sandoval, Thayne Criddle, Tyler Pool), designed and fabricated a legged robot mimicking the dynamic flipping gaits of the Saharan rolling spider.

13. *Pangolin Robot.* Fall 2011-Spring 2012, Six students (Jeff Naylor, Devin Dixon, Jason Payne, David Harward, Joe Evans, James Thompson) coadvised with PhD student Marshall Floyd designed and manufactured a tele-operated quadruped robot capable of also rolling into a ball shape mimicking the Pangolin.

14. *Portal Axle.* Fall 2011-Spring 2012, Five students (Brison Lundgren, Jared Smith, Lauren Jensen, Adam Jenkins, and Derrick Blackburn) designed and fabricated a truck axle modification for providing improved off-road clearance.

15. *Bio-inspired Grasper.* Fall 2010-Spring 2011, Five students (Jason Kalman, Taylor Isom, Chris Johnson, Jason Simpson, Justin Bird) working with a MS student (Courtney Doyle) and co-advised with Jake Abbott developing a gravity actuated grasper for incorporation with a UAV.

16. *Ballistic Launcher.* Fall 2010-Spring 2011, Five students (Jordan Packer, Ben Pruitt, Matt Black, Michael Haslam, Alex Harris) designing and building a targeting game.

17. *Cave-Crawler.* Fall 2009-Spring 2010. Five students (Joshua Schmeiser, Kevin Lynk, Mike Wareing, Hamid Reza, Morteza Nejad) developed a snake like cave crawling robot for search and rescue applications.

18. *JR AutoChopper.* Fall 2007-Spring 2008. Seven students embedded sensors and micro-controllers into a small helicopter to provide semi-autonomous landing, take off, and flight capability.

19. *Auto-Caddy.* Fall 2007-Spring 2008. Six students conceptualized, designed, and built a mobile robot to carry a golf bag and autonomously follow a golfer on a golf course.

20. *Ornithopter.* Fall 2005-Spring 2006. Worked with three of six students on this team (Kuan Chen advised ornithopter design and development) to provide semi-autonomous flight capability. Aspects included embedded control, sensor processing, data filtering, and motion planning.

21. *Hex-a-Ball.* Fall 2005 - Spring 2006. Five students redesigned the hex-a-ball robot and built a full prototype of the robot. The robot was controlled via a tether using a dSpace system and provided ability to evaluate basic walking and rolling locomotion.

22. *Hex-a-Ball.* Fall 2004 – Spring 2005. Five students designed a novel spherical mobile robot with six legs that fold out of the robot to provide hexapedal locomotion. Prototypes of legs and the shell were built and evaluated.

23. *SAE Walking Machine.* Fall 2003 – Spring 2004. Four students completed two robots for the 2004 competition. One robot was based upon further refinement of the 2002-2003 robot while the students also designed and developed a novel biped walking machine. The biped was electrically powered and teleoperated.

24. *SAE Walking Machine.* Fall 2002 - Spring 2003, Three students retrofitted the 2001-2002 robot with an embedded controller for semi-autonomous operation and provided wireless remote tele-operation for the 2003 SAE Walking Machine competition.

25. *Plume Tracking Robot.* Fall 2001- Spring 2002. Three students designed and built a small mobile robot to carry a sensor and evaluate plume tracking algorithms.

26. *SAE Walking Machine.* Fall 2001 - Spring 2002. Eight students designed and built a sliding table walking machine with pneumatic actuation for the 2002 SAE Walking Machine competition. The robot was again pneumatically powered and tele-operated.

27. *SAE Walking Machine.* Fall 2000 – Spring 2001. Eight students conceptualized, designed, and built a novel ape inspired walking machine for the 2001 SAE walking machine competition. The robot was pneumatically powered and tele-operated..

Instruction Activities at Michigan State University, Department of Mechanical Engineering:

1. *Control Systems (ME 451).* Spring 2000. Mathematical modeling of dynamic systems, standard feedback control formulation, transient and sinusoidal steady-state analysis, and time and frequency domain controller synthesis.

2. *Mechanical Design I (ME 371).* Fall 1999. Analysis, design, and manufacture of mechanisms and machinery using linkages, cams, and gears trains.

3. *Mechanical Vibrations (ME 461).* Summer 1996 and Summer 1997. Newtonian methods applied to free, forced, damped, and un-damped mechanical systems including single and multi degree of freedom configurations subjected to numerous sources of forcing.

SERVICE ACTIVITIES

The following activities encouraged young people to pursue engineering and specifically robotics research:

1. <u>FIRST Robotics Competition</u>, Organizing Chair. This event provides a venue for high-school students working in teams to build robots competing in an alliance based robotic sport. Students learn and apply engineering and business principals in a fun and collegiate atmosphere. 2008-current.
2. <u>RobotUTES</u>, faculty advisor. Mentored interdisciplinary team of undergraduate and graduate students competing in the NASA/NIANET RoboOPS competition. Teams design and build rovers that are teleoperated from their home institution while operating on the Mars/Lunar testbed at NASA Johnson Space Center to search for simulated Mars samples. The RoboUTES team conducted numerous outreach activities in the community every year to educate young minds about STEM careers. 2011-20.
3. <u>Utah Student Robotics</u>, faculty advisor. Mentored interdisciplinary team of undergraduate students competing in the NASA Lunabotics competition at Kennedy Space Center. As part of the Artemis Student Challenge, the goal is to educate college students about systems engineering. One of the recent graduates is now working at the Jet Propulsion Lab as a Robotic Systems Engineer.
4. <u>DIY Network: First Robot Rivals Competition</u>. Advised a multidisciplinary team (Dan Flickinger (ME), Ben Mann (ME), Amji Ramanujam (EE/ME), Ben Newton (CS)) from the University of Utah in preparation for this competition. The team competed against Clemson University and Purdue University. '02
5. <u>SAE Walking Machine Team</u>, Faculty Advisor. '00-'04
6. <u>Engineering Day</u> presenter or presentation organizer for the Mechatronics Lab. '01-'04
7. <u>Ball-throwing robot for engineering recruiting</u>. Developed to allow high school students to learn about the design and engineering required to form a robotic system. Students interact with the robot by designing velocity trajectories such that the robot would throw balls at targets in a room. '00-'02.
8. <u>The Learning Channel</u>: *Junk Yard Wars*. Consulted as a team expert in the construction of a walking machine for season finale. '01-'02.

National and International Service Activities:
1. Reviewer for:
   - ASME Transactions on Dynamics Systems, Measurement, and Control
   - ASME Journal of Biomechanical Engineering.
   - ASME Journal of Mechanical Design
   - Journal of Robotics and Autonomous Systems.
   - IEEE Conference on Control Application.
   - IEEE Conference on Control, Automation, Robotics and Vision
   - IEEE International Conference on Robotics and Automation
   - IEEE/RSJ International Conference on Intelligent Robots and Systems
   - IEEE Transaction on Robotics and Automation.
   - International Journal of Mechatronics
   - International Journal of Robotics and Automation, ACTA Press
   - International Journal of Robotics Research.
   - NASA Peer Review Cycles
   - NSF Panel Review Cycles
   - Robotics and Automation Magazine
   - Robotica
   - Sensors
2. Editor:
   a. 2019-current, IEEE Robotics and Automation Society Conference Editorial Board
3. Associate Editor/Program Committee Member:
   a. 2005 IEEE/ASME International Conference on Advanced Intelligent Mechatronics.

b. 2006 IEEE Intl Conference on Robotics and Automation
c. 2007-08 IEEE Conference Editorial Board Member (ICRA PC Member)
d. 2008-09 IEEE Conference Editorial Board Member (ICRA PC Member)
e. 2010-11 IEEE Conference Editorial Board Member (ICRA PC Member)
f. 2012-16 IEEE Conference Editorial Board Member (ICRA PC Member)
g. 2007- IEEE/RSJ International Conference on Intelligent Robots and Systems
h. 2009-13. IEEE Transactions on Robotics, Associate Editor
i. 2012 IEEE International Symposium on Resilient Control Systems (tours, local accommodations)
j. 2015-18. IEEE Robotics and Automation Letters, Associate Editor
k. 2018-19 IEEE Conference Editorial Board Member (ICRA PC Member)
l. 2021 IEEE Robotics and Automation Magazine, Special Issue on VR

4. Award Selection Committee
   a. 2021 IEEE Intl Conference on Robotics and Automation, Service Robotics Chair
5. Organizing Committee Member:
   a. 2007 IEEE/RSJ International Conference on Intelligent Robots and Systems
6. Session Chair/Co-Chair:
   a. ASEE Annual Conference and Exhibition, ('04)
   b. IEEE Intl Conference on Robotics and Automation ('07,'08)
   c. IEEE/RSJ International Conference on Intelligent Robots and Systems ('08, '21)
7. Society Membership:
   Current: IEEE, ASME
   Past: ASEE, SAE Member
8. Sponsor of Overseas Research Faculty:
   Professor Jeh Won Lee, Yeungnam University, (8/03-8/04)
9. External Tenure and Promotion Reviewer:
   a. Georgia Southern University
   b. University of Hawaii, Manoa
   c. Florida Tech University
   d. New Mexico Institute of Mining and Technology
   e. Hong Kong University of Science and Technology, Guangzhou

Expert Witness: Consulted and provided expert testimony on the behalf of Moffatt-Thomas in regards to the design of a John Deere backhoe. ('01-'02)

Consulting: Thomas Engine Corporation, 2008.

Departmental Level Service Activities at the University of Utah:
   University of Utah Graduate Robotics Program, Mechanical Engineering Coordinator ('05-'18)
   Undergraduate Research Traineeship Selection Committee ('04)
   Graduate Seminar Coordinator ('03-'04)
   Mechatronics Faculty Search Committee, Chair ('04)
   Mechanical Engineering Curriculum Committee, Faculty Representative. ('00-October 2017)
   Mechanical Engineering Curriculum Committee, Chair, (November 2017-current)
   Recruiting Committee, Faculty Representative. ('00)
   Mechatronics Certificate Committee, Faculty Representative. ('00-current)

University Level service Activities at the University of Utah
   Judge Intermountain Junior Science and Humanities Symposium ('03)
   University of Utah Union Executive Board, Faculty Representative ('06-current)
   RoboUTES, Faculty Mentor ('11-'20)
   Utah Student Robotics, Faculty Mentor, ('21-current)

Regional Level service Activities at the University of Utah
    Utah FIRST Robotics Competition, Organizer ('09-current)

Service Activities at Michigan State University:
    College of Engineering Curriculum Committee, Graduate Student Representative ('97-'98)
    Mechanical Engineering Department Advisory Committee, Graduate Representative ('96-'97)
    Mechanical Engineering Chairperson Review Committee, Graduate Representative ('97)
    Formula SAE (consultant), Michigan State University. ('96-'00)
- Engine Fuel Systems - Solid modeling and Rapid Prototyping of intake system components
- Frame Design - FEM Analysis
    ASME, IEEE Student Member