The 2020 Mini International Workshop on Deep Intelligent Unmanned Systems

(DIUS 2020)

深智无人系统小型国际研讨会

Organized by

Department of Control Science and Engineering

Tongji University

Shanghai, China. December 9, 2020

Workshop Chairs

- Professor Li Li, Tongji University
- Professor Lihua Dou, Beijing Institute of Technology
- Professor Ben M. Chen, Chinese University of Hong Kong

Workshop Technical Program

Session I: Chaired by Professor Li Li, Tongji University

- 08:45–09:15 Professor Qingkai Yang, Beijing Institute of Technology
  Stress-matrix-based flexible formation control of multi-agent systems
- 09:15–09:45 Professor Hao Fang, Beijing Institute of Technology
  集群机器人的自主协同规划与控制
- 09:45–10:15 Professor Zhi Gao, Wuhan University
  恶劣条件下的智能无人系统环境感知问题的研究
- 10:15–10:45 Professor Bin Xin, Beijing Institute of Technology
  面向复杂任务的异构多无人平台空面协同

Tea Break: 10:45–11:00

Session II: Chaired by Professor Lihua Dou, Beijing Institute of Technology

- 11:00–11:30 Professor Biao Wang, Nanjing University of Aeronautics & Astronautics
  基于矢量场与滚动时域控制的地形跟随系统设计
- 11:30–12:00 Dr. Feng Lin, MicroHiggs Technologies & Peng Cheng Laboratory
  海上探鱼无人机
- 12:00–12:30 Dr. Jinqiang Cui, Peng Cheng Laboratory
  无 GPS 环境下的自主导航技术
- 12:30–13:00 Dr. Shupeng Lai, National University of Singapore
  Robot motion planning with nonlinear model predictive control

About this mini international workshop…

The theme of this mini international workshop is on deep intelligent unmanned systems. We are honored to have eight experts in the field to join this workshop to present their research findings, and to discuss challenges in developing intelligent autonomous systems. Through this workshop, we aim to gain a deeper insight into some fundamental and emerging problems in autonomous systems and their applications.

This workshop is conducted in a dual mode. The program is available online through the Tencent Meeting platform at https://meeting.tencent.com/s/CRps5hipoTnQ (ID: 240 676 835).

Workshop Chairs

Li Li is currently the Department Chair and Professor of Control Science and Engineering at Tongji University, China. She has over 80 publications including 5 books, 30+ journal papers, and 2 book-chapters. Her current research interests are in smart production, computational intelligence and autonomous intelligent systems

窦丽华，北京理工大学自动化学院教授、博士生导师。1987年和2002年获北京理工大学大学硕士和博士学位。主持国家自然科学基金资助面上和重点项目2项，省部级项目10余项。获得2011和2009年国家科技进步二等奖2项，教育部自然科学奖一等奖1项，国防科技进步二等奖6项。担任中国指挥控制学会智能指挥与控制系统工程专委会副主任委员、『火力指挥与控制』期刊编委。

Ben M. Chen is a Professor of Mechanical and Automation Engineering at the Chinese University of Hong Kong and a Professor of Electrical and Computer Engineering at the National University of Singapore (NUS). He was a Provost's Chair Professor in the Department of Electrical and Computer Engineering at NUS and was an Assistant Professor at the State University of New York at Stony Brook, New York, USA, in 1992–1993. His current research interests are in unmanned aerial systems, linear systems theory, robust control and control applications. Professor Chen is an IEEE Fellow.

Abstracts of the Technical Talks

1. Professor Qingkai Yang, Beijing Institute of Technology

报告题目： Stress-matrix-based flexible formation control of multi-agent systems

摘要： Formation systems can be found in many fields, such as environment monitoring, data harvest, and cooperative transportation, etc. In practical applications, it is required that the formation system should be intelligent enough to alter the individuals' collective behavior to adapt to the change of their ambient space, rather than just maintain the prescribed formation shape. This talk will introduce the cooperative flexible formation control problem of multi-agent systems using the so called "stress matrix". In this talk, I will also discuss the constrained formation control in the sense that only very few agents know the formation parameters.

About the speaker…

Qingkai Yang received the Ph.D. degree in control science and engineering from Beijing Institute of Technology, Beijing, China, in March 2018. He obtained his second Ph.D. degree in systems and control from the University of Groningen, the Netherlands, in May 2018. He is currently an assistant professor with the School of Automation, Beijing Institute of Technology. His current research interests include cooperative control of multi-agent systems, autonomous unmanned systems.

2. Professor Hao Fang, Beijing Institute of Technology

报告题目： 集群机器人的自主协同规划与控制

摘要： 集群机器人的自主协同规划与控制一项重要的颠覆性技术。针对信息化、智能化社会对于集群机器人自主协同规划与控制的新需求，本报告从时序任务建模及规划，多任务受限自主协同规划，协同编队及队形变换，协调运动及能量优化等方面分别介绍了集群机器人自主协同规划与控制技术的最新研究进展，分析了自主协同的技术内涵，凝练出制约其技术突破的若干核心关键问题，并给出具有创新性的解决之道。最后对集群机器人自主协同规划与控制的发展趋势做出预测，以期对相关研究起到借鉴和引导作用。

About the speaker…

方浩，北京理工大学自动化学院教授、博士生导师，教育部新世纪优秀人才。2002 年获西安交通大学博士学位。2002 年 4 月至 2003 年 7 月，于法国国立信息与自动化研究院（INRIA-Sophia Antipolis）作博士后。2003 年 11 月至 2004 年 12 月，在法国国家科研中心 CNRS (UNR6602CNRS/Blaise Pascal 大学)，LASMEA 实验室作博士后。主持国家自然科学基金资助项目 2 项。曾获得 2013 年教育部自然科学奖一等奖，2014 年国家级自然科学奖二等奖。担任中国自动化学会控制理论专业委员会委员，多自主体控制学组秘书长。担任『控制理论与应用』副主编，『系统科学与数学』编委。

3. Professor Zhi Gao, Wuhan University

报告题目：恶劣条件下的智能无人系统环境感知问题的研究

摘要：恶劣条件下的环境感知是智能无人系统的核心研究问题之一，在其理论研究及应用探索方面都有着极重要的价值。报告人将针对弱光照、烟雾条件、恶劣天气等条件下的视觉问题研究成果进行汇报，并将重点介绍目标检测领域的研究成果，从小目标检测、到弱监督条件下的目标检测，再到小样本条件下的新类别检测。

About the speaker…

高智，武汉大学遥感信息工程学院教授、博士生导师，国家青年人才计划项目获得者，湖北省『楚天学者』特聘教授。分别于 2002 年和 2007 年在武汉大学获得工学学士和工学博士学位，2008 年至 2019 年就职于新加坡国立大学，2019 年作为海外高层次人才引进回武汉大学执教。高智教授长期从事摄影测量、计算机视觉领域与智能无人系统密切相关的问题研究，创新性地提出了基于准视差获取三维信息的理论和方法，解决了复杂场景中三维信息的快速获取及相机定姿、定位的难题；原创性地提出了块状稀疏鲁棒主成分分析、自适应稀疏表达、同步超分与检测的深度卷积网络等算法。担任中国自动化学会混合智能专委会委员，国际期刊『Unmanned Systems』的编委，多次担任国际会议的编辑、程序委员会成员和分论坛主席，担任 IEEE PAMI、 TGRS、ISPRS JPRS 等 30 余种 SCI 期刊及 10 余次著名会议的审稿人；主持多项中国、新加坡政府科研项目；已发表学术论文 80 余篇，发表于 IEEE PAMI、IJCV、IEEE TIE、IEEE TGRS、ISPRS JPRS、IEEE TITS、CVPR、ECCV、ACCV、BMVC、IROS 等顶级期刊及会议。

4. Professor Bin Xin, Beijing Institute of Technology

报告题目：面向复杂任务的异构多无人平台空面协同

摘要： 空面协同包括空中移动平台与地面或水面移动平台的协同，这一主题已成为当前国际研究的前沿和热点，具有广阔的应用前景。报告首先从异构多智能体的空面协同角度（空地协同/空海协同）论述了空中移动平台与地面/水面移动平台的多样化协同模式，对空面协同进行了系统的分类。然后，以其中一类典型的协同系统和复杂协同作业任务为例，介绍了无人机和无人车的空地协同涉及的一类协同任务规划问题和相应的求解方法。

About the speaker…

辛斌，北京理工大学自动化学院教授，主要研究方向为智能优化的理论和方法、多智能体系统协同优化与控制，在相关研究方向上发表学术论文 100 余篇，出版学术专著 4 部。2018 年获国家自然科学基金优秀青年科学基金，主持国家自然科学基金 3 项、省部级重点项目 5 项。获教育部自然科学奖一等奖 1 项，国防科技进步二等奖 4 项，第 18 届关肇直奖。担任国际期刊 Unmanned Systems, Journal of Systems Sciences and Complexity, Journal of Advanced Computational Intelligence and Intelligent Informatics, Advanced Control for Applications: Engineering and Industrial Systems 编委。北京自动化学会理事、中国仿真学会智能仿真优化与调度专委会委员、控制理论专业委员会非线性系统与控制学组委员、中国指挥与控制学会智能指挥与控制系统工程专委会委员。

5. Professor Biao Wang, Nanjing University of Aeronautics & Astronautics

报告题目：基于矢量场与滚动时域控制的地形跟随系统设计

摘要： 设计了一种基于航迹规划与航迹跟踪的固定翼无人飞行器地形跟随方案。首先，利用三次样条基于地形轮廓规划出一条最优跟随航迹；然后使用矢量场方法作为制导策略，构造面向三次样条连续曲线的矢量场，引导飞行器收敛到目标航迹，根据可行矢量场条件确定合理的矢量场参数；接着设计一个滚动时域控制器用于跟踪矢量场给出的指令，并考虑内部状态与执行器约束，从而达到跟踪最优航迹的目的。仿真结果表明，矢量场制导策略结合滚动时域控制的地形跟随方案拥有精确且可靠的航迹跟踪能力，在存在持续风扰的情况下也可以安全完成地形跟随任务。

About the speaker…

王彪，毕业于南京航空航天大学，分别于 1997、2000、2004 年获得航空动力装置控制工程学士学位，航空发动机硕士学位，导航、制导与控制博士学位。王彪博士当前为南京航空航天大学自动化学院副教授，主要研究兴趣包括无人飞行系统，视觉导引与飞行控制，自抗扰控制和模型预测控制，以及面向地形跟随和自主着陆相关的目标检测识别与跟踪等。王彪博士获得工信部（以及国防科工委）颁发的多项国防科学技术进步奖，参与编写专著『无人旋翼飞行器系统』，发表相关学术论文几十篇，担任国际期刊『Unmanned Systems』编委等工作。

6. Dr Feng Lin, MicroHiggs Technologies and Peng Cheng Laboratory

报告题目：海上探鱼无人机

摘要：海洋是生命的起源、更是人类重要的食物来源地，全球每年通过捕捞获得的渔业产品约为 1 亿吨。其中，中国就占据近半，我国渔业发展迅速，规模庞大，产量连续二十多年世界第一。随着科技的发展，探鱼设备已成为捕鱼作业中不可或缺的助手，渔民对探鱼设备的依赖性越来越强。在现代捕鱼行业中，即使是上百万一套的进口探鱼器也只能探测到船只周围 2 公里左右的鱼群，但是使用探鱼无人机就可以轻松的将探鱼距离扩大到 5 公里，实现从船只周边到全方位海域的跨越，不仅增强了渔船的工作效率，更让现代渔业向智能化不断迈进。作为世界上第一款探鱼无人机，维盛檀越科技集团自主研发的鱼鹰系列无人机，同时拥有探鱼、救援、海钓三大功能，具备海陆空三种工作模式。可应对各种恶劣天气及海况，极大的提高了捕鱼效率。志存苍穹、慧聚蓝海，维盛檀越科技集团研发生产的智能探鱼无人机，将彻底颠覆现有探鱼方式，极大提高渔业收入，更为海上工作者提供了长效有力的安全保障。

About the speaker…

Dr Feng Lin received the B.Eng. degree in Computer Science and Control, and the M.Eng. degree in system engineering from the Beihang University, China, in 2000 and 2003, respectively. He received the Ph.D. degree in Computer & Electrical Engineering from National University of Singapore (NUS) in 2011. He was the recipient of the Best Application Paper Award, 8th World Congress on Intelligent Control and Automation, Jinan, China (2010).

Dr. Lin has worked as a Senior Research Scientist at Temasek Laboratories at NUS, and a Research Assistant Professor in NUS Department of Electrical & Computer Engineering from 2011 to 2019. Dr. Lin is currently the Chief Technology Officer of MicroHiggs Technologies and an Associate Research Scientist at Peng Cheng Laboratory. His main research interests are unmanned aerial vehicles, vision-aided control and navigation, robot vision as well as embedded vision systems. He has served on the editorial board for Unmanned Systems.

7. Dr Jinqiang, Peng Cheng Laboratory

报告题目：无 GPS 环境下的自主导航技术

摘要： 简要回顾无 GPS 导航技术的发展，汇总小型移动机器人自主导航的技术手段，针对树林环境下的无人机自主导航提出一种技术方案，最后支出无 GPS 导航技术的发展趋势和应用前景。

About the speaker…

崔金强现就职于鹏城实验室智能协同院士工作室，博士毕业于新加坡国立大学，本科、硕士均就读于西北工业大学。崔博士的研究方向为无人机自主控制及无 GPS 环境自主导航技术，且在无人平台智能协同领域具备丰富的实践经验，数次在国内外无人机比赛中获得优异成绩，包括国际微小型无人机比赛冠军、美国 DARPA 无人机比赛决赛、中国空军『无人争锋』挑战赛第二名等。

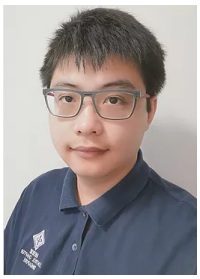
8. Dr Shupeng Lai, National University of Singapore and Peng Cheng Laboratory

报告题目： Robot motion planning with nonlinear model predictive control

摘要： From collision avoidance to object manipulation, many robotic applications require instant reactions to the rapidly changing environment. However, these problems are often nonlinear and non-convex, making them difficult to solve in real time. Nonlinear model predictive control has been widely accepted for a balance between solution quality and computational efficiency. The idea is to solve the problem up to a time horizon, execute only the first several planned actions, then conduct the planning again from the new reached state. The planning and execution are interleaved to both save computing power and increasing responsiveness.

In this talk, the presenter will discuss some basic elements of applying nonlinear model predictive control in mobile robot applications, including motion parameterization, non-convex problem solving, and the effect of reachable set in model predictive control.

About the speaker…



Shupeng Lai is currently an adjunct assistant professor from the National University of Singapore. He receives his Bachelor of Engineering in electrical and electronics engineering from Nanyang Technological University in 2012 and his Ph.D. in electrical and computer engineering from the National University of Singapore in 2016.

His research interests include motion planning, nonlinear model predictive control, multi-agent systems, and aerial systems.