陈豪(Hao Chen)

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个人网页 • 领英

简介

- 擅长无人机/机器人的导航、定位、感知、控制和传感器融合。
- 7年无人机/机器人/嵌入式系统的C++/MATLAB/Python/ROS编程经验。
- 7年无人机/机器人/嵌入式系统的实际项目经验。
- 能够用机器学习方法快速解决实际工程问题。

教育经历

机械与航空航天工程，直博（全额奖学金），绩点: 4.00/4.00（满绩）　　　　2019年9月 – 2023年12月(预计)
俄克拉荷马州立大学 (OSU)　　　　　　　　　　　　　　　　　　　　　美国，俄克拉荷马，斯蒂尔沃特
自动化，本科，绩点: 3.62/4.00　　　　　　　　　　　　　　　　　　　　2015年9月 – 2019年6月
西南科技大学 (SWUST)　　　　　　　　　　　　　　　　　　　　　　　　　中国，四川，绵阳

技能

算法：
- 导航/定位/感知算法：贝叶斯估计与平滑，分布式估计，KF，EKF，MEKF，IEKF，UKF，SLAM
- 控制算法：非线性控制器，自适应控制器，最优化控制器，PID，LQR，MPC
- 机器学习算法：linear/logistic regression, DNN, CNN, RNN, LSTM

理论体系：
- 系统理论：系统动力学，线性系统，非线性系统，离散系统，随机系统，多智能体系统，系统识别
- 控制理论：经典控制，现代控制，非线性控制，自适应控制，最优化控制
- 其他理论：贝叶斯分析，数理统计，机器学习，机器人学

编程语言：　　　　MATLAB, Python，C++，C，R
仿真软件及工具: Simulink，ROS，Gazebo，Git
嵌入式系统：　　　Arduino，STM32，Raspberry Pi

研究与项目经历

➤ **美国自然科学基金-国家机器人计划：低空空域协同自主飞行器的基于风力感知的安全导航**

研究助理　　　　　　　　　　　　　　　　　　　　　　　　　　　　2019年9月– 2023年12月(预计)
控制，机器人及自动化实验室，OSU　　　　　　　　　　　　　　　美国，俄克拉荷马，斯蒂尔沃特

- **系统建模：** 建立四旋翼的非线性模型以及不同的阻力，推力及风场模型。

- **四旋翼的状态及风场估计算法设计:** 利用系统对称性设计了不变扩展卡尔曼滤波器（IEKF）。和传统扩展卡尔曼滤波器（EKF）相比，该滤波器显示出了更小的瞬态误差及更快的收敛速度；针对IMU误差，不同的阻力，推力及风场模型，分别设计了对应的IEKF。

- **多四旋翼集群的状态及风场估计算法设计:** 将设计的EKF/IEKF从四旋翼扩展到四旋翼集群系统中；设计了序列协方差交叉及序列权重指数积的两种多智能体信息融合算法。通过风场信息融合，风场预测能实现更小的误差和更快的收敛速度。

- **基于机器学习的状态及风场估计算法设计:** 训练了基于深度神经网络的精确推力模型；训练了基于长短期记忆网络的风场预测模型；将径向基函数和神经网络风场模型集成到EKF/IEKF设计。

- **MATLAB/Simulink仿真验证:** 开发了MATLAB/Simulink四旋翼模型，其集成了四旋翼非线性动力学模块，桨叶及电机模块，传感器模块，滤波器模块，控制器模块，路径规划模块以及风场模块；将单个四旋翼模型扩展到四旋翼集群模型。仿真结果验证了所设计算法的有效性。

- **室内及室外实验验证：** 搭建了用于获取推力模型的推力台；使用运动捕捉系统OptiTrack进行室内四旋翼位姿反馈，使用集成了风速传感器的移动机器人获取真实风场数据，并使用小型四旋翼Crazyflie2.1进行室内飞行测试；针对室外实验，使用自制大型四旋翼SK8进行户外飞行实验，真实的风场数据则由集成到无人机上的风速传感器以及风速塔获得。实验结果进一步验证了所设计算法的有效性。

- ➢ **"挑战杯" 大学生课外学术科技作品竞赛：结构化环境多机器人协作教育与试验综合系统**
团队成员   2016年9月 – 2018 年5月
特殊环境机器人技术四川省重点实验室，SWUST   中国，四川，绵阳
  - 改进结构化环境中基于A*算法的路径规划与避障策略。

- ➢ **实验室项目：XY轴绘图机器人上位机设计**
团队负责人   2017年7月 – 2017 年11月
特殊环境机器人技术四川省重点实验室，SWUST   中国，四川，绵阳
  - 运用MATLAB设计了XY轴绘图机器人GUI上位机软件，其可以实现图像灰度化，二值化处理，并在此基础上由八邻接方式获得图像边界，再将边界转换为图像即实现了图像轮廓提取。

- ➢ **机器人比赛：2017年四川省机器人大赛**
团队成员   2017年3月 – 2017 年7月
特殊环境机器人技术四川省重点实验室，SWUST   中国，四川，绵阳
  - 实现了基于SLAM的机器人导航及避障。
  - 实现了基于麦克纳姆轮的机器人底盘控制。

其他经历

学术会议： 40th ASME/AIAA online regional symposium, Oklahoma, 2021; American Control Conference, Atlanta, GA, 2022; Modeling, Estimation and Control Conference, Jersey City, NJ, 2022; UAS Weather Technology, Tulsa, OK, 2022; NASA ImaginAviation, online, 2023

助教 (MAE 3724 -系统动力学)   2020秋季，2021春季，2023春季
俄克拉荷马州立大学   美国，俄克拉荷马，斯蒂尔沃特

实习生   2018年6月 – 2018年7月
四川长虹电器有限公司实习   中国，四川，绵阳
  - 学习PLC编程以及长虹空调以及电视生产流水线自动化设备维护。

实习生   2018年1月
松山湖机器人基地   中国，广东，东莞
  - 学习创业产品市场调研，设计定义工具，构建设计解决方案。

服务： IEEE会员 | 审稿人

论文

- Chen Hao, Li Yong, Luo Jingdi. Research on path planning for mobile robots based on improved A* algorithm optimization [J]. Automation and Instrumentation, 2018 (12): 1-4 (Published)
- Chen, H., Bai, H. and Taylor, C.N., 2022, June. Invariant-EKF design for quadcopter wind estimation. In 2022 American Control Conference (ACC) (pp. 1236-1241). IEEE. (Published)
- Chen, H. and Bai, H., 2022. Incorporating thrust models for quadcopter wind estimation. IFAC-PapersOnLine, 55(37), pp.19-24. (Published)
- Chen, H. and Bai, H., 2023. Wind Field Estimation Using Multiple Quadcopters. Modeling, Estimation and Control Conference 2023. (Accepted)
- Chen, H. and Bai, H., 2024. Model-based invariant filters for quadcopter wind estimation. IEEE Transactions on Aerospace and Electronic Systems. (Submitted)
- Chen, H., Bai, H., Jacob, J. and Revard, B., 2024. Experimental validation of dynamics-based wind estimation for quadcopters. AIAA Science and Technology Forum and Exposition. (In preparation)
- Chen, H. and Bai, H., 2024. Temporal-spatial wind field estimation using multiple quadcopters. IEEE Transactions on Aerospace and Electronic Systems. (In preparation)

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Profile

- Expertise in navigation, localization, perception, control, and sensor fusion of UAV/Robotics.
- 7+ years of programming experience on UAV/Robotics by using C++/MATLAB/Python.
- 7+ years of hands-on experience on UAV/Robotics.
- Ability to use various machine learning methods to solve engineering problems.

Education

Ph.D. candidate in Mechanical and Aerospace Engineering. GPA: 4.00/4.00   Sep 2019 – Dec 2023 or Jun 2024 (Expected)
OKLAMOHA STATE UNIVERSITY (OSU)   *Stillwater, OK, USA*
B.E. in Automation. GPA: 3.62/4.00   Sep 2015 – Jun 2019
SOUTHWEST UNIVERSITY OF SCIENCE AND TECHNOGY (SWUST)   *Mianyang, Sichuan, China*

Technical Skills

Algorithms:
- Navigation/Localization /Perception algorithms**:** Bayesian estimation, Bayesian smoothing, distributed estimation, KF, EKF, Multiplicative EKF (MEKF), invariant EKF (IEKF), SLAM
- Control algorithms: PID, LQR, MPC, nonlinear controller, adaptive controller, optimal controller
- Machine Learning algorithms: linear/logistic regression, DNN, CNN, RNN, LSTM

Knowledge Framework:
- System theory: system dynamics, linear system, nonlinear system, digital system, stochastic system, multi-agent system, system identification
- Control theory: classical control, modern control, nonlinear control, adaptive control, optimal control
- Other theory: Bayesian analyze, mathematical statistics, machine learning, robotics

Programming: MATLAB, Python, C++, C, and R
Simulation&Tool: Simulink, ROS, Gazebo, Git
Embedded System: Arduino/STM32/Raspberry Pi
Language: English (fluent), Mandarin (native)

Research/Project Experience

➢ **NSF-NRI: Safe Wind-Aware Navigation for Collaborative Autonomous Aircraft in Low Altitude Airspace.**
Research Assistant   Sep 2019 – Dec 2023 (Expected)
Control, Robotics and Automation Lab (CoRAL), OSU   *Stillwater, OK, USA*

- **System modeling:** build mathematical models for nonlinear quadcopter dynamics which are integrated with various drag, thrust and wind models.

- **IEKFs design for single UAV states and wind estimation:** develop the nominal IEKF by taking advantage of system symmetry, and IEKFs show less transient error and faster convergence speed compared to EKFs; develop IEKFs with IMU biases and various drag, thrust and wind models.

- **Estimation and fusion algorithms design for multi-UAV system states and wind estimation:** extend EKFs/IEKFs from single UAV to multi-UAV system and develop a sequential covariance intersection (SCI) method and a sequential weighted exponential product (SWEP) method for the information fusion.

- **Machine learning implementations for states and wind estimation:** train a DNN for obtaining the accurate thrust; train a LSTM model for wind estimation; integrate the RBF and NN wind model with EKFs and IEKFs.

- **MATLAB/Simulink simulation validation**: develop a quadcopter MATLAB/Simulink model integrating quadcopter dynamics, motor/rotor models, sensor models, wind models, estimators, controllers, and path planners; extend the single quadcopter model to the quadcopter swarm model. The simulation results show the effectiveness

of designed IEKFs and data fusion methods.

- **Indoor/outdoor experiments validation:** build a thrust stand for obtaining thrust models, a ROS-based mobile robot with the anemometer for ground truth wind collection, and integrate a small-size quadcopter, a motion capture system, a mobile robot and a wind generator for indoor flight test; conduct multiples outdoor experiments by using a large-size quadcopter SK8 for flight test and the true wind is measured by the wind sensor on the SK8 and wind tower. The experimental results further verify the superiority of designed algorithms.

➢ **"Challenge Cup" National College Student Curricular Academic Science and Technology Works Competition: Multi-robot Collaboration System for Education and Experimental Purpose in Structured Environment.**
Research Assistant   Sep 2016 – May 2018
Special Environment Key Laboratory of Sichuan Province, SWUST   *Mianyang, Sichuan, China*
- develop path planning and collision avoidance strategy based on improved A star algorithm for multi-robot system in grid space.

➢ **Lab Project: The upper computer software design of XY axis drawing robot**
Research Assistant   Jul 2017 – Nov 2017
Special Environment Key Laboratory of Sichuan Province, SWUST   *Mianyang, Sichuan, China*
- Develop a MATLAB GUI which can achieve image processing, such as image graying, image binarization, image boundary extraction, and image filling.

➢ **Robot Competition: 2017 (2nd) University Robot Competition of Sichuan Province**
Team Member   Mar 2017 – Jul 2017
Special Environment Key Laboratory of Sichuan Province, SWUST   *Mianyang, Sichuan, China*
- Develop the navigation and obstacle avoidance strategy of the robot based on SLAM.
- Implement the robot chassis control based on Mecanum Wheel.

Other Experience

Teaching Assistant   2020 Fall, 2021 Spring, 2023 Spring
OKLAHOMA STATE UNIVERSITY   *Stillwater, OK, USA*
- Work as teaching assistant for the course MAE3724-SYSTEM DYNAMICS.

Internship   Jun 2018 - Jul 2018
Sichuan Changhong Electric Co., Ltd   *Mianyang, Sichuan, China*
- Learn PLC programming and equipment maintenance at air conditioning/TV manufacturing assembly line.

Internship   Jun 2018
XbotPark Startup Incubator   *Dongguan, Guangdong, China*
- Learn market research, designing definition tools and constructing design solutions.

Service: IEEE member | Reviewer

Publications

- Chen Hao, Li Yong, Luo Jingdi. Research on path planning for mobile robots based on improved A* algorithm optimization [J]. Automation and Instrumentation, 2018 (12): 1-4 (Published)
- Chen, H., Bai, H. and Taylor, C.N., 2022, June. Invariant-EKF design for quadcopter wind estimation. In 2022 American Control Conference (ACC) (pp. 1236-1241). IEEE. (Published)
- Chen, H. and Bai, H., 2022. Incorporating thrust models for quadcopter wind estimation. IFAC-PapersOnLine, 55(37), pp.19-24. (Published)
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