

# Tairan Liu

Last update on May 22, 2021

Tairan.Liu@uga.edu • <https://liutairan.github.io/>  
Athens, GA, U.S.A.

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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
  - Multi-Agent Reinforcement Learning
  - Human-Robot/Swarm Interaction
  - Lyapunov-Based Nonlinear Control
  - Robotics (Aerial/Ground/Underwater)
  - Multi-Robot Smart Manufacturing
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## Professional Experience

University of Georgia // Postdoc // Research

ATHENS, GA, U.S.A.

**Coverage Control with Heterogeneous Robots**

*Sep. 2020 – Present*

Ongoing research: new concepts and algorithms of coverage control. Details to be unveiled later.

**Aerial Robotics in Agricultural Measurements and Operations**

*Sep. 2020 – Present*

Ongoing research: testbed design and implementation. Details to be unveiled later.

Louisiana State University // PhD // Research

BATON ROUGE, LA, U.S.A.

**Multi-Agent System Formation Control**

*Jul. 2016 – May 2020*

Proposed new formation control methods, 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 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

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. In *2021 IEEE Conference on Control Technology and Applications (CCTA)*. 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

## 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, Blender, 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

Automatica

IEEE Transactions on Cybernetics

IEEE Robotics and Automation Letters

IEEE Conference on Decision and Control

IEEE International Conference on Robotics and Automation

IEEE Conference on Control Technology and Applications

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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