Trevor J. Bird

linkedin.com/in/trevor-j-bird/ • trevor.0335@gmail.com • 435-232-0335

EDUCATION

Ph.D., Mechanical Engineering, Purdue University, West Lafayette, IN — Expected Aug. 2022
Specialization: Systems, Measurements, and Control — 3.70 GPA
Advisor: Dr. Neera Jain
Thesis: *Hybrid Zonotopes: A Mixed-Integer Set Representation for the Analysis of Hybrid Systems*

M.S., Mechanical Engineering, Purdue University, West Lafayette, IN — May 2020
Advisor: Dr. Neera Jain — 3.74 GPA

B.S., Mechanical Engineering, Utah State University, Logan, UT — May 2017
Minor in Mathematics, Magna Cum Laude — 3.87 GPA

RESEARCH INTERESTS

Safety Verification and Reachability Analysis; Constrained Optimization; Robust and Optimal Control; Fault Diagnostics; Dynamic Modeling; Thermal Systems; Combined Plant and Control Design

HONORS & AWARDS

1. AACC Best Student Paper Award Finalist, ACC, 2022
2. ASME Energy Systems Technical Committee Best Paper Award, DSCC, 2019
3. Graduate Research Fellowship Program, National Science Foundation, 2018-2022
4. Herrick Assistantship, Ray W. Herrick Laboratories, 2018-2019
5. Ingersoll-Rand Fellowship, Purdue University, 2017-2018
6. MAE Undergraduate Researcher of the Year, Utah State University, 2017
7. Best Undergraduate Oral Presentation in Engineering, USU Student Research Symposium, 2017
8. Undergraduate Research Scholar Transcript Designation, Utah State University, 2017
9. EURP Undergraduate Research Fellowship, Utah State University, 2016-2017
10. Dr. Harold W. and Helen Ritchey Engineering Scholarship, Utah State University, 2016-2017

RESEARCH EXPERIENCE

Graduate Research Assistant, Purdue University — June 2017 – Present

- Derived a novel, mixed-integer set representation named the hybrid zonotope for analysis of reachability, safety, and invariance of hybrid systems
- Establishing approximation techniques of hybrid zonotopes to reduce computational burden
- Formulated the representation of explicit model predictive control laws as hybrid zonotopes to verify robustness of predictive controllers when subject to uncertain inputs
- Derived closed-form solutions for all basic set operations of hybrid zonotopes and wrote a MATLAB toolbox for easy implementation by collaborators
- Designed and implemented a multiple input multiple output dynamic controller for a single-phase cooling system robust to heat load profiles and actuator delays
- Developed and experimentally validated a control-oriented model of a PEMFC micro-Combined Heat and Power system with sensible thermal energy storage and evaluated controllability
- Designed and implemented a time critical, real-time controller for a rapid two-phase transient cooling batch process executing actuator control on the order of 10 milliseconds

Undergraduate Research Assistant, Utah State University — May 2015 – June 2017

- Built a coupled thermal-vibrations test bed and developed experimental process for full field measurements of specimen resonance at varying frequencies and temperatures
- Wrote computer scripts to automatically run experiments, trigger measurement devices, and collect data including analog and full field 3D optical measurements
- Designed and built a high magnification camera lens operating in ultraviolet range to capture micro-strain measurements of a specimen located 25 centimeters away inside an environmental chamber

TEACHING EXPERIENCE

MAE 5930: Experimental Solid Mechanics, Undergraduate Lab Assistant Aug. – Dec. 2016
- Developed lab procedures and assisted students in the lab
- Strengthened communication and teaching skills by delineating lab material

ENGR 2030: Engineering Mechanics Dynamics, Undergraduate Teaching Assistant Jan. – May 2015
- Tutored underclassmen seeking assistance with class material
- Developed teaching and multitasking skills by helping up to four students at a time

LEADERSHIP EXPERIENCE

IAC Planning Committee, Ray W. Herrick Laboratories Aug. 2019 – Present
- Plan all interactions between students and Industrial Advisory Committee (IAC) members during annual meeting
- Organize poster show and breakout sessions including approximately 90 students

Herrick Student Resource Committee, Ray W. Herrick Laboratories July 2019 – Present
- Represent student body in faculty meetings and organize student-led events

Undergraduate Student Mentor, Purdue University Jan. 2018 – May 2019
- Mentored one undergraduate research assistant developing rule-based heat and electricity-led control algorithms for micro-Combined Heat and Power systems

Shift Manager/Delivery Driver, Pizza Hut July 2008 – Aug. 2015
- Managed all employees, planned food prep based on projected sales, and handled daily finances
- Trained new employees to all aspects of the job including food safety regulations

PUBLICATIONS

Peer Reviewed Journal Articles

1. J. A. Siefer, **T. J. Bird**, J. P. Koeln, N. Jain, and H. Pangborn, "Robust Successor and Predecessor Sets of Hybrid Systems using Hybrid Zonotopes," *The IEEE Control Systems Letters,* 2022 (Under review)
2. **T. J. Bird**, H. C. Pangborn, N. Jain, and J. P. Koeln, "Hybrid Zonotopes: A New Set Representation for Reachability Analysis of Mixed Logical Dynamical Systems," *Automatica,* 2022 (Under revision)
3. **T. J. Bird**, and N. Jain, "Unions and Complements of Hybrid Zonotopes," *The IEEE Control Systems Letters,* 2021
4. **T. J. Bird**, and N. Jain, "Dynamic Modeling and Validation of a Micro-combined Heat and Power System with Integrated Thermal Energy Storage," *Applied Energy,* 2021
5. A. Nash, B. Fu, **T. J. Bird**, N. Jain, & T. Fisher, "Control-Oriented Modeling of Integrated Flash Boiling for Rapid Transient Heat Dissipation," *AIAA Journal of Thermophysics and Heat Transfer*, 2019
6. R. Hansen, **T. J. Bird**, R. Voie, K. Burn, & R. Berke, "A High Magnification UV Lens for High Temperature Optical Strain Measurements," *AIP Review of Scientific Instruments*, 2019

Peer Reviewed Conference Papers

1. **T. J. Bird,** N. Jain, H. C. Pangborn, and J. P. Koeln, "Set-Based Reachability and the Explicit Solution of Linear MPC using Hybrid Zonotopes," Proceedings of the 2022 American Controls Conference, Atlanta, GA, June 8-10, 2022
   - ➢ AACC Best Student Paper Award Finalist

2. **T. J. Bird**, C. Weaver, and N. Jain. "Switched Linear Model of a Stratified Hot Water Tank for Control of micro-CHP Systems," Proceedings of the 2019 ASME Dynamic Systems and Control Conference, Park City, UT, October 8-11, 2019
   - ASME Energy Systems Technical Committee Best Paper Award

PRESENTATIONS & INVITED TALKS

1. **T. J. Bird**, & N. Jain, "Hybrid zonotopes: A Mixed-Integer Set Representation for the Analysis of Hybrid Systems," University of Texas at Dallas Controls Seminar, Richardson, TX, March 2022
2. **T. J. Bird**, & R. Berke, "Resonant Response of Flat Plates at High Temperatures," Utah State University Student Research Symposium, Logan, UT, Apr. 2017
3. **T. J. Bird**, S. Ames, & R. Berke, "Modal Identification in Flat Plates during Vibrational Resonance at High Temperatures," ASME International Mechanical Engineering Congress & Exposition, Phoenix, AZ, Nov. 2016

SERVICE

CoderDojo, Greater Lafayette Commerce May 2019 – Feb. 2020

- Assisted once a month in teaching children between the ages 7-17 how to write computer scripts, general coding skills, and mechatronics

Minority Engineering Program, Purdue University June 2017 – June 2020

- Host tours of under-represented high school students from across the nation to share my experimental testbed and research goals, encouraging them to pursue higher education

SURF Symposium Presentation Judge, Purdue University Aug. 2019

- Judged poster and oral presentations for summer undergraduate research projects at Purdue Research Symposium

Native American STEM Mentorship Program, Utah State University June 2016

- Mentored two Navajo Nation students working on a two-year degree program offered at a USU extension site to encourage them to transfer to the main campus
- Both NASMP mentees chose to complete a full four-year degree in a STEM field; one mentee chose to continue work done in the program as an undergraduate researcher

Desolation Canyon Service Trip, Utah BLM June 2015 – June 2016

- Traveled along 84 miles of the Green River through Desolation Canyon assisting River Rangers with removing garbage and invasive species

PROFESSIONAL ACTIVIES

Conference Manuscript Reviewer 2018 – Present

- IEEE Conference on Control Technology and Applications (CCTA)
- AACC American Control Conference (ACC)
- ASME Dynamic Systems and Control Conference (DSCC)
- European Control Conference (ECC)
- Purdue High Performance Buildings Conference

Journal Article Reviewer 2019 – Present

- Automatica
- IFAC Mechatronics
- Mathematical and Computer Modelling of Dynamical Systems

Professional Society Memberships 2016 – Present

- Sigma Xi: The Scientific Research Honor Society
- American Society of Mechanical Engineers (ASME)
    - Dynamic Systems & Control Division (DSCD)
    - Energy Systems Technical Committee (ESTC)
- Institute of Electrical and Electronics Engineers (IEEE)