

# Tairan Liu

Last update on June 28, 2021

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## Education

Louisiana State University

BATON ROUGE, LA, U.S.A.

**Doctor of Philosophy**

*May 2020*

Mechanical Engineering, Department of Mechanical & Industrial Engineering

University of Science and Technology of China

HEFEI, ANHUI, P.R.CHINA

**Bachelor of Natural Science**

*Jul. 2012*

Theoretical and Applied Mechanics, Department of Modern Mechanics

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## Research Interests

- Multi-Agent/Robot System
  - Cyber-Physical System
  - Large-Scale Networked System
  - Cooperative Control
  - Distributed System/Algorithm
  - Human-Robot/Swarm Interaction
  - Lyapunov-Based Nonlinear Control
  - Robotics (Aerial/Ground/Underwater/Manipulator)
  - Multi-Robot Smart Manufacturing/Construction
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## Professional Experience

University of Georgia // Postdoc // Research

ATHENS, GA, U.S.A.

**Modeling of Trust in Human-Swarm Interactions**

*Jan. 2021 – Present*

Ongoing research: modeling the trust in human-swarm interactions; using a Dynamic Bayesian Network to infer the trust level between the human operator and the swarm of robots; various extensions including multi-agent system autonomy, task (re)assignment, resource (re)allocation, etc.

**Coverage Control and Path Planning with Heterogeneous Robots** *Sep. 2020 – Jun. 2021*

Proposed new concepts and algorithms of coverage control and path planning for heterogeneous robots. Provided mathematical proofs and conducted numerical simulations to validate algorithms. (Funded by the NSF GCR program.)

**Aerial Robotics in Agricultural Measurements**

*Sep. 2020 – Jun. 2021*

Built an open-source drone platform for field monitoring. Designed a telescopic structure for measurements under/in plant canopy. Developed an open-source graphical user interface (GUI) to define tasks, generate desired flight trajectory, and monitor drone's status and real-time trajectory. (Funded by the NSF GCR program.)

Louisiana State University // PhD // Research

BATON ROUGE, LA, U.S.A.

**Multi-Agent System Formation Control**

*Jul. 2016 – May 2020*

Proposed new formation control approaches, provided mathematical proofs, conducted computational and experimental validation.

**Aerial Robotic Network for Agricultural Applications**

*Jul. 2016 – Oct. 2019*

Designed and built a quadrotor fleet from scratch. Developed autonomous flight control firmware on MCU and flight control/monitor applications on PC. Developed distributed control network for quadrotors. (Funded by the LSU Economic Development Assistantship (EDA) program.)

**Computational Molecule Synthesis**

*Oct. 2015 – May 2016*

Developed open-source software which can decompose large molecules to small bio-active fragments, then use fragments to generate target molecules or new molecules for drug design.

**Multicopter Copter Applications in Agriculture**

*Feb. 2015 – Jun. 2015*

Developed an application to process aerial images. Optimized the software for better processing speed.

Louisiana State University // PhD // Teaching

BATON ROUGE, LA, U.S.A.

**Teaching Assistant and Lab Instructor**

*Jan. 2020 – May 2020*

Fundamentals of Instrumentation and Measurement (ME 3603).

**Teaching Assistant and Lab Instructor**

*Jan. 2016 – May 2016*

Autonomous Vehicles (ENGR 4200).

**Teaching Assistant and Lab Instructor**

*Aug. 2015 – Dec. 2015*

Machine Design Lab (ME 4201).

University of Science and Technology of China

HEFEI, ANHUI, P.R.CHINA

**Bionic Four-Tail Fin UUV (Mimic Dragonfly)**

*Aug. 2011 – Jan. 2013*

Developed program on MCU for motor control, developed remote control and wireless data transfer programs on PC and MCU for the bionic UUV with four oscillatory tail fins. The tail fins were designed to mimic the motion pattern of dragonfly.

**Bionic Long Undulatory Fin UUV (Mimic Black Ghost Knifefish)**

*Nov. 2011 – Jun. 2012*

Designed and built a UUV to mimic the propulsion pattern of black ghost knifefish. Developed program on Arduino for the UUV. Studied the effects of the frequency and amplitude of the swaying fin ray, wave number in the fin surface, and the speed of the incoming flow on propulsion thrust.

**Bionic Double-Tail Fin UUV**

*Sep. 2011 – May 2012*

Conducted experiments to optimize the performance of the double tail fin UUV. Developed a whole system to automatically conduct experiment, collect and process data, and plot results.

**Flow Trajectory After Passing Dual Circular Cylinders**

*Oct. 2011 – Nov. 2011*

Designed and built an adjustable dual-circular-cylinder model for the fluid experiment. Conducted experiments with hydrogen bubbles, laser beam, and high resolution high speed camera to study the water flow trajectory after passing dual circular cylinders.

**Composite Bionic Actuators**

*Apr. 2011 – Aug. 2011*

Assisted with motion pattern design. Developed programs on Arduino for the actuators.

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## Publications

### Refereed Journal Articles

8. **Tairan Liu** and Marcio de Queiroz. Distance + angle-based control of 2-d rigid formations. *IEEE Transactions on Cybernetics*. In press
7. **Tairan Liu** and Marcio de Queiroz. An orthogonal basis approach to formation shape control. *Automatica*, 129:109619, 2021
6. **Tairan Liu**, Marcio de Queiroz, Pengpeng Zhang, and Milad Khaledyan. Further results on the distance and area control of planar formations. *International Journal of Control*, 94(3):767–783, 2021
5. **Tairan Liu**, Victor Fernandez-Kim, and Marcio de Queiroz. Switching formation shape control with distance + area/angle feedback. *Systems & Control Letters*, Jan. 2020. Article 104598
4. Milad Khaledyan, **Tairan Liu**, Victor Fernandez-Kim, and Marcio de Queiroz. Flocking and target interception control for formations of nonholonomic kinematic agents. *IEEE Transactions on Control Systems Technology*, 28(4):1603–1610, 2020
3. Pengpeng Zhang, Marcio de Queiroz, Milad Khaledyan, and **Tairan Liu**. Control of directed formations using interconnected systems stability. *Journal of Dynamic Systems, Measurement, and Control*, 141(4):041003, 2019
2. Limeng Pu, Misagh Naderi, **Tairan Liu**, Hsiao-Chun Wu, Supratik Mukhopadhyay, and Michal Brylinski. eToxPred: a machine learning-based approach to estimate the toxicity of drug candidates. *BMC Pharmacology and Toxicology*, 20(1):2, 2019
1. **Tairan Liu**, Misagh Naderi, Chris Alvin, Supratik Mukhopadhyay, and Michal Brylinski. Break down in order to build up: Decomposing small molecules for fragment-based drug design with eMolFrag. *Journal of Chemical Information and Modeling*, 57(4):627–631, 2017

### Conference Proceedings

3. **Tairan Liu** and Javad Mohammadpour Velni. Multi-agent systems coverage control in mixed-dimensional and hybrid environments. In *Modeling, Estimation and Control Conference (MECC 2021)*. To appear
2. **Tairan Liu**, Marcio de Queiroz, and Farid Sahebsara. Distance-based planar formation control using orthogonal variables. In *2020 IEEE Conference on Control Technology and Applications (CCTA)*, pages 64–69, Montréal, Canada, Aug. 2020
1. **Tairan Liu**, Marcio de Queiroz, Pengpeng Zhang, and Milad Khaledyan. Directed formation control of  $n$  planar agents with distance and area constraints. In *2019 Annual American Control Conference (ACC)*, pages 1824–1829, Philadelphia, PA, Jul. 2019

### Manuscripts in Submission

1. **Tairan Liu**, Davoodi Mohammadreza, and Javad Mohammadpour Velni. Deployment of heterogeneous multi-agent systems with varying mass over a graph. *International Journal of Intelligent Systems*. In submission

## Conference Abstracts, Posters, Presentations, and Talks

3. **Tairan Liu.** Start from distance-based formation control. University of Georgia, Athens, GA, May 2020
2. **Tairan Liu.** Directed formation control of planar agents with distance and area constraints. In *2019 MIE Graduate Student Conference*, LSU, Baton Rouge, LA, Apr. 2019
1. **Tairan Liu**, Misagh Naderi, Supratik Mukhopadhyay, and Michal Brylinski. Decomposing small molecules for fragment-based drug design with eMolFrag. In *SCALA 2018 - Scientific Computing Around Louisiana*, LSU, Baton Rouge, LA, Feb. 2018

## Ph.D. Dissertation

**Tairan Liu.** *Distance-Based Formation Control: Theory, Applications, and Issues*. PhD dissertation, Louisiana State University, May 2020

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## Awards and Honors

Outstanding Graduate Research Assistant, 2019

Department of Mechanical and Industrial Engineering, Louisiana State University, Baton Rouge, LA, U.S.A.

LSU-ME Enrichment Award, 2014

Department of Mechanical and Industrial Engineering, Louisiana State University, Baton Rouge, LA, U.S.A.

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## Grants

Co-authored Proposal

Transportation Consortium of South-Central States, *Real-Time Work Zone Traffic Management via Unmanned Air Vehicles*, \$79,991, 18 months, Co-PIs: Charles Malveaux, Marcio de Queiroz, Xin Li, and Hany Hassan.

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## Skills

**Hardware:** Arduino, Raspberry Pi, STM32 Flight Controller (Pixhawk/Seriously Pro Racing), NodeMCU, XBee, Remote Control, etc.

**Software:** XCTU, QT Creator, TeXstudio, Inkscape, AutoCAD, FreeCAD, Arduino IDE, Dremel DigiLab3D Slicer, etc.

**Programming Languages:** Python, MATLAB/Simulink, C, C++ (*associated with GUI design with QT*) .

**Natural Languages:** Chinese (*mother tongue*) and English.

**Others:** HPC (*Philip@LSU, SuperMike-II@LSU, QB2@LONI*), LaTeX.

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## Professional Activities

### Membership

Institute of Electrical and Electronics Engineers (IEEE)

Institute of Electrical and Electronics Engineers - Control Systems Society (IEEE-CSS)

### Reviewer

#### Journal

- Actuators
- Applied Sciences
- Automatica
- IEEE Robotics and Automation Letters
- IEEE Transactions on Cybernetics
- Mathematics
- Sensors

#### Conference

- IEEE Conference on Control Technology and Applications
- IEEE Conference on Decision and Control
- IEEE International Conference on Robotics and Automation

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## Graduate Level Courses

- Advanced Mechanical Systems Control
- Introduction to Modern Control Theory
- Advanced Linear Systems
- Advanced Topics in Control
- Industrial Robotics
- Topics in Modern System Science
- Advanced Engineering System Dynamics
- Sensors and Actuators
- Numerical Methods in Applied Mechanics
- Advanced Vibrations
- Mathematics Methods in Engineering
- Intelligent Control and Applications in Power Systems
- Stress Analysis in Mechanical Engineering

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## Teaching Interests

### Undergraduate Level Courses

#### Engineering Basics

- Numerical Methods
- Mathematics Methods in Engineering

#### Mechanical Engineering Basics

- Mechanics (Statics and Dynamics)
- Mechanical Vibrations
- Engineering System Dynamics
- Instrumentation and Measurement

#### Control and System

- Classical Control Theory
- Modern Control Theory

- Intelligent Control and Applications

#### Robotics

- Introduction to Robotics
- Sensors and Actuators
- Industrial Robotics
- Autonomous Vehicles

#### Graduate Level Courses

##### Mechanical Engineering

- Advanced Vibrations
- Advanced Dynamics

##### Control and System

- Advanced Linear Systems
- Nonlinear Control Theory

##### Robotics

- Multi-copter Design and Control Practice

##### Advanced Topics

- Introduction to Multi-Agent System Autonomy and Control
- Advanced Topics in Multi-Agent Systems: Consensus, Formation, Coverage, Distributed Algorithms, etc