William S. Nagel

Ph.D. Candidate (graduating May 2022)
Dept. of Mechanical Engineering
University of Utah
1495 E. 100 South
Salt Lake City, UT, 84112

Research Interests

Expertise: Dynamic systems and control, mechatronics, robotics, mechanical design, and smart actuators and sensors.

Application areas: Modeling/control of piezoelectric actuators for micro/nanotechnology, scanning probe microscopy (e.g., AFM), precision positioning and manipulation, precision additive manufacturing.

Education

Doctor of Philosophy (Private dissertation defense completed December 2021)
Mechanical Engineering (robotics track), University of Utah, Salt Lake City, UT
Dissertation title: "Long-Range Low-Coupling Dual-Stage Nanopositioner with Non-Orthogonal Flexure Mechanism: Nonlinear Design and Control for High-Speed Atomic Force Microscopy" Ph.D. Advisor: Kam K. Leang

Masters of Science (August 2015)
Mechanical Engineering, University of Nevada – Reno, Reno, NV
Thesis title: "Development and Implementation of a Spread Rate Measurement System"
M.S. Advisors: Eric L. Wang and Jeffery C. LaCombe

Bachelors of Science (May 2013)
Mechanical Engineering, University of Nevada – Reno, Reno, NV *(Magna Cum Laude)*

Awards and Honors

1. University of Utah, Department of Mechanical Engineering TA of the Year (Fall 2019 – Spring 2020)
2. American Control Conference Best Session Presentation Award (July, 2016)
3. National Science Foundation GK-12 Fellow (College of Eng. E-Fellowship Program, 2012 – 2013)
4. Nevada State Board of Engineers and Land Surveyors Engineering Intern (December, 2012)

Employment and Research Experience

Research and Teaching Assistant (August 2015 – present)
Department of Mechanical Engineering, University of Utah, Salt Lake City, UT
Research and Teaching Assistant (August 2013 – May 2015)
Department of Mechanical Engineering, UNR, Reno, NV
Undergraduate Research Assistant (August 2012 – July 2013)
Department of Mechanical Engineering, UNR, Reno, Reno, NV

Research and Scholarship

Journal Publications

1. W. S. Nagel, S. B. Andersson, G. M. Clayton, and K. K. Leang, *Nonlinear Design and High-Precision Control of a Non-Orthogonal Low-Coupling Hybrid Parallel-Serial-Kinematic Nanopositioner*, **(in press December 2021)** IEEE/ASME Transactions on Mechatronics. Early access via `http://doi.org/10.1109/TMECH.2021.3129445`

2. A. Mitrovic, W. S. Nagel, K. K. Leang, and G. M. Clayton, *Closed-Loop Range-Based Control of Dual-Stage Nanopositioning Systems*, IEEE/ASME Transactions on Mechatronics, Vol. 26, Issue 3, pp. 1412–1421, June 2021.

3. D. Guo, W. S. Nagel, G. M. Clayton, and K. K. Leang, *Spatial-Temporal Trajectory Redesign for Dual-Stage Nanopositioning Systems with Application in AFM*, IEEE/ASME Transactions on Mechatronics special issue on "Nano/Micro- Motion System: Design, Sensing, and Control", Vol. 25, Issue 2, pp. 558–569, 2020.

4. I. Adibnazari, W. S. Nagel, and K. K. Leang, *A 3D-printed 3-DOF tripedal microrobotic platform for unconstrained and omnidirectional sample positioning*, International Journal of Intelligent Robotics and Applications, Vol. 2, Issue 4, pp. 425–435, 2018.

5. W. S. Nagel and K. K. Leang, *Discrete Input-Output Sliding Mode Control with Range Compensation for Dual-Stage Systems*, **(in preparation)** Elsevier Mechatronics.

6. W. S. Nagel and K. K. Leang, *Cascading Discrete Input-Output Linear Quadratic Tracking Control for Dual-Stage Nanopositioners*, **(in preparation)** IEEE Transactions on Automatic Control.

7. J. A. Steiner, W. S. Nagel and K. K. Leang, *Magneto-Electroactive Endoluminal Soft Robot: Electroactive Polymer Effects on Traversal Speed*, **(in preparation)** Soft Robotics.

Book Chapter

1. W. S. Nagel and K. K. Leang, *Mechanical Design and Control for Speed and Precision,* A contributed chapter to the Springer Encyclopedia of Systems and Control 2019 Edition, Edited by John Baillieul and Tariq Samad, Springer London, 2019.

Conference Papers ["(*)" denotes peer-reviewed]

1. (*) W. S. Nagel, A. Mitrovic, G. M. Clayton, and K. K. Leang, *Discrete Input-Output Sliding Mode Control with Range Compensation: Application in High-Speed Nanopositioning*, **(under review)** Submitted for American Control Conference (ACC), Atlanta, GA, USA, June 8 – 10, 2022.

2. (*) W. S. Nagel, O. Hussein, O. Fakharian, M. Aureli, and K. K. Leang, *Surface Roughness Effects on Ionic Polymer-Metal Composite (IPMC) Sensitivity for Compression Loads*, **(Accepted)** Submitted for Society of Photo-Optical Instrumentation Engineers (SPIE) Smart Materials, and Nondestructive Evaluation Conference, Long Beach, CA, USA, March 6 – 10, 2022.

3. (*) Y. Chang, W. S. Nagel, K. K. Leang, and S. B. Andersson *A Comparison of Two Optimization-Based Control Methods for Scanning in SPM via Feature Tracking using a Dual-Stage Nanopositioner*, American Control Conference (ACC), pp. 4314–4320, New Orleans, LA, USA, May 26 – 28, 2021.

4. (*) W. S. Nagel and K. K. Leang, *Cascading Structure Linear Quadratic Tracking Control for Dual-Stage Nanopositioning Systems*, American Control Conference (ACC), pp. 70 – 75, Denver, CO, USA, July 1 – 3, 2020.

5. (*) W. S. Nagel and K. K. Leang, *Robust Sliding-Mode Control for Dual-Stage Nanopositioning Systems*, American Control Conference (ACC), pp. 2489 – 2494, Philadelphia, PA, USA, July 10 – 12, 2019.

6. (*) I. Adibnazari, W. S. Nagel, and K. K. Leang, *Development of a 3-DOF Tripedal Stick-Slip Microrobotic Mobile Platform for Unconstrained, Omnidirectional Sample Positioning*, ASME Dynamic Systems and Control Conference (DSCC), p.V002T24A011, Atlanta, GA, USA, September 30 – October 3, 2018.

7. (*) W. S. Nagel and K. K. Leang, *Design of a Dual-Stage, Three-Axis Hybrid Parallel-Serial-Kinematic Nanopositioner with Mechanically Mitigated Cross-Coupling*,IEEE International Conference on Advanced Intelligent Mechatroics (AIM), pp. 706 – 711, Munich, Germany, July 3 – 7, 2017.

8. (*) W. S. Nagel, G. M. Clayton, and K. K. Leang, *Master-Slave Control with Hysteresis Inversion for Dual-Stage Nanopositioning Systems*, American Control Conference (ACC), pp. 655 – 660, Boston, MA, USA, July 6 – 8, 2016.

Research-Related Posters

1. C. K. Lapins, W. S. Nagel, and K. K. Leang, *Sliding Mode Control of an Ionic Polymer Metal Composite (IPMC) Actuator*, American Control Conference (ACC), July 1 – 3, 2020.

2. W. S. Nagel and K. K. Leang, *System Identification of a Multi-Axis Dual-Stage Precision Positioning Platform*, ASME Dynamic Systems and Control Conference (DSCC), October 8 – 11, 2019.

3. J. Ngo, R. Histed, O. A. Hussain, W. S. Nagel, Y. Liao, M. Aureli, and K. K. Leang, *Fabrication and Dynamic Response Characterization of Tailored 3D-Structured IPMC Sensors*, ASME Dynamic Systems and Control Conference (DSCC), October 8 – 11, 2019.

4. B. Hartman, S. B. Andersson, W. S. Nagel, and K. K. Leang, *Non-Raster High-Speed AFM Imaging of Biopolymers*, Biophysics Society Annual Meeting, 2017.

5. T. Ashley, T. Huang, W. S. Nagel, S. B. Andersson, and K. K. Leang, *High Speed AFM Through Non-Raster Scanning and High Speed Actuation*, Biophysics Society Annual Meeting, 2016.

Workshops and Presentations

1. W. S. Nagel and K. K. Leang *Cascading Structure Linear Quadratic Control (LQC) for Dual-Stage Nanopositioning Systems*, University of Utah Robotics Seminar, September 10, 2020.

2. S. B. Andersson, B. Hartman, W. S. Nagel, and K. K. Leang, *High-Speed AFM through Non-Raster Scanning and High-Speed Scanning*, 4th Bio-AFM Workshop, Kanazawa, Japan, October 2016.

3. J. Ren, Q. Zou, and K. K. Leang, *Field-Programmable Gate Array Implementation for High-Speed, High-Bandwidth Feedforward Control*, American Control Conference (ACC), Boston, MA, USA, July 6 – 8, 2016. (Presenter)

Teaching and Mentoring

Courses Taught

Teaching at University of Utah (January 2017 – present)

Course	Course Number	Semester	Credits	Students	Evaluation
Year 2020 – 2021					
Classical Control Systems (TA)	ME EN 5220/6220	Summer	3	16	N/A
Mechatronics (Head TA)	ME EN 3230	Fall	4	72	5.45/6.00
Year 2019 – 2020					
Dynamics Systems and Control	ME EN 3220	Summer	3	5	5.66/6.00
Mechatronics (Head TA)	ME EN 3230	Spring	4	111	5.74/6.00
Mechatronics (Head TA)	ME EN 3230	Fall	4	55	5.46/6.00
Year 2018 – 2019					
Mechatronics (TA)	ME EN 3230	Spring	4	111	5.63/6.00
Mechatronics (TA)	ME EN 3230	Fall	4	60	N/A
Year 2016 – 2017					
Mechatronics II (TA)	ME EN 3210	Spring	4	130	5.12/6.00

Teaching at University of Nevada, Reno (January 2014 – December 2014)

Course	Course Number	Semester	Credits	Students†	Evaluation
Year 2014 – 2015					
Introduction to Engineering (TA)	ENGR 100	Fall	3	62	4.64/5.00
Year 2013 – 2014					
Introduction to Mech. Eng. (TA)	ME 151	Spring	3	60	N/A

"†" denotes classes where the enrollment of sections taught are provided rather than the full course total.

Student Mentees

1. Chantel K. Lapins, Project: *Nonlinear position control of ionic polymer-metal composite actuators* (April 2020 – June 2020). After earning her bachelor's degree, Chantel entered the doctoral degree program at the Unviersity of Utah.
2. Iman Adibnazari, Project: *Fabrication of a stand-alone amplifier for an experimental multi-axis nanopositioner; Design, fabrication, and validation of a planarly unconstrained micro-robotic platform* (January 2017 – August 2018). After graduating from the University of Utah (BS), Iman entered the doctoral degree program at the University of California, San Diego.
3. Vincent Camilleri, Project: *Development and calibration of an autonomous humidity measurement system for mobile weather vehicle systems.* (October 2013 – May 2015). After earning his bachelors degree, Vincent continued on to enter the master's program at UNR.

Course/Lecture Development

1. Classical Control Systems – expanded laboratory exercises to include MATLAB system identification for real-world controller design experience. (Summer 2021)
2. Mechatronics – modified existing laboratory exercises and modules to be conducted remotely for COVID-19 accommodations. E.g., Arduino/Matlab code to perform function of in-lab data acquisition hardware. (Fall 2020)
3. Mechatronics – restructured feedback control lab exercises to be conducted entirely through video conference call software. (April 2020)
4. Mechatronics – designed and built free-rotating platform with magnetic indicators for semester autonomous robot project. (August 2019)
5. Digital Logic Module – created a multi-week project for high-school students to introduce Boolean algebra and logic gates. Groups designed circuits to correctly illuminate a seven-segment display. (May 2015)
6. Electrical Resistance Lab Module – created a day-long project for high-school students to calculate equivalent resistances and measure on physical components. (April 2015)
7. Rotational Inertia Lab Module – designed and constructed a free-rotating structure with adjustable inertia for high-school students learning physics principles. (March 2015)

Guest Lecturing

1. Types of Mathematical Models [ME EN 3220 - Dynamic Systems and Control](January 2020)
2. Disturbances and Sensitivity for Feedforward and Feedback Systems [ME EN 5200/6200 - Classical Control] (October 2019)
3. Block Diagram Reduction and Manipulation [ME EN 3220 - Dynamic Systems and Control] (March 2019)
4. Bounded-Input Bounded-Output (BIBO) Stability [ME EN 5200/6200 - Classical Control] (September 2017)

Service

Review Activities

Active reviewer for the following publications:

1. IEEE/ASME Transactions on Mechatronics
2. IEEE Transactions on Industrial Electronics
3. Elsevier Mechanisms and Machine Theory
4. Elsevier Mechatronics
5. Springer International Journal of Intelligent Robotics and Applications
6. Annual IEEE Conference on Decision and Control, IEEE/RSJ International Conference on Intelligent Robots and Systems, IEEE International Conference on Robotics and Automation, IFAC World Congress, and the annual American Control Conference.

Professional Society Membership

1. IEEE, student member (2016 – present)
2. ASME, student member (2019 – present)

Society, Community, and Department Service

1. Student volunteer for the virtual American Control Conference (July 2020)
2. Assisted with lab tours for the University of Utah Robotics Program for ASME International Mechanical Engineering Congress and Exposition (November 2019)
3. Student volunteer for the annual ASME Dynamic Systems and Control conference (October 2019).
4. Photographer for annual department alumni social event (October 2019).
5. Presented research overview to visitors from ASEE Annual Conference & Exposition (June 2018).
6. Toured and interviewed prospective graduate students considering the University of Utah (February 2018).
7. Student volunteer for the annual American Control Conference (July 2016).
8. Graduate representative on the UNR Mechanical Engineering Differential Fees Committee (Spring 2015).
9. E-FIT program for incoming freshmen engineering students. Organized a trebuchet building project and competition, and presented a workshop on tips for success in university. (July 2014).
10. FIRST Robotics mentor for Reed High School (November 2014 – June 2015).

References

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