第 36 届中国过程控制会议

The 36th Chinese Process Control Conference

2025 年 7 月 25-27 日中国·宜宾

July 25 - 27, 2025, Yibin, China

程 序 册

Final Program

主办单位： 中国自动化学会过程控制专业委员会
中国自动化学会

承办单位： 四川轻化工大学

协办单位： 《控制工程》编辑部
四川文理学院
西南石油大学
四川轻化工大学大学科技园
智能感知与控制四川省重点实验室

第 36 届中国过程控制会议程序总览

<table>
<tr><td colspan="9">2025 年 7 月 25 日（周五）</td></tr>
<tr><td>08:30—20:30</td><td colspan="8">注册（地点：华邑酒店大堂）</td></tr>
<tr><td>18:00—20:00</td><td colspan="8">晚餐（地点：华邑酒店三楼多功能厅 1、2，华邑会议室 2、3、4）</td></tr>
<tr><td>20:00—22:00</td><td colspan="8">中国自动化学会过程控制专业委员会会议（地点：会议中心三楼九河叙府厅）</td></tr>
<tr><td colspan="9">2025 年 7 月 26 日（周六）</td></tr>
<tr><td>08:30—09:00</td><td colspan="8">开幕式 （地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td>09:00—09:50</td><td colspan="8">大会报告 1: Advancing Process Control with Reinforcement Learning: From Algorithms to Industrial Impact
报告人: Prof. Jong Min Lee （主持人：高福荣）（地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td>09:50—10:40</td><td colspan="8">大会报告 2：有色冶金多相多场工艺控制与优化工业软件
报告人：阳春华 教授（主持人：丁进良）（地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td>10:40—10:50</td><td colspan="8">茶歇（地点：华邑酒店三楼宴会厅廊道）</td></tr>
<tr><td>10:50—11:40</td><td colspan="8">大会报告 3：电液控制系统的传递矩阵分析方法
报告人：焦宗夏 教授（主持人：李少远）（地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td>11:40—13:30</td><td colspan="8">午餐（地点：华邑酒店三楼多功能厅 1、2，华邑会议室 2、3、4）</td></tr>
<tr><td>13:30—14:20</td><td colspan="8">大会报告 4: Probabilistic Reduced-Dimensional Modeling of Multi-dimensional Time Series from Dynamic Systems
报告人：秦泗钊 教授（主持人：赵珺）（地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td>14:20—15:10</td><td colspan="8">大会报告 5：太阳能光热发电及其控制问题
报告人：金建祥 教授（主持人：程鹏）（地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td>15:10—15:20</td><td colspan="8">茶歇（地点：华邑酒店三楼宴会厅廊道）</td></tr>
<tr><td>会议室</td><td>会议中心 2 楼
长乐厅</td><td>会议中心 2 楼
未央厅</td><td>会议中心 2 楼
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登云厅</td><td>会议中心 2 楼
百瑞厅</td><td>会议中心 3 楼
九河厅</td><td>会议中心 3 楼
叙府厅</td><td></td></tr>
<tr><td>15:20—18:00</td><td>SatA1
复杂工业过程控制与优化 1</td><td>SatA2
复杂工业过程控制与优化 2</td><td>SatA3
先进控制理论与方法</td><td>SatA4
决策与控制一体化系统</td><td>SatA5
信息感知与检测技术</td><td>专题论坛：
大模型及其工业应用 I</td><td>专题论坛：
具身智能</td><td></td></tr>
<tr><td>18:30—20:30</td><td colspan="8">晚宴（地点：华邑酒店三楼宴会厅）</td></tr>
<tr><td colspan="9">2025 年 7 月 27 日（周日）</td></tr>
<tr><td>会议室</td><td>会议中心 3 楼
金江厅</td><td>会议中心 2 楼
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登云厅</td><td>会议中心 3 楼
连廊</td><td>会议中心 3 楼
九河厅</td><td>会议中心 3 楼
叙府厅</td></tr>
<tr><td>08:30—09:10</td><td rowspan="3">SunA1
张钟俊奖评奖</td><td rowspan="3">SunA2
学生优秀论文奖评奖</td><td>主旨报告 1
薛文超</td><td>主旨报告 2
何潇</td><td>主旨报告 3
刑兰涛</td><td rowspan="2">Poster 1
张贴论文
1 组</td><td rowspan="5">专题论坛：
大模型及其工业应用 II</td><td rowspan="5">专题论坛：
传统固态酿造的智能化转型：关键技术及应用实践</td></tr>
<tr><td>09:10—10:10</td><td>SunA3
故障检测、诊断与决策 1</td><td>SunA4
数据驱动建模 1</td><td>SunA5
机器学习算法及应用 1</td></tr>
<tr><td>10:10—10:30</td><td colspan="5">茶歇（地点：会议中心二楼、三楼廊道）</td></tr>
<tr><td>10:30—10:50</td><td rowspan="3">SunB1
参数估计与系统辨识</td><td rowspan="3">SunB2
多智能体协同控制 1</td><td>主旨报告 4
芦安洋</td><td>主旨报告 5
李怡蓓</td><td>主旨报告 6
贾孟硕</td><td rowspan="3">Poster 2
张贴论文
2 组</td></tr>
<tr><td>10:50—11:10</td><td rowspan="2">SunB3
故障检测、诊断与决策 2</td><td rowspan="2">SunB4
数据驱动建模 2</td><td rowspan="2">SunB5
机器学习算法及应用 2</td></tr>
<tr><td>11:10—12:10</td></tr>
<tr><td>12:10—13:30</td><td colspan="8">午餐（地点：华邑酒店三楼多功能厅 1、2，华邑会议室 2、3、4）</td></tr>
<tr><td>会议室</td><td>会议中心 3 楼
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登云厅</td><td>会议中心 2 楼
百瑞厅</td><td>会议中心 3 楼
岷江厅</td><td></td></tr>
<tr><td>13:30—14:50</td><td>SunC1
工业过程管理与决策系统</td><td>SunC2
多智能体协同控制 2</td><td>SunC3
故障检测、诊断与决策 3</td><td>SunC4
数据驱动建模 3</td><td>SunC5
机器学习算法及应用 3</td><td>SunC6
优化控制</td><td>SunC7
容错控制与可靠控制</td><td></td></tr>
<tr><td>14:50—15:10</td><td colspan="8">茶歇（地点：会议中心二楼、三楼廊道）</td></tr>
<tr><td>15:10—16:30</td><td>SunD1
工业智能控制与智能制造</td><td>SunD2
机器视觉与无人系统</td><td>SunD3
故障检测、诊断与决策 4</td><td>SunD4
过程数据分析与建模</td><td>SunD5
机器学习算法及应用 4</td><td>SunD6
信息物理系统</td><td>SunD7
人工智能与智能机器人</td><td></td></tr>
<tr><td>16:30—17:00</td><td colspan="8">颁奖仪式+闭幕式（地点：会议中心三楼九河叙府厅）</td></tr>
<tr><td>18:30—20:00</td><td colspan="8">晚餐（地点：华邑酒店三楼多功能厅 1、2，华邑会议室 2、3、4）</td></tr>
</table>

欢迎辞 (Welcome Speech)

尊敬的各位专家、学者、同仁：

第36届中国过程控制会议将于2025年7月25日至2025年7月27日在“万里长江第一城”的四川宜宾举行。我们谨代表本次会议承办单位和会议程序委员会对所有投稿作者及参会人员表示最诚挚的感谢与最热烈的欢迎！

中国过程控制会议已经成功举办了35届，吸引了众多海内外专家学者欢聚一堂。在此，我们要向为推动过程控制领域学科发展进步奉献毕生精力和热情的各位老同志、老前辈们表示崇高的敬意！更要衷心感谢一直以来为促进中国过程控制会议发展壮大而做出贡献的每一个人！

本届会议由中国自动化学会过程控制专业委员会主办，四川轻化工大学承办，《控制工程》编辑部、四川文理学院、西南石油大学、四川轻化工大学大学科技园、智能感知与控制四川省重点实验室协办。会议的宗旨是为海内外过程控制领域的专家、学者、研究生及工程设计人员提供一个学术交流、研讨和报告他们最新研究成果的机会，以推动过程领域内控制科学和控制工程的发展。

本届会议搭建了一个高规格的过程控制学术交流平台，征文主题涵盖多方领域，紧扣热点方向，关注包括工业过程管理与决策系统、决策与控制一体化系统、工业过程与自动化系统、批次过程的建模与控制、安全监控系统、建模与仿真系统、工业互联网系统、人工智能驱动的自动化、海上风电系统的过程控制、热工过程智能控制、智能酿造装备及品质控制、工业软件技术等在内的相关重要技术领域。

会议共收到论文投稿374篇，经程序委员会严格认真的评审，有367篇论文被会议录用并收入会议论文集。本届会议继续设立张钟俊奖、学生优秀论文奖和张贴优秀论文奖。共有64篇论文的作者向会议提出了奖项的申请，这表明社会各界对过程控制领域的关注在不断增加，也反映出各位专家学者对我们会议的认可和支持。会议设立了评奖委员会对各类奖项论文认真评审，最终获奖论文将在会议闭幕式上举行隆重的颁奖仪式。

为了完成论文的评议和组织本届大会，过程控制指导委员会和组委会多方筹措，积极协调，不辞辛劳，尽心尽力，付出了大量的心血和努力。在此我们向过程控制指导委员会和组委会致以衷心的谢意！

本届会议非常荣幸地邀请到焦宗夏教授、Jong Min Lee教授、秦泗钊教授、阳春华教授、金建祥研究员做中国过程控制大会特邀报告。同时，还邀请何潇（清华大学）、薛文超（中科院数学与系统科学研究院）、邢兰涛（山东大学）、芦安洋（东北大学）、李怡蓓（中国科学院数学与系统科学研究院）和贾孟硕（上海交通大学）做大会主旨报告，分享他们的最新研究成果。会议设立了专题研讨，集中探讨具身智能、工业大模型等对人才培养和工程领域的新挑战和新举措。

会议将一如既往的以口头宣讲和张贴宣讲的形式，让每一位论文作者充分展现出自己在科研学术和工程应用等方面的新思路、新方法、新技术、新概念、新成果。我们希望，借助于本

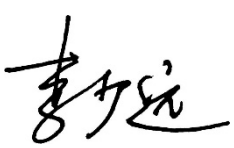
届会议提供的交流平台，各位参会者能够彼此之间开展真诚而务实的多视角畅谈和探讨，碰撞出思想的火花，切磋学艺、共同发展、促进合作、增进友谊！

连续35届不间断盛会，见证了中国过程控制发展的风雨与辉煌足迹。我们相信，这将是一次承前启后、团结奋进的会议。谨向为本届会议顺利召开做出贡献的人士致以我们最真诚的感激和谢意！感谢中国自动化学会和过程控制专业委员会对会议的指导；感谢程序委员会委员和审稿人对会议投稿论文的评审；感谢组委会成员为会议提供的周到服务；感谢大会报告人和主旨报告人的精彩报告；感谢各位投稿作者、各位与会嘉宾、专家学者对会议的支持；感谢各位志愿者的辛勤和努力！

四川宜宾市有“万里长江第一城、中国酒都、中国竹都”之称，底蕴深厚，积聚了多姿多彩的长江文化、酒文化、僰苗文化、哪吒文化、抗战文化、民俗风情文化。在宜宾举办的本次中国过程控制会议大会，连接学界与工业界，交流不同领域的创新成果，为科技强国、科技创新贡献来自过程控制的一份力量。让我们在这里共同汇集智慧，分享成果，携手开创行业美好明天。

会议总主席

李少远



程序委员会主席

丁进良

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重要信息 (Important Information)

- 会议时间：2025 年 7 月 25 日 -7 月 27 日
- 会议地点：四川省宜宾市宜宾国际会议中心（四川省宜宾市黄桷坪路 1 号）
- 宾馆地址：四川宜宾华邑酒店
- 会议语言：中文和英文

会议现场注册：

注册时间：2025 年 7 月 25 日 08:30-20:30
注册地点：四川宜宾华邑酒店大堂

组委会联系方式：

联系人：王小刚，刘勇
电话：**15700674356** / **13890028629**
电子信箱：cpcc2025@163.com
会议网站：http://2025.cn-tcpc.org/

组织机构(Organizing Committee)

主办单位：	中国自动化学会	
	中国自动化学会过程控制专业委员会	
承办单位：	四川轻化工大学	
协办单位：	《控制工程》编辑部	四川文理学院
指导委员会名誉主席：	孙优贤(浙江大学)	吴　澄(清华大学)
	吴宏鑫(北京控制工程研究所)	
指导委员会主席：	柴天佑(东北大学)	桂卫华(中南大学)
	钱　锋(华东理工大学)	唐立新(东北大学)
	于海斌(中科院沈阳自动化研究所)	
指导委员会委员：	黄德先(清华大学)	孙彦广(冶金自动化所)
	张宏建(浙江大学)	朱群雄(北京化工大学)
	王　伟(大连理工大学)	
会议总主席：	李少远(上海交通大学)	
程序委员会主席：	丁进良(东北大学)	
程序委员会副主席：	何　潇(清华大学)	熊兴中(四川轻化工大学)
程序委员会区域主席：	秦泗钊(香港岭南大学)	
	黄　彪(阿尔伯塔大学)	
	姚　远(台湾清华大学)	
	王殿辉(拉筹伯大学)	
程序委员会委员：	过程控制专委会委员及部分特邀专家	
大会报告主席：	高福荣(香港科技大学)	苏宏业(浙江大学)
大会出版主席：	程　鹏(浙江大学)	赵　珺(大连理工大学)
专题研讨会主席：	褚　健(宁波智能研究院)	顾佳晨(中国钢研总院)
	王　卓(中科院沈阳自动化研究所)	徐　圆(北京化工大学)
张贴论文主席：	阳春华(中南大学)	卢静宜(华东理工大学)
组织委员会主席：	曹立佳(四川轻化工大学)	
组织委员会委员：	周顺勇(四川轻化工大学)	王小刚(四川轻化工大学)
	刘　勇(四川轻化工大学)	赵　俊(四川轻化工大学)
	杨成福(四川文理学院)	陈光平(四川文理学院)
CPCC2025 会议官网及大会论文评审系统：	庞　戈(浙江大学)	

交通线路(Transportation)

到达宜宾国际会议中心：

1. 【从宜宾西站】：距离约 9.8 公里，乘坐 46 路公交车，在流杯池公园换乘 12 路公交车，在工职校下车步行 500 米到达；或乘坐出租车约 26 元。

2. 【从宜宾站】：距离约 8.1 公里，乘坐 K06 路公交车，在田坝街换乘 27 路公交车，在工职校下车步行 500 米到达；或乘坐出租车约 23 元。

3. 【从宜宾东站】：距离约 13 公里，乘坐 12 路公交车，在白沙湾下车步行 500 米到达；或乘坐出租车约 30 元。

4. 【从宜宾五粮液机场】：距离约 21 公里，机场乘坐大巴至恒旭大酒店，步行 400 米在河湾苑小区换乘 12 路公交车，在白沙湾下车步行 500 米到达；或乘坐出租车约 50 元。

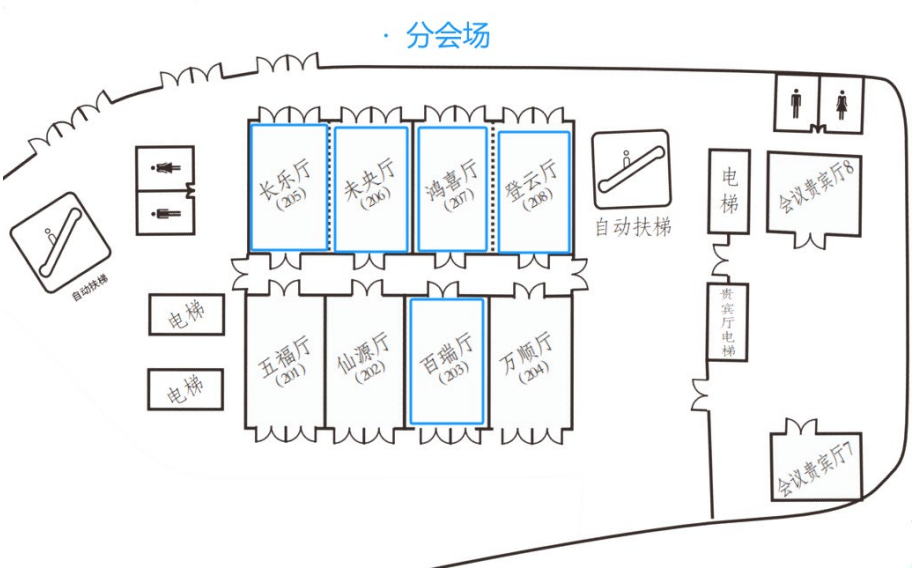
宜宾国际会议中心位置：


流杯池公园
岷江
白塔山公园
北大街
翠屏区
合江门
翠屏山索道
金沙广场
长江南路西段
金沙江
印象汇
蜀南大道
凤凰小区
宜宾国际
会议中心
黄桷坪路二段
红星路
长江
三江路

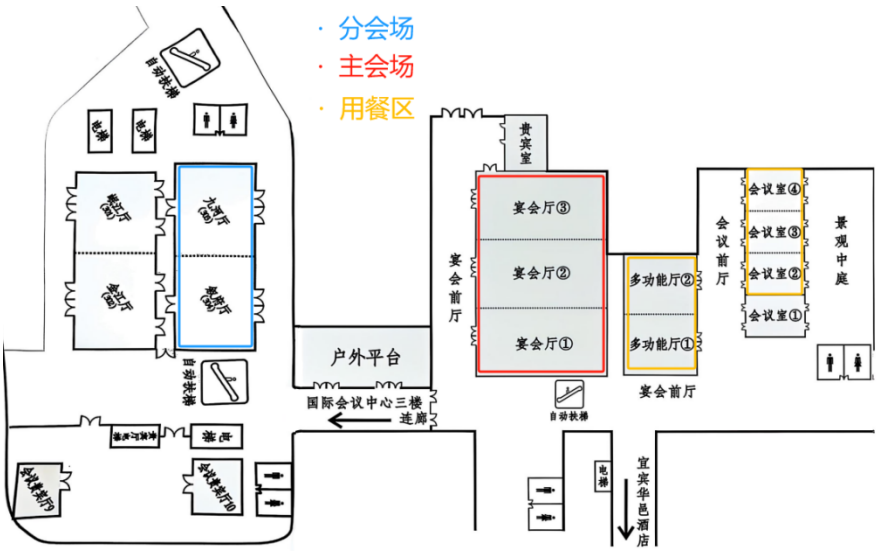
会场平面图(Venue Layout)

1.会议酒店分布

2.会议中心 2 楼



3.会议中心 3 楼



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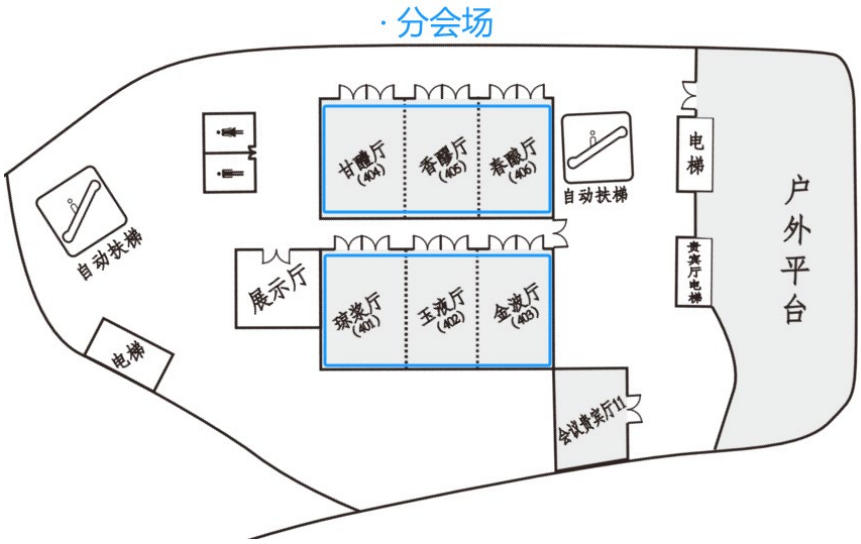


大会报告(Plenary Reports)

报告一

时　间：　7 月 26 日上午 09:00-09:50

地　点：　华邑酒店三楼宴会厅

报告人：　Prof. Jong Min Lee (Seoul National University)

题　目：　Advancing Process Control with Reinforcement Learning: From Algorithms to Industrial Impact

主持人：　高福荣 教授 (香港科技大学)

内容摘要：

Reinforcement learning (RL) has emerged as a transformative tool across diverse engineering fields, yet its adoption in chemical process control and optimization remains at an early stage. While numerous RL algorithms have been developed in computer science and operations research, systematic understanding of their applicability and effectiveness in process systems is still limited.

This plenary talk presents a comprehensive study of RL' s role in chemical process control. We first trace the evolution of RL applications in process systems, from early adaptive control strategies to recent advances in deep reinforcement learning (DRL). A comparative evaluation of modelfree and model-based RL approaches is presented using standard process control benchmarks, focusing on convergence behavior, computational demands, and robustness to disturbances. Furthermore, we discuss the integration of RL with conventional control frameworks such as model predictive control (MPC), and how hybrid strategies can enhance stability and performance.

The talk concludes by outlining future research directions, including offline RL for data-efficient training and domain-specific reward engineering, to bridge the gap between theoretical innovation and industrial deployment.

个人简介：

Jong Min Lee is a Professor in the School of Chemical and Biological Engineering at Seoul National University (SNU) (Seoul, Korea). From September 2016 to August 2017, he was a Visiting Associate Professor in the Department of Chemical Engineering at MIT. He also held the Samwha Motors Chaired Professorship from 2015 to 2017. He obtained his B.Sc. degree in Chemical Engineering from SNU in 1996 and completed his Ph.D. in Chemical Engineering at the Georgia Institute of Technology (Atlanta, United States) in 2004. He subsequently held a research associate position in Biomedical Engineering at the University of Virginia (Charlottesville, United States) from 2005 to 2006. From 2006, he served as an Assistant Professor of Chemical and Materials Engineering at the University of Alberta (Edmonton, Canada) before joining SNU in 2010. He is also a registered professional engineer with APEGA in Alberta, Canada.

His current research interests include modeling, control, and optimization of large-scale chemical process, energy, and manufacturing systems under uncertainty, as well as reinforcement learning-based control. He has been a member of the National Academy of Engineering of Korea (NAEK) since March 2022 (Chemical and Biological Engineering Division). Since June 2023, he has served as Chair of the IFAC Technical Committee TC 6.1 on Chemical Process Control. He has also been a Senior Editor of the International Journal of Control, Automation, and Systems (IJCAS) since February 2022 and has served on the Editorial Board of Computers & Chemical Engineering since June 2018.

报告二

时　间：　7 月 26 日上午 09:50-10:40

地　点：　华邑酒店三楼宴会厅

报告人：　阳春华 教授（中南大学）

题　目：　有色冶金多相多场工艺控制与优化工业软件

主持人：　丁进良 教授 (东北大学)

内容摘要：

有色金属是国家资源安全与战略新兴产业的基石。工业软件作为工业技术与领域知识的数字化载体，是实现有色冶金智能化转型的核心引擎。本报告首先分析有色冶金工艺控制与优化工业软件研发的挑战性难题，介绍多相多场高保真建模、生产过程精准调控、有色冶金智能模型库与工业软件平台构建等关键技术，以及实际工业应用案例，最后给出未来发展的一点思考。

个人简介：

阳春华，中南大学教授，校学术委员会副主任、“工业智能与系统”教育部重点实验室主任；国家杰青获得者、IEEE Fellow、全国高校黄大年式教师团队负责人。长期从事复杂工业过程控制、智能制造系统技术研究，出版学术专著 3 部，发表 SCI 论文 200 余篇，授权国家发明专利 100 余项。获国家技术发明二等奖 1 项、国家科技进步二等奖 3 项，获何梁何利科学与技术进步奖、全国创新争先奖、全国三八红旗手、宝钢优秀教师特等奖等。担任《IEEE Trans. Industrial Electronics》,《IEEE/ASME Trans. Mechatronics》等期刊编委。兼任国际自动控制联合会 IFAC MMM 副主席、中国自动化学会副理事长、中国女科技工作者协会常务理事等。

报告三

时　间：　7 月 26 日上午 10:50-11:40

地　点：　华邑酒店三楼宴会厅

报告人：　焦宗夏　教授（北京航空航天大学）

题　目：　电液控制系统的传递矩阵分析方法

主持人：　李少远　教授（青岛科技大学、上海交通大学）

内容摘要：

电液控制系统广泛应用于高端装备，其建模与仿真分析对于系统设计与性能提升有重要意义。报告探讨了电液控制系统的传递矩阵分析方法，提供了一种频域分析手段。以航空电静液作动器为典型案例，介绍该方法的运用方式，并分析系统的频域动态特性。

个人简介：

焦宗夏，中国工程院院士，北京航空航天大学自动化科学与电气工程学院教授、北航机载系统创新中心主任。担任飞行器一体化控制全国重点实验室主任、中国航空学会常务理事与机电分会名誉主任、中国机械工程学会常务理事与流控分会主任。担任《航空学报》、《CJA》两刊主编。

长期从事航空机载机电系统与飞行控制系统研究，在电液控制理论、核心基础件、新概念飞行器、高端试验装备等方面取得多项原创性成果，系统解决了飞行器高可靠液压、高安全制动、伺服作动与飞行器试验等难题，成果应用于航空、航天等多个重大型号研制。连续 5 年入选爱思唯尔高被引学者，获国家技术发明二等奖 2 项、国家科技进步二等奖 1 项。

报告四

时　间：　7 月 26 日下午 13:30-14:20

地　点：　华邑酒店三楼宴会厅

报告人：　秦泗钊 教授 (岭南大学)

题　目：　Probabilistic Reduced-Dimensional Modeling of Multi-dimensional Time Series from Dynamic Systems

主持人：　赵珺 教授 (大连理工大学)

内容摘要：

Multi-dimensional time series are ubiquitous in engineering, science, and economics. While the dimension of sensors increases with modern sensing technology and data acquisition, the dimension of dynamics is often relatively small. In this talk I will present a probabilistic latent vector autoregressive framework, where dimension reduction and optimal dynamic prediction are simultaneously achieved. The dynamic latent variables are enforced by a reduced dimensional predictive model with maximized predictability. The solution requires an oblique projection to achieve uncorrelated realizations of noises in the dynamic and static subspaces. An iterative solution is developed using a maximum likelihood framework. Many popular algorithms such as slow factor analysis are special cases of the PredVAR framework. Data from a chaotic Lorenz oscillator and industrial processes are used to show the superiority of the proposed algorithms. The reduced-dimensional dynamic modeling framework has wide applications in prediction, control, and diagnosis of anomalies.

个人简介：

秦教授现任岭南大学校长及韦基球数据科学讲座教授，他分别于 1984 年和 1987 年在清华大学自动控制系取得学士和硕士学位，其后于 1992 年取得美国马里兰大学化学工程博士学位。他先前任职包括：香港城市大学数据科学学院院长兼数据科学讲座教授、香港数据科学研

究院院长；香港中文大学（深圳）副校长及校长讲席教授；美国南加州大学 Viterbi 工程学院副院长及 Fluor 教授；得克萨斯大学（奥斯汀）讲座教授。

秦教授为美国国家发明家科学院院士，香港工程院院士，欧洲人文与科学院院士，国际自动控制联合会会士、美国化学工程学会会士、电机电子工程师学会（IEEE） 会士。他曾荣获 2022 年美国化学工程学会颁发的计算与化学工程奖；2022 年 IEEE 颁发的控制系统学会技术转化奖；美国国家科学基金会颁发的职业奖等。

报告五

时　间：　7 月 26 日下午 14:20-15:10

地　点：　华邑酒店三楼宴会厅

报告人：　金建祥　研究员（浙江大学）

题　目：　太阳能光热发电及其控制问题

主持人：　程鹏　教授（浙江大学）

内容摘要：

光热发电是太阳能发电的一种新的技术路线，它通过高倍聚焦太阳光，获得高温热能，然后储存在介质中，在电网需要时通过汽轮发电机组发电。它具有低碳、长时储能以及电网友好等特点，在未来高比例新能源电力系统具有重要价值。在光热发电领域存在大量的控制问题，包括测量，控制，网络，优化，海量天文计算，智能标定，智能运维等，报告重点介绍这些问题并给出解决方案和应用实例。

个人简介：

金建祥，全国劳动模范、国务院政府特殊津贴专家、新世纪百千万人才工程国家级人选、中华人民共和国成立 70 周年纪念章奖章获得者、跨世纪优秀人才培养计划人员、浙江省特级专家。1984 年 7 月毕业于浙江大学，同年留校任教。现任浙江大学控制学院教授（研究员）、博导，工业控制技术全国重点实验室主任。四十年来，金建祥主要研究自动化和新能源领域前沿科技与产业化应用，聚焦太阳能热发电以及熔盐储能技术、工业自动化、智能化仪器仪表等领域，承担并出色完成了 10 多项国家重点科技攻关项目；金建祥也是多项 IEC 国际标准项目的召集人。获国家科技进步二等奖 2 次、国家技术发明二等奖 1 次、省部级科技进步一等奖 7 次。

主旨报告（Keynote Reports)

报告一

时　间：　7 月 27 日上午 08:30-09:10

地　点：　会议中心 2 楼未央厅

报告人：　薛文超 教授（中科院数学与系统科学研究院)

题　目：　基于不确定性在线估计与学习的模型预测控制方法

内容摘要：

利用观测器实时估计与补偿系统中的各种不确定性，已成为工程抗扰控制设计的有效范式。本报告探讨如何基于抗扰控制的不确定性在线估计机制改进模型预测控制（MPC）方法，重点介绍扰动估计值嵌入 MPC 优化问题的控制输入优化框架。具体而言，通过构建扩展状态观测器（ESO）获取扰动估计量并在线学习其模型，进一步融合至预测模型控制问题建模中，从而降低传统 MPC 处理扰动时的保守性约束设计。在此基础上，从理论上严格论证系统在满足鲁棒约束遵循性的同时能够维持递归可行性。最后，介绍所提方法在典型实际控制系统的应用效果。

个人简介：

薛文超，中科院数学与系统科学研究院研究员，博士生导师。2007 年于南开大学获学士学位，2012 于中科院数学与系统科学研究院获博士学位。研究领域主要包括非线性不确定系统的控制与滤波，飞行器系统控制等，并致力于实际系统控制与状态估计中基础理论问题的提炼与解决。主持国家基金委优秀青年基金项目，中国科协青托项目，北京市基金重点项目等。获军队科学技术奖一等奖、中国工业与应用数学学会应用数学青年科技奖、中国自动化学会科技成就奖(创新团队)、中国科学院年度团队提名奖等；获 IEEE DDCLS 2018, CCC 2019, CCDC 2022 等会议的论文奖；目前担任《控制理论与应用》副主编，IFAC Journal of Control Engineering Practice 等杂志编委；担任中国自动化学会控制理论专委会秘书长、中国指挥与控制学会理事等。

报告二

时　间：　7 月 27 日上午 08:30-09:10

地　点：　会议中心 2 楼鸿喜厅

报告人：　何潇　长聘教授（清华大学）

题　目：　深海载人潜水器的实时安全性评估技术

内容摘要：

动态系统的实时安全性评估技术在防止潜在安全事故导致重大损失方面发挥着关键作用。随着系统功能的日益复杂及安全性要求的不断提高，实时安全性评估技术面临更大挑战。本报告以“蛟龙号”深海载人潜水器为对象，在讨论其工作原理及运行特点的基础上，引出动态系统实时安全性评估的概念定义，回顾动态系统实时安全性评估技术的进展。从数据价值分析与高效利用、评估模型实时更新两个维度介绍了课题组近期的研究成果。探讨实时安全性评估中亟待解决的问题及未来的发展方向。

个人简介：

何潇，清华大学自动化系长聘教授、安全控制技术研究中心主任、交通运输部重点领域创新团队负责人。研究方向为动态系统的状态估计、故障诊断、容错控制与实时安全性评估。在国内外期刊会议上发表论文 300 余篇。主持国家自然科学基金重点项目 1 项、面上项目 3 项，2015 年获得国家优青基金，2021 年获中国自动化学会青年科学家奖。现任 IEEE Senior Member、美国 Sigma Xi 荣誉研究会 Full Member、中国自动化学会故障诊断专委会副主任兼秘书长、过程控制专委会副主任、中国指控学会云控制与决策专委会副主任、智能控制与系统专委会副主任、北京自动化学会常务理事。担任 IEEE TNNLS、IEEE TASE、Control Engineering Practice 等多个国际期刊的编委。2012 年获 SAFEPROCESS 国际会议 Paul Frank 最佳理论论文提名奖，2021 年获方崇智最佳论文一等奖，2022 年及 2023 年两获张钟俊院士优秀论文奖。获 2018 年吉林省科技进步一等奖、2015 年与 2020 年中国自动化学会自然科学奖一等奖、2022 年中国自动化学会技术发明一等奖、2023 年北京市自然科学二等奖。培养（合作培养）4 位博士获得中国自动化学会优秀博士学位论文。

报告三

时　间：　7 月 27 日上午 08:30-09:10

地　点：　会议中心 2 楼登云厅

报告人：　邢兰涛 教授 (山东大学)

题　目：　Distributed Control of DC Microgrids: Our Recent Results

内容摘要：

Direct current (DC) microgrids are gaining increasing attention in modern power systems due to their high efficiency and compatibility with renewable energy sources and storage systems. A critical challenge in the operation of DC microgrids is to achieve accurate current sharing among parallel converters. Traditional droop control methods can address this, but at the cost of undesirable voltage deviations on the DC bus.To overcome this limitation, we introduce two novel concepts: Virtual Voltage Drop (VVD) and Virtual Current Directive (VCD). By dynamically averaging VVD and VCD across the network, the proposed control strategy achieves both accurate current sharing and voltage regulation. Additionally, we analyze the stability issues that arise when constant power loads (CPLs) are connected to the microgrid, providing insights into how the proposed method maintains robustness under such challenging conditions. The effectiveness of our approach is validated through both simulation and experimental studies.

个人简介：

邢兰涛，山东大学控制学院教授、博士生导师，国家海外优青，山东省杰青。浙江大学工学博士，曾担任澳大利亚昆士兰科技大学博士后研究员，新加坡南洋理工大学校长博士后研究员（2019 年度全球超过 800 个申请人中的 12 个获得者之一）。入职山东大学前曾获得爱尔兰圣三一大学（2024 年 QS 世界大学排名：81）助理教授 offer。从事信息物理系统控制理论及其在电网中的应用研究，单篇论文谷歌学术引用超 1300 次；出版英文专著一部，曾获 ICIEA 2021 国际会议最佳论文奖。现担任顶级期刊 IEEE Transactions on Industrial Electronics 和 IEEE Transactions on Smart Grid 副编。

报告四

时　间：7 月 27 日上午 10:30-11:10

地　点：会议中心 2 楼未央厅

报告人：芦安洋 教授 (东北大学)

题　目：网络攻击下信息物理系统的安全性分析与安全防护

内容摘要：

信息物理系统是一类深度集成信息技术和自动化技术的智能系统。近几十年来，随着信息物理系统逐渐成为能源、医疗、交通等关键基础设施的核心，其面临的安全威胁也日益严重。由于对通讯网络依赖的不断增强，信息物理系统面临的网络信息攻击威胁尤为突出。而网络攻击下的信息物理系统安全技术正是保障关键基础设施安全和产业安全的重要手段之一。本次报告主要介绍团队近年来在隐蔽性攻击设计、隐性攻击检测以及安全状态估计三个方面开展的研究。首先，针对隐蔽性攻击设计问题，构建了基于虚拟系统的攻击模型，将攻击的恶意性描述为设计攻击诱导监测中心估计一个与正常系统相似的虚拟系统，进而实现恶化估计性能的目标。基于构建的攻击模型，提出了不依赖观测器信息的攻击设计策略，并给出隐蔽性攻击存在的充要条件。其次，针对隐蔽性攻击下的信息物理系统，考虑到传统的残差检测器无法检测精心设计的隐蔽性攻击，提出了一类基于辅助信息的攻击检测方法。通过分析系统脆弱点以及关键辅助信息，有效实现了对隐蔽性攻击的检测。最后，在检测攻击的基础上，进一步考虑在攻击干扰下获取正确系统状态信息（安全状态估计），重点解决了现有安全状态估计方法面临的计算复杂度高以及适用范围受限的问题。

个人简介：

芦安洋，东北大学研究员、博士生导师。主要研究方向包括：信息物理系统安全性分析与防护、故障/攻击诊断、容错/容侵控制。发表学术论文 40 余篇，以第一作者身份发表 SCI 检索论文 24 篇。一作论文包括控制领域国际顶级期刊 IEEE Transactions on Automatic Control 及 Automatica 论文共 14 篇（含长文 7 篇）。所发表论文 Google 学术引用 2100 余次（单篇最高 350 次）。主持国家自然科学基金面上基金、青年科学基金、辽宁省优秀青年基金、辽宁省面上、博士后面上、广东省区域联合基金地区培育项目等。入选 2020 年国家博士

后创新人才支持计划，获 2023 年中国自动化学会自然科学奖一等奖、2021 年中国自动化学会优秀博士学位论文奖、2020 年博士后创新人才支持计划优秀创新成果奖等。担任国际期刊 Journal of Control and Decision、Applied Sciences、International Journal of Intelligent Autonomous Systems 及 Actuators 的编委，为中国人工智能学会动态规划与智能自适应学习专委会委员、中国指挥与控制学会青年工作委员会委员。

报告五

时　间：　7 月 27 日上午 10:30-11:10

地　点：　会议中心 2 楼鸿喜厅

报告人：　李怡蓓 副研究员 (中国科学院数学与系统科学研究院)

题　目：　Inverse Problems in Optimal Control and Dynamic Games

内容摘要：

Inverse optimal control (IOC), also referred to as inverse reinforcement learning (IRL), has witnessed significant advancements in the robotics and control community. The goal of IOC is to reconstruct the optimization mechanism underlying the observed expert demonstrations, where the unknown cost function is identified from partial and noisy observations of the optimal policies. In this talk, we first present some recent development in finite time-horizon inverse linear quadratic optimal control. Well-posedness of the inverse problem is justified and robust data-driven algorithms are designed to identify the true cost function with almost sure convergence. We then extend the results into a class of noncooperative dynamic games, where individual objectives of the players are recovered from noisy and permutated observations of the Nash equilibria. To address the issue of unlabeled data that usually arises in large-scale networks, a linear sum assignment problem (LSAP)-based framework is proposed that is able to tackle the unknown and time-varying permutations in the data. Identifiability of the game model is guaranteed and efficient least squares identification algorithms are designed.

个人简介：

李怡蓓副研究员于 2022 年 6 月获得瑞典皇家工学院数学系博士学位，2022 年 9 月-2024 年 8 月于新加坡南洋理工大学从事博士后研究，2024 年 9 月至今就职于中国科学院数学与系统科学研究院，现担任副研究员。入选国家高层次人才青年项目，曾主持瑞典 Wallenberg-NTU 荣誉博士后基金、获第 39 界中国控制会议关肇直奖、国际空中机器人大赛（IARC）亚太地区第二名等奖项。现担任《Journal of Systems Science and Complexity》、《Control Theory and Technology》等期刊编委职务。主要研究兴趣包括逆强化学习、动态博弈系统、多智能体系统的编队控制等。

报告六

时　间：　7 月 27 日上午 10:30-11:10

地　点：　会议中心 2 楼登云厅

报告人：　贾孟硕 长聘教轨副教授 (上海交通大学)

题　目：　From Simulation to Discovery: Empowering LLMs in Power Systems

内容摘要：

Large language models (LLMs) have evolved from problem solvers to versatile research assistants. Yet in power systems, their application remains limited. This talk poses a central question: Can we "optimize" algorithms in energy systems, particularly those that are modular and not easily expressed through numerical variables? Addressing this challenge calls for rethinking optimization and expanding the role of LLMs in the research process. As an early exploration in this direction, the talk first introduces a feedback-driven multi-agent framework that enables LLMs to manage power system simulations, one of the essential tools for algorithm validation. This framework achieves over 93% success on benchmark tasks, significantly outperforming standard models and fine-tuned baselines. Building on this, the talk presents RePower, an autonomous platform that enables LLMs to operate devices, design methods, test approaches, and iteratively refine algorithms. Validated on key tasks such as optimization and state estimation, RePower demonstrates strong performance and adaptive learning capabilities. Finally, the talk concludes with a discussion of open questions.

个人简介：

贾孟硕，上海交通大学自动化系长聘教轨副教授、博士生导师。2016 年在华北电力大学获得学士学位；2021 年在清华大学获得博士学位。2021 年起在苏黎世联邦理工学院开展博士后研究；2023 年破格晋升为苏黎世联邦理工学院 Senior Scientist(高级研究员)；2025 年加入上海交通大学自动化系工作至今。主持瑞士国家科学基金一项，入选上海市海外高层次青年人才，并担任 IEEE Systems Journal、IET Renewable Power Generation、Cyber-Physical Energy Systems 等期刊的(创刊)编委。

专题论坛 1 (Panel Forum 1)

工业论坛

大模型及其工业应用 I

时间：2025 年 7 月 26 日 15:30—18:00

地点： 会议中心 3 楼九河厅

论坛简介：

大模型是当前人工智能领域最具代表性的技术之一，以人工智能大模型为技术底座、工业应用为切入点的工业大模型正成为赋能新型工业化的新方向。然而，大模型落地工业场景仍面临数据质量、信息安全、应用逻辑等多方面挑战。本论坛汇聚学术界、产业界大模型领域的知名专家、学者，共同探讨工业大模型的关键技术、体系架构与典型应用，展望未来工业大模型的发展方向。

联合论坛主席： 阳春华 教授（中南大学）
梁骁俊 副研究员（鹏城实验室）

嘉　　宾： 任　磊 教授（北京航空航天大学）
徐　凯 教授（国防科技大学）
毛　睿 教授（深圳大学）
苏　修 教授（中南大学）
陈晓波 研究员（西南电子设备研究所）

报告一

报告人： 任磊 教授（北京航空航天大学）

题　目： 工业大模型+具身智能：驱动未来工业世界

内容摘要：

本报告将总结工业互联网与人工智能 2.0 融合创新的热点技术，并探讨面向人工智能 3.0 时代的工业具身智能与工业元宇宙理论体系。在此技术上提出工业大模型的定义与内涵，工业大模型的体系架构、构建方法与核心关键技术。围绕工业制造业产品全生命周期应用，讨论工业大模型典型应用场景。并将讨论工业大模型面临的未来挑战，展望未来的技术与产业发展方向。

个人简介：

任磊，工业互联网领域首个国家杰出青年基金获得者，国家重点研发计划工业软件专项首席科学家。北京航空航天大学二级教授、蓝天杰出教授，自动化学院和软件学院教授，复杂产品智能制造全国重点实验室专委会副主任。研究领域包括工业互联网与工业软件、工业AI与工业大模型。主持国家重大科技专项、国家重点研发计划、自然科学基金重大研究计划等国家级和省部级项目30余项，含亿级1项和千万级3项。在IEEE汇刊等国际知名刊物发表论文100余篇，引用万余次，入选斯坦福全球前2%顶尖科学家终身影响力榜单。主持或参与制订国际/国家标准15项。获专利及软著70余项，核心技术服务于数十万家企业。获省部级一等奖3项。担任IEEE、CCF、CAAI、CAA等10余个国内外专委会委员，中国仿真学会智能物联专委会副主任、中国指控学会云控制与决策专委会副主任，中国仿真学会常务理事 ，IEEE TNNLS、TMECH等国际顶级期刊编委。担任中国工业互联网产业联盟人才工作组副主席，在全国高校中率先开设了《工业互联网》课程。担任IEEE系列及国内外学术会议主席数十次，受邀做大会报告百余次。

报告二

报告人： 徐凯 教授（国防科技大学）

题　目： 融合物理规律与数据驱动的世界模型及工业具身智能应用

内容摘要：

在真实世界中训练具身智能机器人代价很高，目前广泛采用的做法是基于仿真环境的学习。但构建一个通用且高保真的仿真环境仍然非常困难，即便为某个单项任务构建相应的仿真环境也很困难。同时，为使仿真训练的智能体能够由虚到实迁移，常需要在包括几何、结构、材质、动力学等的高维空间中进行采样，维数灾难问题突显。如能对目标环境快速构建一个机理化的专用世界模型，则只需在机理引导下对该模型进行小范围域随机化，即可支持鲁棒可泛化的策略学习。我们探讨了三种融合物理规律和数据驱动的专用世界模型学习：1）物理仿真预训练与适配——基于大规模物理仿真预训练通用世界基础模型以及面向目标环境的快速适配；2）可微神经渲染——基于可微神经渲染优化动力学模型和物理参数；3）物理信息网络：以物理公式约束优化动力学模型和物理参数。最后，我们介绍融合物理规律与数据驱动的世界模型在工业具身智能场景中的初步落地，包括：1）面向智能焊接机器人，基于焊接物理过程建模的焊接工艺实时控制；2) 面向柔性高精度装配机器人，基于装配形变建模的装配过程精细控制。

个人简介：

徐凯，国防科技大学教授。普林斯顿大学访问学者。研究方向为计算机图形学、三维视觉、具身智能、数字孪生等。在国际上较早开展了数据驱动三维感知、建模与交互工作，提出面向复杂三维数据的结构化感知、建模与交互理论方法系统，并规模化落地应用于智能制造等领域。主持国家自然科学基金青年科学基金A类（杰青）、B类（优青）、重点项目等。发表TOG/TPAMI/TVCG/TIP等A类论文100余篇。入选全球前2%顶尖科学家榜单。担任图形领域顶级国际期刊ACM Transactions on Graphics、IEEE Transactions on Visualization and Computer Graphics的编委，Computational Visual Media的领域执行编委。多次担任领域

内重要会议的大会主席和程序主席。担任中国图象图形学会智能图形专委会副主任、中国工业与应用数学学会几何设计与计算专委会副主任。曾获湖南省自然科学一等奖2项（排名1和3）、中国计算机学会自然科学一等奖2项（排名1和3）、军队科技进步二等奖、军队教学成果二等奖、中国电子学会青年科学家奖。

报告三

报告人： 毛睿 教授（深圳大学）
题　目： 基于度量空间的图数据通用表征

内容摘要：

一次表征多次使用的通用表征是预训练模型的研究核心之一。传统机器学习往往限定于欧几里得范数，与图（graph）天然的非欧几里得特性间存在鸿沟。度量空间不限制数据内部结构，仅须数据间距离满足正定、对称、三角不等性，可以表征很多图数据。我们提出先将图表征为度量空间再向量化，然后多范数下训练和融合模型的新范式，研究面向度量空间的表征学习理论框架，包括多范数下的通用近似性，模型参数优化机制，多模态/多任务训练融合机制等。本研究有望为图数据通用表征探索新的路径。

个人简介：

毛睿，男，教育部长江学者奖励计划特岗学者，深圳大学特聘教授，博导，深圳市高层次专业人才、深圳市“孔雀计划”海外高层次人才；主要研究方向是通用大数据处理和高性能计算；97年和00年在中国科学技术大学获计算机科学学士和硕士，06年和07年在美国得克萨斯大学奥斯汀分校获统计学硕士和计算机科学博士，07～10年在甲骨文美国公司从事数据库研发；10年加入深圳大学，现任大数据系统计算技术国家工程实验室副主任、深圳计算科学研究院执行院长、广东省普及型高性能计算机重点实验室主任、广东省国产高性能数据计算系统工程技术研究中心主任、深圳市服务计算与应用重点实验室主任；中国计算机学会杰出会员，理事，深圳分部主席，大数据专家委副主任，数据库专委常委；深圳市计算机学会副理事长；主持10余个国家级项目；提出了应对多样性挑战的大数据泛构模式，建立了基于度量空间的通用大数据管理分析理论框架；获2014教育部科技进步二等奖、2016军队科技进步二等奖、2021广东省教学成果一等奖、2022国家教学成果二等奖、2023“全国高校黄大年式教师团队”、2023中国计算机学会自然科学二等奖、2023中国电子学会自然科学二等奖、2024中国电子学会自然科学一等奖。

报告四

报告人： 苏修 教授（中南大学）

题　目： 具身智能研究进展与挑战：三维感知、灵巧操作与泛化迁移

内容摘要：

具身智能作为实现通用人工智能的重要路径，近年来在感知、决策与控制的深度融合上取得了显著进展。然而，在真实环境中实现高效、鲁棒的具身行为仍面临多重挑战。本报告聚焦具身智能中的三个关键问题：三维空间感知的精准性、灵巧操作的通用性以及结构感知与任务泛化能力的提升。我们将深入探讨基于多模态感知与重建的三维理解方法，覆盖高维动作空间下灵巧手的感知-控制一体化策略，并分析在跨任务、跨环境迁移过程中，如何通过结构先验、表示学习及模型泛化机制提升系统的适应能力。通过对当前代表性工作与未来研究趋势的梳理，本报告旨在为具身智能系统的研究与应用提供技术视角与思考路径。

个人简介：

苏修，男，博士毕业于悉尼大学，现任中南大学特聘教授，先后入选国家级海外优青，湖南省第16批百人计划，长期从事多模态大模型、具身智能等人工智能领域研究。近五年发表学术论文30篇，其中第一/通讯作者发表CCF/CAAI-A类论文16篇，2024年获湖南省计算机学会科学技术奖一等奖。目前重点关注具身智能领域的三维感知、灵巧操作与泛化迁移，致力于提升智能体在真实场景中的环境理解与任务执行能力。当前的研究工作涵盖具身大模型（VLA）、特种机器人设计与控制、以及跨任务/跨场景的泛化机制建模，以推动具身智能系统向更高水平的自主性与适应性发展。

报告五

报告人： 陈晓波 研究员（西南电子设备研究所）

题　目： 工业智能变革中的大模型研究与实践

内容摘要：

从工业智能的本质、需求牵引和技术驱动出发，探索VUCA时代(易变性、不确定性、复杂性和模糊性)工业智能的发展思路和系统化方案(工业大脑驱动的韧性工业体系)，并就研究实践的工艺大模型和计划异构智能体详细报告工业场景落地和关键技术研究突破情况，进一步探讨未来工业智能的方向和问题。

个人简介：

西南电子设备研究所总装集成中心主任，研究员级高级工程师，国防科技工业企业"智能制造组"专家。长期从事复杂电子产品整机集成制造技术、集成能力规划、数字化与智能化转型等方面工作。

专题论坛 2 (Panel Forum 2)

工业论坛

大模型及其工业应用 II

时间：2025 年 7 月 27 日 08:30—12:00

地点： 会议中心 3 楼九河厅

论坛简介：

大模型是当前人工智能领域最具代表性的技术之一，以人工智能大模型为技术底座、工业应用为切入点的工业大模型正成为赋能新型工业化的新方向。然而，大模型落地工业场景仍面临数据质量、信息安全、应用逻辑等多方面挑战。本论坛汇聚学术界、产业界大模型领域的知名专家、学者，共同探讨工业大模型的关键技术、体系架构与典型应用，展望未来工业大模型的发展方向。

联合论坛主席： 阳春华 教授（中南大学）
梁骁俊 副研究员（鹏城实验室）

嘉　　宾： 袁小锋 教授（中南大学）
陈致蓬 教授（中南大学）
张超波（鹏城实验室）
梁骁俊（鹏城实验室）

报告一

报告人： 袁小锋 教授（中南大学）

题　目： 工业时序大模型研究进展与挑战

内容摘要：

工业时序大模型是推动智能制造转型的核心技术。随着新型工业化和数字化转型深入推进，工业时序大模型在工艺优化、设备预测性维护、质量控制、异常检测等工业领域应用快速发展。大规模预训练、多模态融合、边缘计算优化、知识蒸馏等大模型创新技术成为工业时序数据建模的发展新动力，但也面临长序列建模计算复杂度爆炸、多模态异构数据时空对齐与融合、模型可解释性要求、实时推理与精度平衡、跨场景领域迁移等技术难题。本报告聚焦工业场景时序分析核心挑战，深入探讨工业时序大模型技术发展现状、关键挑战与未来趋势。

个人简介：

袁小锋，中南大学教授，入选教育部青年长江学者、湖南省科技创新领军人才、中国科协青年托举人才、湖南省杰出青年基金获得者。主要从事大数据分析、模式识别、机器视觉、大模型及应用等人工智能领域相关研究工作，主持国家自然科学基金重大研究计划培育项目、面上项目、青年基金和国家重点研发计划子课题共 4 项，以及省部级和校企合作项目 15 项，获吴文俊人工智能优秀青年奖、中国自动化学会自然科学一等奖、二等奖和湖南省自然科学二等奖各 1 项。先后担任国际自动控制联盟 IFAC Industry Committee、IFAC TC 1.1、中国自动化学会过程控制专委会等多个专委会委员，担任 IEEE TIM、IEEE SJ 等国际期刊副编辑，并担任 IEEE-CAA JAS 等期刊青年编委。

报告二

报告人： 陈致蓬 副教授（中南大学）

题　目： 工业具身智控大模型

内容摘要：

工业是现代文明基石，驱动技术迭代与经济繁荣，是国家核心竞争力的根本。而大模型技术，凭借深层语义洞察、跨域知识融通、动态任务适配等能力，将重塑工业未来生产范式，驱动工业由自动化迈向智能自主化。但大模型在工业垂直领域中应用，面临时序数据敏感不足、物理化学规律难嵌入、模型输出可信度低及复杂问题探索能力弱等问题。为此，提出工业垂域具身智控大模型体系架构，包括四大关键技术：①时序数据元模型化技术；②确定性知识与模型随机性融合策略；③虚实具身反馈验证机制；④具身反馈强化学习算法。将其应用于有色冶金行业，构建了有色垂域具身智冶大模型，实现了从解决方案、思维链图到可执行控制代码的端到端生成，是工业智能控制领域大模型应用的一次前瞻性探索。

个人简介：

陈致蓬，中南大学副教授、博士生导师，现任中南大学工业智能与系统教育部重点实验室副主任，湖南省青年骨干教师，全国高校黄大年式教师团队骨干。长期从事新型工业互联网和工业大模型相关研究，出版学术专著 1 部，发表 SCI 论文 30 余篇，申请发明专利 65 项，PCT 专利 1 项，新产品认证 4 项，软著 4 项。获中国自动化学会技术发明一等奖 1 项，中国有色金属工业科学技术一等奖 1 项，中国有色金属学会教学成果特等奖 1 项。

报告三

报告人： 张超波（鹏城实验室）

题　目： 多模态数据驱动的工业炉窑运行优化技术

内容摘要：

冶金工业作为典型的长流程生产过程，包含大量大型高耗能装备，是制造强国和双碳战略的主战场。其中，工业炉窑作为冶炼行业的典型重要装备，由于其运行工况波动大、反应机理复杂、生产数据具有海量异构流式等特点，目前依赖人工观察或传统机器学习的数据分析技术难以指导工人进行有效操作，存在较大的随机性和滞后性。综合利用专家经验、工艺机理和生产数据，实现多模态数据的流式处理与智能融合分析，是实现其运行预测与优化控制的关键基础。为此，本报告利用人工智能与知识构建、推理技术，研究面向多模态工业大数据的实时处理与表征学习方法；基于融合的多模态数据特征，研究工业炉窑的料面三维重建、工况预测以及优化控制技术；以为湿法炼锌回收环节的核心装备锌回转窑为验证对象，开展多模态数据融合与分析关键技术的应用示范。

个人简介：

张超波博士毕业于香港科技大学，目前是鹏城国家实验室的助理研究员、博士生导师，主要研究方向是工业智能感知、工业大数据分析、多模态大模型、云边端协同智能决策等关键技术。到目前为止，共负责指导 5 名联培博士生，主持国家自然科学基金青年项目 1 项，主持中国博士后科学基金项目 2 项，参与科技部重大攻关项目 2 项，在国内外一流学术期刊或重要会议上发表论文 30 余篇，申请国家发明专利 20 余项，获选深圳市海外高层次人才、深圳市“优秀博士后”等称号。

报告四

报告人： 梁骁俊（鹏城实验室）

题　目： AI 大模型赋能新型工业化应用探索

内容摘要：

面向国家“新型工业化”战略需求，本报告聚焦 AI 大模型赋能工业智能的核心路径。 针对当前普遍存在的“知识壁垒、决策瓶颈、验证缺失”三大挑战，我们以通用大模型为基座，深度融合工业领域知识，重点突破了三项关键技术：1、构建高质量多层级工业知识库，打破信息孤岛，为智能应用奠定坚实基础；2、研发工业知识增强的大模型智能决策技术，提升跨场景、跨流程的端到端推理与决策能力；3、打造工业 AI 大模型可信评测平台，确保模型应用的安全、可靠与可验证性。成果已在“复杂系统正向设计”和“锌冶炼过程任务规划”两个典型工业场景中成功验证。

个人简介：

梁骁俊，鹏城实验室智能系统与应用创新研究所副所长，副研究员，博士生导师，研究方向为知识自动化与工业智能系统。2012 年获清华大学学士，2017 年获美国宾夕法尼亚大学博士，入选广东省引进青年拔尖人才，发表 SCI 论文 30 余篇，主持鹏城实验室重大任务课题 2 项、国家自然科学基金项目 1 项、广东省重点研发旗舰项目课题 1 项，担任中国自动化学会系统仿真专业委员会副主任、深圳市计算机学会大模型专委会执行委员。

专题论坛 3(Panel Forum 3)

具身智能论坛

时间：2025 年 7 月 26 日 15:20-18:00

地点： 会议中心 3 楼九河厅

论坛简介:

具身智能（Embodied Intelligence）是人工智能与机器人学交叉融合的前沿领域，强调智能体通过物理本体与环境的动态交互，实现自主学习和持续进化。其中蕴含着巨大的市场潜力和发展机遇。本次论坛邀请到杭州“六小龙”之一的云深处科技，以及非夕科技、星逻智能、微分智飞等几个充满活力的具身智能科技企业创始人。他们将分享如何积极探索技术创新，不断推动关键技术突破和应用落地，助力具身智能实现从“书架”到“货架”的转变，真正融入社会场景，释放更大的经济和社会价值。

联合论坛主席： 邵之江 教授（浙江大学）

朱秋国 副教授（浙江大学）

联合论坛秘书： 詹美燕（浙江大学）

嘉 宾： 朱秋国 浙江大学副教授、云深处科技创始人兼 CEO

胡晓平 非夕科技副总裁

王海滨 星逻智能创始人兼董事长

周博宇 微分智飞联合创始人

报告一

报告人： 朱秋国（浙江大学/云深处科技）

题　目： 具身人形机器人关键技术及应用

内容摘要：

2025 年政府工作报告将“具身智能”列为未来重点发展产业，明确提出要加快智能机器人、新一代智能终端及智能制造装备的研发与应用。在此背景下，本报告聚焦具身智能人形机器人领域，系统梳理其发展历程与技术演变，深入探讨具身移动和具身操作的核心技术路径与最新进展。同时，报告将结合云深处科技在四足机器人领域的最新进展，展示其在工业巡检、应急救援、特种作业等场景中的实际应用案例，分析高动态运动控制、智能环境交互等关键技术的落地挑战。最后，基于当前技术瓶颈与市场需求，展望具身机器人的未来趋势，为行业技术布局与政策制定提供参考。

个人简介：

朱秋国，杭州六小龙之一“云深处”科技（DEEP Robotics）创始人兼 CEO，浙江大学控制科学与工程学院、浙江大学国家卓越工程师学院，副教授、博士生导师。2017 年创立云深处科技，此前长期从事仿人机器人，仿生机器人，机器智能等研究，曾任第 28 届 IDC Robocon 执行主席，2017 年获浙江大学青年创新奖， 2018 年获得浙江大学十大学术进展。2024 年入选浙江省首届十大最具创新力青年科技型企业家。2025 年入选 2024 福布斯中国科创人物。

杭州云深处科技（DEEPRobotics）成立于 2017 年，2018 年推出能够上下楼梯、自主导航和智能交互的四足机器人，2019 年发布具备自主充电能力的四足机器人。公司致力于拓展具身智能机器人技术与应用边界，凭借在技术研发与场景落地上的持续突破，迅速成长为业界瞩目的“杭州六小龙”之一，并成为“中国智造”走向世界的新锐力量。2025 年 7 月 8 日，杭州云深处科技有限公司宣布完成近 5 亿元人民币新一轮融资。

报告二

报告人： 胡晓平（上海非夕机器人科技有限公司)

题　目： 仿人化技术路线驱动下的机器人跨行业应用变革

内容摘要：

传统的工业机器人和协作机器人已经发展几十年，但其在工业等领域的渗透率依然很低，主要因为现有机器人未能像人类那样灵活地使用工具和适应环境，传统位置控制的技术路径已经到了应用潜力的极限。

非夕团队研究的力控规划模式能突破传统规划的瓶颈，使机器人更好地适应环境，模拟人类行为模式，展现出超越当前机器人的能力。而现有机器人硬件无法满足团队研究的力控规划的落地需求，因此非夕团队意识到硬件创新是核心突破口，而该领域在行业中暂未被探索，存在巨大商业机遇。另一方面，机器人是人工智能落地的最佳载体，机器人执行任务是也需要“力”的感知和控制，因此非夕团队始终同步研究人工智能与机器人软硬件协同，通过第一性原理，两者的结合可以极大地压缩具身智能大模型的训练空间，提高大脑决策的通用性及鲁棒性。通过以上技术路线的升级，目前，非夕的自适应机器人产品已经在工业制造、农业生产、医疗健康、家庭服务等多领域跨场景的应用落地。

个人简介：

胡晓平现任非夕科技副总裁，上海市青年企业家协会会员，全国人形机器人标准委员会工作组成员，上海浙江大学控制学院校友分会副会长，本硕分别毕业于浙江大学控制学院和中科院自动化研究所，从事机器人和人工智能技术的研究，毕业后在非夕科技负责集团运营，持续推动集工业级力控、计算机视觉和人工智能技术于一体的仿人化自适应机器人产品研发和应用，为不同行业的客户提供基于非夕机器人平台型产品的创新性解决方案和服务。

上海非夕机器人科技有限公司成立于 2016 年 11 月，是一家全球领先的通用智能机器人公司，首创“自适应机器人”这一新品类，以“仿人化”为核心理念，将人类“手感”抽象为

极致的力控能力，将“手眼协调”的行为模式转化为机器人具备泛化操作能力的层级式智能系统，大幅提升机器人复杂工况的应对能力、工艺的通用性与适应性。在专注核心技术研发的同时，非夕科技积极参与行业标准建设，牵头制定的国家标准《机器人自适应能力技术要求》已正式发布。2025 年 6 月 23 日非夕科技对外宣布已完成 C 轮亿级美元融资。

报告三

报告人： 王海滨 （星逻智能科技（苏州）有限公司）

题 目： 用 AI 开启低空新蓝海

内容摘要：

10 年前关注到无人机在工业和能源场景的应用，7 年前我们研发出首台无人机机库，这是一套集无人机自动化驾驶与充电功能于一体的系统。我们将无人机打造为自主机器人，拥有敏捷的“身法”和聪明的“大脑”，产品“星逻驭光”目前已覆盖全球 700 多个场站，共计 16.7GW，堪称全球最大规模的无人机光伏检测系统。在风电检测方面，我们让无人机自动抓怕静止或是转动中的叶片，无人机能够像小蜜蜂一样穿梭在以高铁时速掠过的叶片，并抓怕到清晰的裂痕照片，这可以说是无人机自动巡检中实时性要求最高的应用。随后又开发了 Grabber 飞掠者无人机，无人机集成了机械指，通过机器视觉抓取光伏机器人，实现跨板飞跃，这就是全世界第一款会“打飞的”的光伏机器人“ Lantern”。星逻智能研发团队来自浙大和交大，熟悉光伏、风电以及能源传输，了解无人机在其巡检上独特的视角优势，力图把无人机与机器人串联起来，打通了一套检测与执行的完整闭环解决方案，用 AI 技术，驱动无人机与机器人协同工作，为全球新能源发电的提效，提供闭环解决方案。

个人简介：

王海滨，男，汉族，星逻智能创始人兼董事长，本科毕业于浙江大学，硕士毕业于上海交通大学，精通无人机工业应用和无人机电池管理与充电，具有 20 余年无人机相关行业经验。同时，王海滨也获评了苏州工业园区金鸡湖领军人才、姑苏领军人才、江苏省双创人才称号。产学研方面，王海滨受邀担任浙江大学创业导师。2017 年创立星逻智能，推出了中国第一台无人机自动充电机库，同时也是中国出口海外的第一套无人机全自动巡检产品。目前，他带领星逻智能扎根无人机低空领域，研发出针对于低空城市建设、新能源巡检运维等智能化软硬件，项目落地全球近百个城市。

星逻智能自 2017 年成立以来始终专注于无人机赋能技术的研发与商业化落地。作为中国低空经济领域的开拓者，研发团队来自浙大和交大，打通了一套检测与执行的完整闭环解决方案，为全球新能源发电的提效，提供闭环解决方案。产品市场国内超 40 个区县同时海外打通欧洲、东南亚、日本等地，是中国第一家出口海外的无人机智能化系统供应商。2025 年 6 月公司获得“B+轮”融资，涉及融资金额超亿人民币。

报告四

报告人： 周博宇 （微分智飞（杭州）科技有限公司/南方科技大学）

题 目： 飞行机器人：从物理智能到具身智能

内容摘要：

随着机器人和人工智能技术的快速发展，自主飞行机器人及其集群系统在复杂动态环境下的自主控制已走向成熟。本报告将介绍飞行机器人最新自主导航算法，阐述面向高动态、强干扰、多约束场景下基于物理智能的模型构建和优化求解方法；进而，介绍基于具身智能和数据驱动的端到端决策和控制算法，并展示其在真实复杂环境中的验证效果。通过多学科交叉视角，报告将揭示群体智能在复杂环境适应性、系统鲁棒性及可扩展性方面的进展，为未来大规模智能集群的工程化应用提供理论支撑与技术参考。

个人简介：

周博宇，微分智飞（杭州）科技有限公司联合创始人，首席科学家。南方科技大学机械与能源工程系助理教授（副研究员），博士生导师。2018 年本科毕业于上海交通大学，2022 年博士毕业于香港科技大学机器人研究所。主要从事空中机器人、导航、主动感知、操作、多机相关研究。近年来在 IEEE TRO、RAL、RSS、ICRA、IROS 等机器人领域顶级期刊和会议发表论文三十余篇。代表成果获得机器人顶刊 IEEE TRO 最佳论文奖（亚洲单位首次），RAL 最佳论文奖，ICRA 无人机最佳论文提名，多个工作被列为 TRO 受欢迎论文、RAL 受欢迎论文（排名第一），多次被 IEEE Spectrum，Tech Xplore 等知名科技媒体报道。

微分智飞（杭州）科技有限公司于 2024 年 7 月成立，由机器人领域知名学者、浙江大学高飞教授领衔。公司核心行业产品智能自主无人机集成多源数据融合和自主决策，突破卫星拒止环境下的自主导航与动态避障，支持多种行业载荷快速适配，实现高危场景连续作业效率大幅提升。2025 年 5 月完成数千万元天使轮及天使+轮融资。

专题论坛 4(Panel Forum 4)

传统固态酿造的智能化转型：关键技术及应用实践

时间：2025 年 7 月 27 日 08:30-12:00

地点：会议中心 3 楼叙府厅

论坛简介:

传统白酒固态酿造兼具工业价值与文化遗产属性，在全球气候变化及制造业智能化转型的浪潮下，白酒产业正迎来深度调整与高质量发展的关键机遇。然而，白酒酿造工业从传统粗放型生产方式向智能化、绿色化转型发展仍面临着数据分析、工艺升级、智能装备研发等挑战。本论坛将邀请智能制造学者、酿造工艺专家及行业先锋企业，围绕传统固态酿造的智能化转型：关键技术及应用实践展开研讨，共谋传统酿造智能化转型的未来蓝图。

联合论坛主席：栾小丽 教授（江南大学）

熊伟丽 教授（江南大学）

嘉　　宾：许正宏 四川大学先进酿造科技创新中心主任

石清海 淄博盖米测控系统有限公司董事长

杜　海 江南大学生物工程学院教授

熊伟丽 江南大学物联网工程学院教授

张宿义 泸州老窖股份有限公司副总经理

郑　佳 宜宾五粮液股份有限公司技术研究中心主任

报告一

报告人： 许正宏 主任（四川大学先进酿造科技创新中心）

题　目： 新发展格局下的白酒产业现状与转型升级

内容摘要：

在新发展格局下，中国白酒产业正面临深度调整与转型机遇。随着消费升级与理性化趋势增强，白酒市场面临产能过剩与同质化竞争，行业分化加剧，倒逼企业不断优化生产工艺，数字化、智能化酿造技术加速渗透。报告将简要介绍我国白酒的产业现状，并在此基础上探讨白酒产业转型升级的策略。

个人简介：

许正宏，四川大学先进酿造科技创新中心主任、教授，固态酿造国家工程技术研究中心副主任。国家级人才计划科技创新领军人才，四川省学术和技术带头人。长期从事传统酿造和合成生物学方向的研究与教学工作。主持国家重点研发项目、国家 863 重大项目课题、国家自然科学基金等课题 20 余项。在 Curr Opin Biotech, Metab Eng, AEM, Food Chem, Food Microbiol、微生物学报、生物工程学报等国内外学术期刊联合发表科研论文 200 余篇，授权国际或中国发明专利 100 余项。兼任中国调味品协会科学技术委员会副主任委员，中国酒业工业协会白酒专家技术委员会委员等，担任《Food Microbiology》、《Systems Microbiology and Biomanufacturing》等期刊编委。以第一完成人获包括江苏省科学技术奖一等奖、天津市科技进步奖特以及国家级教学成果二等奖。

报告二

报告人： 石清海 董事长（淄博盖米测控系统有限公司）

题　目： 在线近红外水分仪在固态酿造行业的应用

内容摘要：

在线近红外水分仪技术的原理、应用场景、优势及市场前景。

技术原理方面：在线近红外水分仪基于近红外光谱技术，通过检测水分子对特定波长光的吸收特性，实现对物料水分含量的快速、无损测量，具有非接触、响应快、多参数检测等优点。

应用场景涵盖：原料入厂检测、酒醅发酵过程中的水分监测、糟醅干燥控制以及成品酒的质量把关，能够有效提升生产效率与产品一致性。

与传统离线检测对比：在线检测具备实时性强、自动化程度高、数据重复性好等显著优势，虽然初期投入较高，但长期运维成本更低，更适用于现代智能化生产线。

市场前景广阔：随着食品行业对质量控制要求的提升及国家政策推动，近红外水分仪市场需求持续增长，国产设备在性能和性价比上逐步具备竞争力。

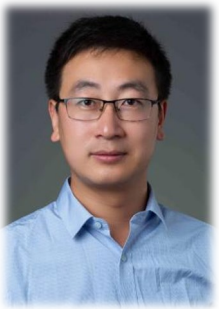
个人简介：

石清海，淄博盖米测控系统有限公司董事长，长期致力于工业自动化检测与过程控制领域的技术创新与产业发展。凭借对行业趋势的敏锐洞察和卓越的管理能力，他带领盖米测控从一家区域性企业成长为国内领先的在线检测解决方案提供商，尤其在近红外水分分析、液体浓度监测、智能化酿造控制系统等领域具有深厚的技术积累和市场影响力。

在他的战略引领下，公司不断加大研发投入，推出多款适用于食品、酿酒、化工、锂电池等行业的高精度在线检测设备，广泛应用于固态酿造、原料质检、生产过程监控等多个关键环节，助力客户实现智能制造与质量升级。同时，石清海积极推动产学研合作，与多家高校及科研机构建立长期合作关系，推动国产高端仪器的技术突破与市场拓展。

作为一位兼具技术背景与商业远见的企业家，石清海始终坚持“以客户为中心、以科技为驱动”的发展理念，致力于将盖米测控打造成为行业内值得信赖的品牌，为中国制造的高质量发展贡献力量。

报告三



报告人： 杜海 教授（江南大学生物工程学院）

题　目： AI 赋能传统固态酿造多组学数据挖掘及其感官品质智能预测

内容摘要：

本报告聚焦于人工智能赋能传统固态酿造的关键技术路径与应用实践，系统阐述了 AI 技术在白酒多组学数据挖掘与感官品质智能预测中的原理、应用优势与发展前景。

技术原理方面：基于机器学习的多组学数据挖掘框架整合微生物组学与风味组学数据，通过构建可解释性强的预测模型，实现对堆积发酵升温状态及成品感官等级的精准判断，具备高维特征提取、动态预测与模型可解释性等技术优势。

应用场景涵盖：堆积发酵过程中的温度异常识别与调控、基酒感官差异解析与关键香气物质筛选、成品质量等级分类与预测等，有效支撑传统酿造从“经验驱动”向“数据驱动”的智能化转型。

与传统工艺管理对比：AI 建模实现了工艺过程的实时监控、可量化分析与预警响应，提升了产品稳定性与生产决策科学性，虽需前期数据集成与模型训练投入，但整体效率提升显著，适配高质量发展需求。

未来前景广阔：在数字化酿造、产业协同平台建设与 AI 大模型应用等方向，AI+酿造模式有望重塑传统发酵工业生态，为实现智能化、标准化与定制化生产提供全新路径。

个人简介：

杜海，博士，江南大学生物工程学院教授，博士生导师。中国蒸馏酒产业技术创新战略工作委员会委员，2020 届国家级特邀白酒评酒委员。2019 入选江苏省高层次创新创业人才引进计划“科技副总”。长期从事酿酒工程与微生物学科领域科学研究。聚焦传统发酵过程微生态解析及功能物质代谢形成机理的研究工作。采用多组学技术，对不同地域、不同香型工艺酿造菌群多样性及其演替规律进行系统研究，涉及功能菌群生长、相互作用及代谢功能机制解析。

相关成果在国内外期刊上累计发表论文 40 余篇。授权发明专利 16 项。近 5 年主持、参与国家自然科学基金（青年科学项目、重点项目、面上项目）、国家重点研发计划等项目 10 项。并承担多项“白酒龙头企业技术攻关项目。近 5 年研究的 4 项成果均被鉴定达到国际领先水平。科研成果 分别获省部级、协会科技进步一、二、三等奖 5 项。

报告四

报告人： 熊伟丽 教授（江南大学物联网工程学院)

题　目： 面向白酒酿造的智能建模及优化技术

内容摘要：

白酒酿造工业是我国轻工制造业的重要支柱，其独有的固态发酵工艺也是珍贵的非物质文化遗产。然而，固态发酵过程具有间歇性、非线性、大滞后和强耦合等复杂特性，传统依赖人工经验的生产方式面临出酒率不稳定、品质波动大、劳动强度高等挑战。以数据驱动和知识融合为核心，研究了低质多采样率数据学习与多尺度软测量、多批次数据的时空融合与深度知识迁移、复杂约束下的多目标动态优化等关键技术。自主研制的大规模窖池物联网、装甑机器人等智能装备及系统，构建了智慧酿酒综合管控与大数据平台，有效推动了传统固态发酵行业的智改数转、提质增效与高质量发展。

个人简介：

熊伟丽，教授、博士生导师。江苏省“青蓝工程”中青年学术带头人、江苏省“六大人才高峰”计划，加拿大阿尔伯塔大学访问学者。主要从事数据驱动的智能软测量技术、复杂工业过程建模、故障监测及优化等的研究与开发工作。中国自动化学会过程控制专委会委员、仪表与装置专委会委员、广东省科技特派员等。主持国家自然基金面上、青年项目、国家外专项目、江苏省产学研等省部级以上纵向项目 9 项。在 TII、TCST 和 TIM 等国内外权威期刊上，以第一/责任作者发表研究论文近百篇。以第一发明人授权发明专利 44 项，其中国际发明专利 4 项。获得江苏省科学技术二等奖、中国商业联合会科技进步一等奖以及中石化自动化应用协会科技进步一等奖等。

报告五

报告人： 张宿义 副总经理（泸州老窖股份有限公司）

题　目： 双碳战略下的白酒酿造

内容摘要：

在全球气候变化及制造业智能化转型浪潮下，先进技术发展为传统产业转型升级带来崭新机遇。近年来，在国家“双碳”战略目标和“中国智造”政策双重驱动下，作为传统行业的白酒酿造企业正加速从传统粗放型生产方式向智能化、绿色化转型发展。

作为国有大型骨干酿酒企业，泸州老窖积极探索智能酿造的前沿技术，本报告将从白酒行业智能酿造现状、政策支持，泸州老窖科研平台优势、关键问题攻关、智能化装备及技术应用等方面进行深入剖析，以科技引领、数智赋能探索传统酿造行业的高质量发展新模式。

个人简介：

张宿义，泸州老窖股份有限公司副总经理，国务院政府特殊津贴专家，四川省学术和技术带头人，天府科技领军人才，四川工匠，四川省非物质文化遗产项目代表性传承人，中国酿酒大师。主持主研国家、省级科研项目 34 项，其中主持国家 863 计划 1 项，国家重点研发计划 1 项，工信部智能制造专项项目 1 项，获省部级科技进步奖 14 项，其中一等奖 4 项，行业科技奖励 40 余项。参与制定国家标准 13 项，发表论文 362 篇（其中 SCI 收录 62 篇），获授权专利 185 件（其中发明专利 84 件），编著专著 13 部。

报告六

报告人： 郑佳 主任（宜宾五粮液股份有限公司技术研究中心）

题　目： 五粮液酿造过程品质控制关键技术与应用

内容摘要：

本研究系统阐述了五粮液酿造技艺，进一步确定了影响产品质量的过程控制关键参数体系，构建了质量相关的控制方法体系，展望了面相未来的基于 AI 的质量控制模型。

个人简介：

郑佳，博士，正高级工程师，现任宜宾五粮液股份有限公司技术研究中心党支部书记、主任、分工会主席。入选天府万人计划、宜宾英才计划，荣获全国食品工业科技创新杰出人才、中国酒业科技领军人才、宜宾青年五四奖章等多项荣誉，兼任全国知识管理标准化技术委员会地理标志分技术委员会委员、固态发酵资源利用四川省重点实验室主任、四川大学和江南大学等硕博士产业导师等。

口头报告 (Oral Sessions)

2025/07/26 15:20 **2 楼长乐厅**

复杂工业过程控制与优化 1

主　席: 杨春雨　中国矿业大学

15:20-15:40 **SatA1.1**

Two-point coupled control of residual chlorine during tap water disinfection in response to sudden contamination

杨亚岚　中国地质大学
安剑奇　中国地质大学
张顺　中国地质大学
熊嘉豪　中国地质大学

15:40-16:00 **SatA1.2**

基于双线性预测控制的 *PID* 控制器参数整定

许锋　中国石油大学
李炫哲　中国石油大学
李剑　中国石油大学
梁栋　中国石油大学

16:00-16:20 **SatA1.3**

基于相对增益阵和优先级的过程系统操作优化

初文鹤　中国石油大学
肖勇湘　中国石油大学
许锋　中国石油大学

16:20-16:40 **SatA1.4**

基于状态空间模型的常规控制回路配对方法

张晓萌　中国石油大学
方劲舟　中国石油大学
许锋　中国石油大学

16:40-17:00 **SatA1.5**

数据丢包场景下磨矿过程多速率分层逆优化控制

任鹏旭　中国矿业大学
代伟　中国矿业大学
张淇瑞　中国矿业大学
杨春雨　中国矿业大学

17:00-17:20 **SatA1.6**

基于双网络辅助状态图重构 *DDPG* 算法的三相蓄热式热力氧化炉优化控制策略

李大宇　北京化工大学
刘子龙　北京化工大学

17:20-17:40 **SatA1.7**

Multi-Physics Coupled Energy Consumption Modeling for Direct Seawater Electrolysis Hydrogen Production process

于康　中国地质大学
安剑奇　中国地质大学
李胜军　江苏唯达水处理技术股份有限公司
李丹阳　中国地质大学

17:40-18:00 **SatA1.8**

Design of Single-Phase Power Inverter System Based on Model-Free Adaptive Control

严俊鹏　温州大学
张正江　温州大学
陈冲　温州大学
吴龙杰　温州大学
朱志亮　温州大学

2025/07/26 15:20 **2 楼未央厅**

复杂工业过程控制与优化 2

主　席: 安爱民　兰州理工大学

15:20-15:40 **SatA2.1**

An Extended Data-Driven Quality Optimization Method for Injection Molding Based on Large Language Models

HaiPeng Zou　Xiamen University of Technology
Yuxuan Xie　Xiamen Institute of Technology
Xiaoyu Li　Xiamen university of technology
Ke Yao　Guangzhou HKUST Fok Ying Tung Research Institute
Xiangsong Kong　Xiamen University of Technology

15:40-16:00 **SatA2.2**

Dynamic Modeling of Arsenic Removal Process in Copper Electrolyte Purification Based on Electrodeposition Decontamination Technology

Yixiao Ding　Pengjiaping Campus of Lanzhou University of Technology
Aimin An　Institute of Electrical Engineering and Information Engineering, Lanzhou University of Technology

16:00-16:20 **SatA2.3**

Multivariable Model Predictive Control of Wastewater Treatment Process Based on EKF

Tao Chang — Lanzhou University of Technology
Aimin An — Institute of Electrical Engineering and Information Engineering, Lanzhou University of Technology

16:20-16:40 **SatA2.4**

Distributed Model Predictive Control for BOG Treatment System in LNG Receiving Terminal

刘智举 上海交通大学
李少远 上海交通大学
郑毅 上海交通大学
黄猛 杭州电子科技大学

16:40-17:00 **SatA2.5**

Intelligent Learning-Based Distributed Predictive Operational Optimization Control for Rotary Kiln of Calcination

郑毅 上海交通大学
孟巡 上海交通大学
杨林乐 上海交通大学
李少远 上海交通大学

17:00-17:20 **SatA2.6**

基于渐进算法的复杂工业过程非凸鲁棒优化方法

张恩泽 中国矿业大学
褚菲 中国矿业大学
张勇 中国矿业大学
李会军 中国矿业大学
王军 中国矿业大学

17:20-17:40 **SatA2.7**

基于 *Q* 学习的延时系统无模型最优跟踪控制

王心雁 东北大学
Jialu Fan Northeastern University
庞文砚 东北大学

17:40-18:00 **SatA2.8**

路径约束非线性切换系统的混合智能动态优化方法

李欢 东北大学
付俊 东北大学
柴天佑 东北大学

2025/07/26 15:20 2 楼鸿喜厅

先进控制理论与方法

主　席: 赵志诚　太原科技大学

15:20-15:40 **SatA3.1**

Model Predictive Control for Train Convoy Operation: Hardware-in-the-Loop Simulation Performance Validation

haoran zhang Beijing Jiaotong University
Debiao Lu Beijing Jiaotong University
Bai-gen Cai Beijing Jiaotong University
Jian Wang Beijing Jiaotong University
Jiang Liu Beijing Jiaotong University
Wei Jiang Beijing Jiaotong University
Yibo Cui China Academy of Railway Sciences

15:40-16:00 **SatA3.2**

Conditional Disturbance-Compensation Control of Pneumatic Control Valve System

Zhi Song Wang Jiangnan University
Xing Fang Institute of Automation, Jiangnan University
Huang Chenxin Jiangnan University
Fei Liu Jiangnan University, China

16:00-16:20 **SatA3.3**

Development of a Sliding Mode Control Method for Permanent Magnet Synchronous Motors using Time-Sharing Fused Reaching Law

Xiantao Zhu Jiangsu University of Technology
Wei Guo Jiangsu University of Technology
Ranran Liu Jiangsu University of Technology

16:20-16:40 **SatA3.4**

存在时滞的高速列车新型动态面速度跟踪控制

谭畅 南京航空航天大学
谢玟洪 华东交通大学

16:40-17:00 **SatA3.5**

一种运行 -统计变量融合成像的 *MPC* 系统模型失配诊断方法

李丽娟 南京工业大学

17:00-17:20 **SatA3.6**

基于双级扩张状态观测器的永磁同步电机转速分层滑模控制

栗毅淼 太原科技大学
赵志诚 太原科技大学

17:20-17:40 **SatA3.7**

Neural network-based adaptive iterative learning control for unknown nonlinear nonaffine discrete-time systems

Mingming Lin Qingdao Universtiy of Science Technology
Ronghu Chi Qingdao University of Science Technology

17:40-18:00 **SatA3.8**

Active Disturbance Rejection Control Based Regulating Valve Control in High-Altitude Chamber

Yize Chen	Fuzhou University
HEHONG ZHANG	NTU
Hongyu Lin	Fuzhou University
Xiang Xu	Fuzhou University
Bo Feng	Fuzhou university
Chao Zhai	China University of Geosciences

2025/07/26 15:20 **2 楼登云厅**

决策与控制一体化系统

主　席: 闻继伟　江南大学

15:20-15:40 **SatA4.1**

Nonlinear Homotopy-Penalty Interior-Point Method for Six-DoF Powered Landing Guidance

Kai Chen	Zhejiang University
Zhenyu Wei	Zhejiang University
Zhijiang Shao	Zhejiang University

15:40-16:00 **SatA4.2**

非线性切换系统的抗攻击无扰切换预测控制

解磊	江南大学
闻继伟	江南大学
万海英	江南大学
高爽	江南大学
栾小丽	江南大学

16:00-16:20 **SatA4.3**

Research on Quality Defect Diagnosis Method for Tire Joints Based on Improved MHA-IDQN

Qingduo Hu	Qingdao University of Science and Technology
wei zhang	Qingdao University of Science and Technology
Bao-Lin Zhang	Qingdao University of Science and Technology
Bingzheng Guan	MESNAC CO.,LTD

16:20-16:40 **SatA4.4**

Dynamic closed-loop constraint identification test for model predictive control

Xiao Zheng	Zhejiang University
Zuhua Xu	Zhejiang University
JUN ZHAO	zhejiang university
Chunyue Song	Zhejiang University

16:40-17:00 **SatA4.5**

基于机理模型的主蒸汽温度内模控制方法

李俊杰	浙江大学 NIGCS 大平台
张奕楠	浙江大学
杨雨	浙江大学 NGICS 大平台
道尔吉苏荣	浙江大学 NGICS 大平台
张翔	浙江大学 NGICS 大平台
王文海	浙江大学

17:00-17:20 **SatA4.6**

Model Predictive Control Strategy Based on Deep Neural Networks for Inverted Pendulum Systems

Meng Kang Wang	Beijing University of Chemical Technology
Han Yang	College of Information and Science Technology
Xiaolei Li	Beijing University of Chemical Technology, Beijing, China.
Yukun Shi	Beijing University of Chemical Technology
Youqing Wang	Beijing University of Chemical Technology

17:20-17:40 **SatA4.7**

Adaptive Iterative Learning Economic Model Predictive Control for Non-repetitive Disturbances

赵宇石	华北电力大学
马乐乐	华北电力大学
刘向杰	华北电力大学

17:40-18:00 **SatA4.8**

A simplified finite control set repetitive model predictive control method for improving the performance of grid-connected inverters

Shao Yuanyuan	Lanzhou University of Technology
Aimin An	Institute of Electrical Engineering and Information Engineering, Lanzhou University of Technology

2025/07/26 15:20 **2 楼百瑞厅**

信息感知与检测技术

主　席: 孙兰香　中国科学院沈阳自动化研究所

15:20-15:40 **SatA5.1**

Design of an Automatic Optical Power Calibration Mechanism and System for Fiber Identifiers

曹非凡	江南大学
邵梓康	江南大学物联网工程学院
杨素林	江南大学
谢林柏	江南大学物联网工程学院

15:40-16:00 **SatA5.2**

Laser-induced breakdown spectroscopy chemical element online analysis technology and equipment

孙兰香	中国科学院沈阳自动化研究所

16:00-16:20 **SatA5.3**

基于红外图像的正极材料烧结炉三维温度场重建

綦彪	中南大学
陈宁	中南大学
陈嘉瑶	中南大学
桂瑰	中南大学
阳春华	中南大学
桂卫华	中南大学

16:20-16:40 **SatA5.4**

A hyperspectral image compression method based on superpixel segmentation

Xueqian Yu	Central South University
Can Zhou	Central South University
Yan Sun	Central South University

16:40-17:00 **SatA5.5**

SASGNN: A Sparse Attention Graph Neural Network for Long Sequence Multivariate Forecasting in Industrial Processes

Wang Yulong	Central South University
Xiaoli Wang	Central South University

17:00-17:20 **SatA5.6**

面向工业设备管控的工控数据可视化及实现

刘浩	东北大学
吴永建	东北大学自动化中心
刘辉	东北大学
吴志伟	东北大学

17:20-17:40 **SatA5.7**

Quality Index Prediction for Polypropylene Batch Processes Based on Data Features

Jinmiao Wang	China University of Petroleum
Zhu Wang	China University of Petroleum

2025/07/27 08:30 3 楼金江厅

张钟俊奖评奖

主　席: 李少远　青岛科技大学、上海交通大学

08:30-08:50 **SunA1.1**

A Feedback-Enhanced Soft Actor-Critic Control Method for Industrial Processes

Zhixuan Peng	Central South University
Bei Sun	Central South University
Fakun Zheng	Fujian Science & Technology Innovation Laboratory for Optoelectronic Information of China
Yucheng Ke	Fujian Metal-New Aluminum Technology Co., Ltd.

08:50-09:10 **SunA1.2**

工业级大型焦炉炭化室 *CFD* 仿真与参数分析

李怀旭	大连理工大学
王超	大连理工大学
李宛格	大连理工大学
韩中洋	大连理工大学
赵珺	大连理工大学

09:10-09:30 **SunA1.3**

Global Asymptotic Tracking Control with Input Saturation and Adaptive Performance: A Low-Complexity Approach

Wenxin Lai	Shanghai jiao tong university
Yuanlong LI	Shanghai Jiao Tong University
Bo Yang	Shanghai Jiao Tong University

09:30-09:50 **SunA1.4**

String-Stable Controller Design for Nonlinear Vehicular Platoons

Weinan Gao	Northeastern University
Nairong Qiao	Northeastern University
Tianyou Chai	Northeastern University

09:50-10:10 **SunA1.5**

A Dynamic Multi-objective Evolutionary Algorithm based on Difference Prediction

Xiaoli Li	Beijing University of technology
Anran Cao	beijing university of technology
Kang Wang	Beijing University of Technology

10:10-10:30 **SunA1.6**

Semi-Supervised Discriminant Analysis for Out-of-Distribution Detection with Limited Labeled Data

Meng-hui Guo	China University of Petroleum, Beijing
Jian-wei Liu	China University of Petroleum, Beijing Campus

10:30-10:50 **SunA1.7**

Physics-Informed Multi-Source Stationary Subspace Analysis for Fault Detection in Blast Furnace Ironmaking

Siwei Lou	Zhejiang university
Yi Li	Zhejiang University
Chunjie Yang	Zhejiang University
Hanwen Zhang	University of Science and Technology Beijing
Ping Wu	Zhejiang Sci-Tech University

2025/07/27 08:30 2 楼长乐厅

学生优秀论文奖评奖

主　席: 周平　东北大学

王宏　曼彻斯特大学

08:30-08:50 **SunA2.1**

Dynamic Event-Triggered Consensus of Multi-Agent Systems: New Insights into Event-Separation Properties

Sikang Zhan — Key Laboratory of System Control and Information Processing, Ministry of Education of China, Shanghai 200240, China
Ruchao Su — Shanghai Jiao Tong University
Xianwei Li — Shanghai Jiao Tong University
Shaoyuan Li — Shanghai Jiao Tong University

08:50-09:10 **SunA2.2**

Semi-Supervised Detection of Sub-Micron Scratches on Laser Chips via Recursive Texture Entropy Optimization

Pan Liu — Central South University
Liang Wang — Central South University
Weihua Gui — Central South University

09:10-09:30 **SunA2.3**

StictionGPT: Detecting Valve Stiction in Control Loops using Large Vision Language Model

Tianci Xue — Xi'an Jiaotong University
Chao Shang — Tsinghua University
Dexian Huang — Tsinghua University

09:30-09:50 **SunA2.4**

A coal price prediction method based on DeepSeek-R1 fusion of quantitative multi-scale event characterization

Jiang Luo — Central South University
yalin wang — central south university
Chenliang Liu — Central South University
Xiaofeng Yuan — Central South University
Weihua Gui — Central South University

09:50-10:10 **SunA2.5**

Infrared and Visible Image Fusion Method under Scattering Medium Disturbance

李凡训 — 中南大学
潘冬 — 中南大学自动化学院
蒋朝辉 — 中南大学
余浩洋 — 中南大学
桂卫华 — 中南大学

10:10-10:30 **SunA2.6**

Multi-objective Optimization for Effective Drift Motion Control

Bei Zhou — Zhejiang University
Lei Xie — Zhejiang University
Hongye Su — Zhejiang University, China

10:30-10:50 **SunA2.7**

流程模拟嵌套求解模块的混合自动微分框架

张嘉宁 — 浙江大学
胡玉洁 — 工业智能与系统工程研究所
祝慧鑫 — 浙江大学
陈曦 — 浙江大学

2025/07/27 09:10 — 2 楼未央厅

故障检测、诊断与决策 1

主　席: 徐祖华　浙江大学

09:10-09:30 **SunA3.1**

基于 *CEEMDAN-SVD-MEAE* 的抽油机电机声音异常检测

詹汶鑫 — 中国石油大学
李康 — 清华大学
高小永 — 中国石油大学
任桂山 — 中国石油大港油田分公司

09:30-09:50 **SunA3.2**

基于电流基波幅值波动的牵引逆变器故障分类方法

刘紫辉 — 南昌大学
陶宏伟 — 南昌大学
余运俊 — 南昌大学
宋运泉 — 南昌大学
华欣兰 — 南昌大学
龚宇波 — 江西江投数字经济技术有限公司

09:50-10:10 **SunA3.3**

Process monitoring based on Autoregressive-JITL-MSET Method for air separation unit

Yiyang Shou — Zhejiang University
Yan Liu — Zhejiang University
Zuhua Xu — Zhejiang University
JUN ZHAO — zhejiang university
Ruqiang Xue — Hangzhou Oxygen Plant Group Co., Ltd
Kai Wang — Hangzhou Oxygen Plant Group Co., Ltd

2025/07/27 09:10 — 2 楼鸿喜厅

数据驱动建模 1

主　席: 潘天红　安徽大学

09:10-09:30 **SunA4.1**

GammaVAE: Generation of Time-Series Data for Constrained in Fermentation Processes

chengcheng liu — jiangnan university
Zhao Shunyi — JIangnan University
Fei Liu — Jiangnan University, China

09:30-09:50 **SunA4.2**

Battery Inconsistency Detection using K-means Clustering with Center Optimization

Hu Yang — Anhui University
Tianhong Pan — Anhui University
Jiaqiang Tian — Xi'an University of Technology

09:50-10:10 **SunA4.3**

Water Body Remote Sensing Image Augmentation and Eutrophication Prediction Based on Multimodal Fusion of Atmospheric and Water Quality Information

孙艺涵 北京工商大学
王立 北京工商大学
王小艺 北京工商大学
刘载文 北京工商大学

2025/07/27 09:10 **2 楼登云厅**

机器学习算法及应用 1

主　席: 代伟　中国矿业大学

09:10-09:30 **SunA5.1**

Gaussian reinforcement learning for optimal tracking control of unknown systems with random disturbances

Xincheng Li Liaoning Petrochemical University
Yiqing Gang Liaoning Petrochemical University
Jinna Li Liaoning Petrochemical University

09:30-09:50 **SunA5.2**

基于动作注入状态预测模型的强化学习框架及其在路径跟踪中的应用研究

黄道缘 江南大学
杨杰龙 江南大学

09:50-10:10 **SunA5.3**

Template for Preparation of Papers for Chinese Process Control Conference

刘浩然 中国矿业大学
刘艳涛 中国矿业大学
刘鑫 中国矿业大学
南静 中国矿业大学
代伟 中国矿业大学

2025/07/27 10:50 **2 楼长乐厅**

参数估计与系统辨识

主　席: 陈伟锋　浙江工业大学

10:50-11:10 **SunB1.1**

Product Quality Prediction of Deisobutanizer Column Based on Attention Mechanism and Bidirectional Long Short-Term Memory (Bi-LSTM) Network

Zehui Li China University of Petroleum
Renchu He China University of Petroleum

11:10-11:30 **SunB1.2**

基于神经网络无迹卡尔曼滤波的全钒液流电池 *SOC* 估计

曹力丰 太原理工大学
肖舒怡 太原理工大学
任密蜂 太原理工大学
阎高伟 太原理工大学

11:30-11:50 **SunB1.3**

Branch and Bound Identification Method for Time Delay Systems

刘强 浙江工业大学
陈伟锋 浙江工业大学

11:50-12:10 **SunB1.4**

Parameter Transfer identification for NARX model based on sparse Bayesian learning.

Siyuan Li Jiangnan university
Shuang Gao Jiangnan University
Xiaojing Ping Jiangnan University
Xiaoli Luan Jiangnan University, China
Feng Ding Jiangnan University
Fei Liu Jiangnan University, China

12:10-12:30 **SunB1.5**

An Expectation Gradient Descent Samples-Transfer Identification Method for Dynamic Systems with Non-Ideal Data

Yan Huang Jiangnan University
Shuang Gao Jiangnan University
Xiaojing Ping Jiangnan University
Xiaoli Luan Jiangnan University, China
Fei Liu Jiangnan University, China

2025/07/27 10:50 **2 楼长乐厅**

多智能体协同控制 1

主　席: 何大阔　东北大学

10:50-11:10 **SunB2.1**

Observer-Based Active Disturbance Rejection Control for Multi-Agent Leader-Following Consensus via Dynamic Event-Triggered

张奎 四川轻化工大学
何平 华中农业大学
李杰泰 四川轻化工大学
谢锦玮 四川轻化工大学

11:10-11:30 **SunB2.2**

The finite-time distributed formation control of USVs based on FTESO

Lulu Wang Harbin University of Science and Technology
Ao Xu Harbin University of Science and Technology
Ning Yang Harbin University of Science and Technology
Ge Song Harbin University of Science and Technology

11:30-11:50 **SunB2.3**

Multi-Agent Resilient Coverage Control in Unknown Dynamic Environments

Zheyuan Ning	Harbin Institute of Technology
Hao Luo	Harbin Institute of Technology
hao wang	Harbin Institute of Technology
YunFeng Zhang	Harbin Institute of Technology
Yuchen Jiang	Harbin Institute of Technology

11:50-12:10 **SunB2.4**

Observer-based adaptive neural network control for multi-agent systems with input delay and input saturation

li xin	Northeastern University
dakuo he	Northeastern University

12:10-12:30 **SunB2.5**

Distributed Game-Based Dynamic Formation Control and Obstacle Avoidance for Multiple UAVs

Yong Xiao	Northwestern Polytechnical University
Xiaoxiang Hu	inertial technology research center
chen yang	Northwestern Polytechnical University
Bing Xiao	Northwestern Polytechnical University

2025/07/27 11:10 2 楼未央厅

故障检测、诊断与决策 2

主　席: 侍洪波　华东理工大学

11:10-11:30 **SunB3.1**

解决工业故障诊断中的域偏移和类失衡问题的可迁移特征提取方法

张一铭	华东理工大学
侍洪波	华东理工大学

11:30-11:50 **SunB3.2**

化工过程多变量系统的互耦合度与模型失配判别

李炫哲	中国石油大学
范闻轩	中国石油大学
方劲舟	中国石油大学
许锋	中国石油大学

11:50-12:10 **SunB3.3**

面向小样本问题的集成元学习工业过程故障诊断方法研究

陈相池	华东理工大学
侍洪波	华东理工大学
汤思昱	华东理工大学

2025/07/27 11:10 2 楼鸿喜厅

数据驱动建模 2

主　席: 杨慧中　江南大学

11:10-11:30 **SunB4.1**

未知模型下深度 *Koopman* 卡尔曼滤波

肖媛媛	江南大学
徐琛	江南大学
谢莉	江南大学
杨慧中	江南大学

11:30-11:50 **SunB4.2**

TCGA-Net: A Temporal Convolution and GRU Based Dual Attention Network for Multiscale Soft Sensor Modeling

Huanqi Sun	Jiangnan University
WeiLi Xiong	School of Internet of Things Engineering, Jiangnan University
Junxia Ma	Jiangnan University
Xudong Shi	Jiangnan University

11:50-12:10 **SunB4.3**

A Topology-Enhanced Hierarchical Spatio-Temporal Decoupled Attention Architecture for Soft Sensing of Key Water Quality Indicators in Wastewater Treatment

朱红求	中南大学
李宗宸	中南大学
夏斯博	中南大学

2025/07/27 11:10 2 楼登云厅

机器学习算法及应用 2

主　席: 曹雨齐　浙江大学

11:10-11:30 **SunB5.1**

Bone Marrow Cell Classification Based on Multi-scale Feature Fusion

兰倩	江南大学
谢莉	江南大学
杨慧中	江南大学
徐琛	江南大学

11:30-11:50 **SunB5.2**

PatchX-MLP：一种用于 *SCR* 入口 *NOx* 浓度预测的时序预测算法

杨仙林	浙江大学
钱金传	浙江大学
张新民	浙江大学
宋执环	浙江大学

11:50-12:10 **SunB5.3**

A Study on Spartina Alterniflora Monitoring Method Based on Deep Learning and UAV Images

Ziang Li	Zhejiang University
Baiyu Zhu	Zhejiang university
Pingjie Huang	Zhejiang University
Hongjian Zhang	Zhejiang University
Yuqi Cao	Zhejiang University

2025/07/27 13:30 3 楼金江厅
工业过程管理与决策系统

主　席: 潘冬　中南大学

13:30-13:50 **SunC1.1**

Research on multi-objective optimization method for continuous casting and hot rolling production scheduling

华明清	中南大学
蒋朝辉	中南大学
潘冬	中南大学自动化学院
余浩洋	中南大学
桂卫华	中南大学

13:50-14:10 **SunC1.2**

Optimization scheduling of electrolytic copper foil production process based on hierarchical genetic algorithm

赵宣茗	中南大学
裘智峰	中南大学
孙思祖	中南大学
黄大建	中南大学

14:10-14:30 **SunC1.3**

Optimization of Integrated Energy System Scheduling Based on Multi-Strategy Collaborative Presolve Approaches

贾健	浙江工业大学
陈伟锋	浙江工业大学

14:30-14:50 **SunC1.4**

数据与机理融合的换热网络基准能效建模与监测

张哲	中国石油大学
孙琳	中国石油大学
罗俊	中国石油大学

14:50-15:10 **SunC1.5**

A Multi-Parameter Fusion Intelligent Decision-Making Framework for Mixed Oil Cutting

Huajun Xu	China University of Petroleum
YONG LI	China petroleum pipeline engineering corporation
Tao Wang	China Petroleum Pipeline Engineering Corporation
Jinghao Guo	Beijing Research Institute of Building Materials Science and Technology
Xiaoyong Gao	China University of Petroleum

2025/07/27 13:30 2 楼长乐厅
多智能体协同控制 2

主　席: 王标　沈阳航空航天大学

13:30-13:50 **SunC2.1**

Simulated Annealing-Optimized Artificial Potential Field Method for Multi-Agent Collision Avoidance

Liu Xianghang	Lanzhou University of Technology
Aimin An	Institute of Electrical Engineering and Information Engineering, Lanzhou University of Technology

13:50-14:10 **SunC2.2**

Trajectory Tracking Control for Flexible Manipulator Based on Combined Neural Network Control

yongquan Li	Lanzhou University of Technology
Aimin An	Institute of Electrical Engineering and Information Engineering, Lanzhou University of Technology

14:10-14:30 **SunC2.3**

基于深度强化学习的无人机空战自主决策方法研究

周铭哲	沈阳航空航天大学
刘利智	沈阳航空航天大学
孟光磊	沈阳航空航天大学
王标	沈阳航空航天大学

14:30-14:50 **SunC2.4**

A Hierarchical Framework for Event-Triggered Fault-Tolerant Consensus Control of Multi-Agent Systems Under DoS Attacks

Yunan Qu	Jiangnan University
Xiaoli Luan	Jiangnan University, China
Haiying Wan	Jiangnan university
Fei Liu	Jiangnan University, China

2025/07/27 13:30 2 楼未央厅
故障检测、诊断与决策 3

主　席: 刘峥　北京工业大学

13:30-13:50 **SunC3.1**

Few-shot Fault Diagnosis for Electric Submersible Pump Based on Transformer-enhanced Prototypical Network

Liang Cheng Wang	China University of Petroleum, Beijing
Kang Li	China University of Petroleum-Beijing
Xiaoyong Gao	China University of Petroleum

13:50-14:10 **SunC3.2**

基于融合特征迁移的污水处理膜污染零样本故障诊断

蔡国庆	北京工业大学
刘峥	北京工业大学
韩红桂	北京工业大学

14:10-14:30 **SunC3.3**

Cascading Failure-Oriented SGC Critical Topology Identification for Renewable Energy Grids

Min Yin	Shanxi University
Xiaomin Wang	Shanxi University
Jianrong Wang	Shanxi University
Xinchun Jia	Shanxi University
Yunfei Xie	Shanxi University
Yuhang Wang	Shanxi University

2025/07/27 13:30 2 楼鸿喜厅

数据驱动建模 3

主　席: 陶宏伟　南昌大学

13:30-13:50 **SunC4.1**

Individual Thermal Comfort Assessment Based on Infrared and Linear Skin Temperature Data-driven Modeling

向晓争	南昌大学
胡嘉文	南昌大学
万晓凤	南昌大学
余运俊	南昌大学
郑志斌	南昌大学
陶宏伟	南昌大学
张欢	南昌大学

13:50-14:10 **SunC4.2**

Learning Spatiotemporal Dependencies for Time Series Imputation via Adaptive Multi-task Gradient Guidance

guodong Li	central south university
yalin wang	central south university
Chenliang Liu	Central South University
Jiang Luo	Central South University
Yitao Chen	Central South University
Hongrui Liu	Central South University

14:10-14:30 **SunC4.3**

Optimization of Structural Parameters of Multi-step Prediction Neural Network Based on Sequence Similarity Evaluation

Jiawang Zheng	China University of Petroleum-Beijing
Zhu Wang	China University of Petroleum

14:30-14:50 **SunC4.4**

A Study on the Modeling and Prediction Method of the FCC Fractionation System Based on ISSA-AM-LSTM

Shaowei Han	China University of Petroleum
Jingjing Han	Zhongshi Intelligent Control
Jun Tong	ZhongShi x-Conreol Technology CO., Ltd, Beijing
Xiaoyong Gao	China University of Petroleum

2025/07/27 13:30 2 楼登云厅

机器学习算法及应用 3

主　席: 朱红求　中南大学

13:30-13:50 **SunC5.1**

基于 *VMD-ALA-Transformer-BiLSTM* 的短期风电功率预测模型

侯益明	中国石油大学
叶昌燕	华电科工股份有限公司
高小永	中国石油大学

13:50-14:10 **SunC5.2**

基于 *ACE-Match* 的伪标签生成方法及在文本分类中的应用

钟国亮	中南大学
李勇刚	中南大学
王金峰	中南大学
朱红求	中南大学

14:10-14:30 **SunC5.3**

基于 *ECI-YOLO* 的浅近水域目标检测算法

崔山虎	北京石油化工学院
顾飞	北京石油化工学院
杨益	北京石油化工学院
刘晓生	北京石油化工学院
徐文星	北京石油化工学院
朱群雄	北京化工大学

14:30-14:50 **SunC5.4**

Online Accelerated Gradient Algorithm Based on Typical Samples for Self-Organizing RBF Neural network

YanNi Su	Beijing Institute Of Petrochemical Technology
Miaoli Ma	Beijing Institute Of Petrochemical Technology
Bin Wang	Beijing Institute of Petrochemical Technology
Zhaofeng Zhao	Beijing Institute of Petrochemical Technology

2025/07/27 13:30 2 楼百瑞厅

优化控制

主　席: 段敬业　四川轻化工大学

13:30-13:50 **SunC6.1**

基于自适应动态策略差分算法的研究与应用

汪奇	四川轻化工大学
谭飞	四川轻化工大学
熊兴中	四川轻化工大学
段敬业	四川轻化工大学

13:50-14:10 **SunC6.2**

Multi-Objective Optimization Method for Optimal Excitation Parameters of Controllable Active Seismic Source

洪利	防灾科技学院
田可文	防灾科技学院
张强	防灾科技学院
张晓东	中国石油大学
刘哲	浙江大学

14:10-14:30 **SunC6.3**

Optimization Method for Hammer Impact Excitation of Controllable Active Seismic Source

洪利	防灾科技学院
郭宏鑫	防灾科技学院
张强	防灾科技学院
张晓东	中国石油大学
刘哲	浙江大学

14:30-14:50 **SunC6.4**

基于狐猴多目标优化和最优速度障碍法的无人机三维路径规划

张超	郑州航空工业管理学院
汤谦	郑州航空工业管理学院
王敬宇	郑州航空工业管理学院
方鑫	郑州航空工业管理学院
张静蕊	郑州航空工业管理学院

2025/07/27 13:30 3 楼岷江厅

容错控制与可靠控制

主　席: 许锋　中国石油大学

13:30-13:50 **SunC7.1**

考虑执行器失效的选择性控制系统设计

孔汝成	中国石油大学
张晓萌	中国石油大学
黄佳宇	中国石油大学
许锋	中国石油大学

13:50-14:10 **SunC7.2**

Reliability Analysis of Nuclear Power Plant Reactor Protection System Based on Bayesian Network

Kaiyue Ma	Zhejiang University
tong guan	Zhejiang University
Zhiyuan Zhang	Zhejiang University
Yinxiao Zhan	Zhejiang University
jun liang	Zhejiang University

14:10-14:30 **SunC7.3**

基于最优基准区间 -自适应匹配路径的 *Lamb* 波温度补偿方法

邱永健	齐鲁工业大学
吕珊珊	齐鲁工业大学
张劭宇	齐鲁工业大学

2025/07/27 15:10 3 楼金江厅

工业智能控制与智能制造

主　席: 陈曦　浙江大学

15:10-15:30 **SunD1.1**

基于 *DT-PPO* 算法的机械臂逆运动学求解方法

杨春雨	中国矿业大学
李志鑫	中国矿业大学
赵悦宏	中国矿业大学
顾心仪	中国矿业大学

15:30-15:50 **SunD1.2**

Research on Workpiece Recognition and Robot Grasping Technology Based on Improved YOLOv8 and Binocular Vision

刘宝	中国石油大学
刘天宝	中国石油大学
胡仲硕	中国石油大学
梁福学	青岛隆利福机械科技有限公司

15:50-16:10 **SunD1.3**

Design of Adaptive Controller Based on BP Neural Network and Internal Model Control

林忠凯	温州大学电气与电子工工程学院 1 号楼 1B-415B
张正江	温州大学
严俊鹏	温州大学
陈冲	温州大学
吴龙杰	温州大学
朱志亮	温州大学

16:10-16:30 **SunD1.4**

基于联立方程的聚合反应过程模拟软件

林晓文	浙江大学
焦申华	浙江大学
陈曦	浙江大学

2025/07/27 15:10 2 楼长乐厅

机器视觉与无人系统

主　席: 黄玉水　南昌大学

15:10-15:30 **SunD2.1**

Gait Recognition Method Based on Fusion of Gait Silhouette and 2D Skeletal Features

Binghan Zhan — Sichuan University of Science and Engineering
Xiaogang wang — Sichuan University of Science Engineering
Keyu Chen — Sichuan University of Science Engineering
Zhiwei Yin — Sichuan University of Science Engineering
Renjie Zou — SUSE

15:30-15:50 **SunD2.2**

基于改进 *YOLOv8n* 的破碎大豆颗粒实例分割算法

杨春雨 — 中国矿业大学
胡子扬 — 中国矿业大学

15:50-16:10 **SunD2.3**

A Non-intrusive Thermal Comfort Prediction Method Integrating RGB Images and Human Pose Keypoints

余运俊 — 南昌大学
郑志斌 — 南昌大学
向晓争 — 南昌大学
陶宏伟 — 南昌大学
黄玉水 — 南昌大学
胡嘉文 — 南昌大学

16:10-16:30 **SunD2.4**

基于 *Transformer* 的冻干粉缺陷检测模型

张维 — 清华大学
饶水辉 — 清华大学
熊智华 — 清华大学
叶昊 — 清华大学

2025/07/27 15:10 2 楼未央厅

故障检测、诊断与决策 4

主　席: 彭鑫　华东理工大学

15:10-15:30 **SunD3.1**

A Novel Diffusion Generation Model for Chip Edge Detection

黄嘉庆 — 中南大学
贺建军 — 中南大学
陈致蓬 — 中南大学

15:30-15:50 **SunD3.2**

Multi-Source Domain Transfer Learning with Feature Fusion for Fault Diagnosis

Haoze Li — University of Science and Technology Beijing
Jiahao Wang — University of Science and Technology Beijing
Linlin Li — University of Science and technoloty Beijing
Xin Peng — East china university of science and technology
Maiying Zhong — Shandong University of Science and Technology

15:50-16:10 **SunD3.3**

A Bearing Fault Diagnosis Algorithm Incorporating Time-Frequency Analysis and Sparse Swin Transformer

Zihan Xu — Beijing University of Chemical Technology
Jinhao Ge — Beijing University of Chemical Technology
Haoqian Wang — Beijing University of Chemical Technology
Sheng Gao — Beijing University of Chemical Technology
Xin Ma — Beijing university of chemical technology
Youqing Wang — -
Rui Fan — Zhongdian Herui Technology Co., Ltd

16:10-16:30 **SunD3.4**

Few-shot Learning Photovoltaic Fault Diagnosis Based on PCA-TirTCN

Yanbo Jian — Lanzhou University of Technology
Aimin An — Institute of Electrical Engineering and Information Engineering, Lanzhou University of Technology

2025/07/27 15:10 2 楼鸿喜厅

过程数据分析与建模

主　席: 马君霞　江南大学

15:10-15:30 **SunD4.1**

基于动态图卷积网络的半监督软测量建模方法

杜康萍 — 江南大学
史旭东 — 江南大学
马君霞 — 江南大学
熊伟丽 — 江南大学物联网工程学院

15:30-15:50 **SunD4.2**

有色冶金过程多视角生产知识融合表征方法

邓一凡	中南大学
阳春华	中南大学
李勇刚	中南大学
朱红求	中南大学
孙备	中南大学

15:50-16:10 **SunD4.3**

Adaptive Causal Inference Spatio-Temporal Graph Convolutional Networks for Correlation Modeling in Disjunction Processes

Chenhao Ren	Beijing University of Technology
Honggui Han	Beijing University of Technology
Fangyu Li	Beijing University of Technology
Zheng Liu	Beijing University of Technology

2025/07/27 15:10 2 楼登云厅

机器学习算法及应用 4

主　席: 倪雨青　江南大学

15:10-15:30 **SunD5.1**

A Hybrid Model for Few-Shot Attribute Extraction Using Prototypical Networks and k-Nearest Neighbors

Taiyu zhang	Jiangnan University
Yuqing NI	Jiangnan University
Ziyang Guo	Hong Kong University of Science and Technology

15:30-15:50 **SunD5.2**

An Edge Detection Algorithm of the Improved Canny Operator

bowen zhang	Sichuan University of Light Industrial Technology
Shiyong Yang	Sichuan University of Science Engineering
Chunlan Luo	Yibin College
hongping pu	University of Electronic Science and Technology of China

15:50-16:10 **SunD5.3**

Improving NOX Emission Prediction in SCR Systems via Continual Learning under Dynamic Operating Conditions

Peng Chen	China University of Petroleum
Xu Baochang	College of Information Science and Engineering, China University of Petroleum, Beijing
Wei He	China National Petroleum Corporation
Hongtao Hu	China University of Petroleum

16:10-16:30 **SunD5.4**

Uncertainty-Aware Soft Sensor with Dual-Branch Modeling Architecture

Yongjing Wang	Zhejiang University
Bocun He	Zhejiang University
Xinmin Zhang	Zhejiang University
Zhihuan Song	Zhejiang University
Zhijiang Shao	Zhejiang University

2025/07/27 15:10 2 楼百瑞厅

信息物理系统

主　席: 王焕钢　清华大学

15:10-15:30 **SunD6.1**

Analysis and Simulation for Multiple Resonant-Point Phenomena in Complicated Power Transfer System

郭樾垚	清华大学
熊智华	清华大学
王焕钢	清华大学
杨耕	清华大学

15:30-15:50 **SunD6.2**

A High-Precision Reference Source Design With Exponential Curvature Compensation

魏元红	四川轻化工大学
何平	华中农业大学
罗和平	电子科技大学

15:50-16:10 **SunD6.3**

Recursive State Estimation With Self-Energized Relays: Integrating Parameter Design for Simultaneous Information and Wireless Power Transfer

Jiahao Song	Tsinghua University
Zidong Wang	Brunel University London
Xiao He	Tsinghua University

16:10-16:30 **SunD6.4**

Event-triggered Prescribed Performance Model-free Adaptive Sliding-mode Control for Robot Arm with Data Dropouts

Changxiao Ma	Jiangnan university
Huarong Zhao	Jiangnan University
Dezhi Xu	Southeast University
Zhengdao Zhang	Jiangnan University
Li Peng	Jiangnan University

2025/07/27 15:10 3 楼岷江厅

人工智能与智能机器人

主　席: 胡嘉文　南昌大学

15:10-15:30 **SunD7.1**

Microrobot Actuation Modeling by Angle Constraints and Infinity-Norm Current Optimization

Yanbo Hua — Jiangnan University
Haiying Wan — Jiangnan university
Xiaoli Luan — Jiangnan University, China
Fei Liu — Jiangnan University, China

15:30-15:50 **SunD7.2**

Dynamic Modeling and Focus Control of a Piezo-Actuated Liquid Tunable Lens

段增鸿 — 东北大学

15:50-16:10 **SunD7.3**

基于粘滑原理的介电弹性体驱动机器人眼球

于辰 — 东北大学

复杂工业过程控制与优化 1

时间: 2025/07/26 15:20 **主 席: 杨春雨 中国矿业大学**

地点: 2 楼长乐厅

15:20-15:40 **SatA1.1**

Two-point coupled control of residual chlorine during tap water disinfection in response to sudden contamination

杨亚岚, 安剑奇, 张顺, 熊嘉豪
(中国地质大学)

This paper addresses the control challenges associated with sudden ammonia nitrogen contamination in raw water by designing a two-point coupled control method for residual chlorine in the drinking water disinfection process. This method effectively controls residual chlorine concentrations by leveraging the distinct mechanistic characteristics of the pre-chlorination and mid-chlorination stages. During the pre-chlorination control stage, considering the complexity and nonlinear characteristics of residual chlorine consumption caused by raw water quality pollution, this paper designs a pre-chlorination self-disturbance controller that integrates a nominal model with time-delay input. This is combined with a raw water quality state classification expert system, a feedforward controller based on the nominal model of residual chlorine changes during pre-chlorination under raw water quality pollution conditions, and an extended state observer with time-delay input. The water quality state classification expert system is used to identify the raw water quality state, the feedforward controller is used for compensation dosing, and the expanded state observer with time-delay input is used to estimate disturbances caused by sudden pollution, enabling dynamic adjustment of sodium hypochlorite dosing control parameters to quickly and accurately respond to the impact of sudden raw water quality pollution. During the intermediate chlorination control stage, to achieve supplementary disinfection for the pre-chlorination stage and ensure the stability of residual chlorine concentration in the clear water tank, this paper designs a feedforward dynamic compensation-adaptive PID intermediate chlorination feedback controller. By combining feedforward information from the pre-chlorination stage with residual chlorine feedback information from the intermediate chlorination stage, coupled control is employed to suppress the impact of sudden water quality pollution.

15:40-16:00 **SatA1.2**

基于双线性预测控制的 *PID* 控制器参数整定

许锋, 李炫哲, 李剑, 梁栋
(中国石油大学)

PID 控制器在现代工业过程控制中占据着重要位置，其控制品质取决于 PID 参数。本文提出了一种基于双线性预测控制方法以实现单输入单输出系统和多输入多输出系统 PID 控制器参数整定，基于单变量和多变量系统闭环 PID 控制系统的双线性状态空间模型，通过状态反馈预测控制（SFPC）策略，以各回路 PID 控制器的比例、积分、微分系数为操纵变量，以未来某段时域内的预测偏差最小为目标函数，滚动优化求解各回路 PID 控制器的比例、积分、微分参数。最后，利用 Matlab 软件仿真两个实例表明该方法是一种计算简单、跟踪性能好、误差较小的整定方法。

16:00-16:20 **SatA1.3**

基于相对增益阵和优先级的过程系统操作优化

初文鹤, 肖勇湘, 许锋
(中国石油大学)

实际化工过程难以建立精确的数学模型，采用求解最优化问题的方法来处理操作优化问题，只能理论上保证经济性能的最优，优化结果可能与实际情况不相符且难以实现。现场操作人员进行操作优化往往侧重于化工过程“更优”而非“最优”，且一般只需根据关键约束调整若干操作变量，即可确定出较为优化的操作点。本文基于对约束变量的保护，将操作变量划分优先级，将多变量过程系统优化问题转变成多个依次进行的单变量调节过程，并以串联反应釜为例验证了该优化方法的有效性。研究结果显示，与传统的求解最优化问题的方法相比，本文方法虽然略微牺牲经济性能，但不依赖系统精确的数学模型，且优化过程直观明了，各变量的变化情况和变化趋势清晰可见，具有更强的操作性。

16:20-16:40 **SatA1.4**

基于状态空间模型的常规控制回路配对方法

张晓萌, 方劲舟, 许锋
(中国石油大学)

基于线性状态空间模型，针对每个状态与输入输出之间的关联，提出了一种基于内部状态空间模型的控制回路配对方法。通过状态变量来分析输入输出之间的关联强弱程度。由输入对状态的可控性矩阵和状态对输出的可观性矩阵推导输入对输出的相对增益阵，确定输入输出的控制回路配对，实现多变量常规 PID 控制系统结构设计。

16:40-17:00 **SatA1.5**

数据丢包场景下磨矿过程多速率分层逆优化控制

任鹏旭, 代伟, 张淇瑞, 杨春雨
(中国矿业大学)

磨矿过程的运行优化控制通常采用基础回路控制层和运行控制层双层结构, 由于被控对象的特性、各检测装置采样周期的不同, 导致层级之间以及控制回路内部普遍存在多速率问题. 同时, 运行控制层机理复杂难以用数学模型进行描述，且网络环境下可能存在反馈信息丢包现象. 此外, 传统方法中性能指标权重参数一般由人工试错设定, 设置不当会严重影响控制性能. 针对上述多速率与

数据丢包并存的复杂磨矿过程运行优化控制问题, 本文提出一种基于逆向强化学习的多速率丢包逆优化控制方法. 该方法利用提升技术解决时间尺度不一致的问题, 在史密斯预估器对丢包数据进行预测的基础上, 采用一种基于逆向强化学习的数据驱动优化控制方法, 从磨矿过程的演示运行数据中学习重构性能指标权重参数, 进而依据重构的性能指标优化求解基础回路设定值. 理论分析和工业应用验证了所提方法的有效性.

17:00-17:20 **SatA1.6**

基于双网络辅助状态图重构 *DDPG* 算法的三相蓄热式热力氧化炉优化控制策略

李大字, 刘子龙
(北京化工大学)

蓄热式热力氧化炉（Regenerative Thermal Oxidizer, RTO）是一种常用于工业有机废气治理的装置，能够通过高温氧化将挥发性有机化合物（Volatile Organic Compounds, VOCs）转化为无害的二氧化碳和水。三相 RTO 系统结构复杂，输入输出变量高度耦合，传统控制方法难以有效应对其动态变化，难以实现理想的控制性能。针对这一问题，本文提出了一种基于双网络辅助状态图重构 DDPG(Deep Deterministic Policy Gradient) 算法的三相蓄热式热力氧化炉控制优化策略。该方法通过两个独立的神经网络分别学习主控制目标与辅助控制目标，同时基于图结构对系统状态进行重构，增强状态特征的表达能力。改进后的 DDPG 算法可在连续动作空间内实现对阀门开度的智能调整，精准跟踪并实时调控 RTO 关键状态量。实验结果表明，该方法不仅能够稳定实现温度控制目标，还有效降低了系统燃油消耗，显著提升了能源利用效率。

17:20-17:40 **SatA1.7**

Multi-Physics Coupled Energy Consumption Modeling for Direct Seawater Electrolysis Hydrogen Production process

于康, 安剑奇, 李胜军, 李丹阳
(中国地质大学)

Direct seawater electrolysis represents a promising route for green hydrogen production, effectively alleviating the freshwater resource constraints inherent to conventional water electrolysis. However, its industrial adoption is challenged by the complex composition of seawater, tightly coupled multi-physics phenomena, and high energy consumption under dynamic operating conditions. To address the excessive energy demand in the direct seawater electrolysis process, this paper presents a multi-physics-coupled mathematical model for DC energy consumption that systematically elucidates the key mechanisms of energy loss and enables energy-efficient operation and system optimization. First, by incorporating corrections for Faradaic efficiency, thermal balance, and gas recovery rate, an analytical expression for specific DC energy consumption is derived. Next, a two-dimensional seawater electrolyzer model is implemented in COMSOL Multiphysics, coupling electrochemical reactions, electric field distribution, gasliquid two-phase flow, ion transport, and heat transfer to achieve integrated electro-thermal-chemical-fluid simulation. Using this model, the effects of operating temperature, system pressure, and electrolyte concentration on the cell voltage are investigated. The results provide practical guidance for adjusting electrolyzer operating conditions, reducing energy consumption, and enhancing the viability of direct seawater electrolysis for hydrogen production.

17:40-18:00 **SatA1.8**

Design of Single-Phase Power Inverter System Based on Model-Free Adaptive Control

严俊鹏, 张正江, 陈冲, 吴龙杰, 朱志亮
(温州大学)

Inverters, which convert direct current (DC) to alternating current (AC), are widely used in new energy systems such as photovoltaic and wind power generation. Traditional control methods rely on precise system models. However, the nonlinearity of the system, parameter uncertainties, and external disturbances make it difficult for these methods to achieve ideal performance in practical applications. To address this challenge, this paper proposes a control strategy for single-phase power inverters based on model free adaptive control (MFAC) combined with dynamic data reconciliation (DDR) filtering technology. The proposed method estimates system parameters in real time using input-output data, thereby avoiding the complexity of traditional modeling and effectively handling the system's nonlinearity and uncertainties. Moreover, the integration of DDR filters effectively suppresses measurement noise, enhancing the system's dynamic response and stability. Simulation results demonstrate the superiority of this control method under various noise interferences. The findings show that the MFAC-based control strategy significantly improves the control accuracy and stability of the inverter system. This study provides a new approach for the efficient control of power inverters and offers theoretical support for the control design of complex inverter systems.

复杂工业过程控制与优化 2

时间: 2025/07/26 15:20 **主 席: 安爱民 兰州理工大学**

地点: 2 楼未央厅

15:20-15:40 **SatA2.1**

An Extended Data-Driven Quality Optimization Method for Injection Molding Based on Large Language Models

HaiPeng Zou ,Yuxuan Xie ,Xiaoyu Li ,Ke Yao ,Xiangsong Kong
(Xiamen University of Technology)

Injection molding remains the most widely used polymer processing method in modern manufacturing. The quality of injection-molded products is influenced by the complex interplay of multiple parameters, encompassing both process settings and control settings, making the optimization of quality control performance a critical challenge. The quality control process in injection molding can be conceptualized as an iterative search procedure for optimal process parameter settings. Conventional quality control approaches predominantly rely on quality feedback data derived from either process models or real-world manufacturing operations during these iterative cycles. However, substantial repositories of text-based engineering expertise and operational rules in the injection molding quality control domain remain underutilized. The failure to effectively leverage these domain-specific knowledge poses a significant constraint on advancing the efficiency of quality control methodologies. To address this challenge, an Extended data-driven optimization framework based on large language model (LLM-EDO), which systematically integrates textual expertise, process models, and operational data holistically, is proposed. Leveraging advances in artificial intelligence (particularly large language model architectures) and data-driven optimization, this methodology synthesizes multi-source, heterogeneous, and multimodal manufacturing data. The framework incorporates an offline-online dual-channel data collaboration architecture and a feature-alignment-driven text-numeric cross-modal fusion mechanism, enabling knowledge extraction from multi-source heterogeneous data streams, optimization decision-making, and dynamic adaptation to complex production environments. This method is validated through comparative experiments to demonstrate its effectiveness.

15:40-16:00 **SatA2.2**

Dynamic Modeling of Arsenic Removal Process in Copper Electrolyte Purification Based on Electrodeposition Decontamination Technology

Yixiao Ding ,Aimin An
(Pengjiaping Campus of Lanzhou University of Technology)

Copper electrolyte purification is a key step in the wet metallurgy process to produce high-purity cathode copper. Among them, the electrodeposition desulfurization process, due to its high efficiency and low pollution characteristics, has become the mainstream technology for the removal of arsenic. This paper focuses on the complex characteristics of the dynamic coupling between copper and arsenic ions in the electrodeposition desulfurization process. Based on the continuous stirred tank reactor (CSTR) model, a nonlinear dynamic mechanism model was constructed, taking into account the combined influence of electrochemical reaction kinetics, thermodynamic equilibrium, and process parameters (such as current density, flow rate, copper-arsenic concentration ratio). The model parameters were optimized using the sequential quadratic programming (SQP) algorithm, achieving precise predictions of ion concentrations and temperatures in the reactor (copper ion concentration prediction R = 0.983, arsenate R = 0.944). The simulation results show that the dynamic regulation of copper ion concentration and current density in the electro-deposition desulfurization process is the core factor for improving arsenic removal efficiency, and the stepped flow distribution can effectively inhibit the generation of arsenic hydride gas. This research provides theoretical basis and dynamic control strategies for the industrial optimization of the electro-deposition desulfurization process, improving the quality of cathode copper and production safety.

16:00-16:20 **SatA2.3**

Multivariable Model Predictive Control of Wastewater Treatment Process Based on EKF

Tao Chang ,Aimin An
(Lanzhou University of Technology)

In order to improve the operating performance of urban sewage treatment plants, optimize the effluent quality and improve the operating costs. This paper proposes a multivariable model predictive control method for sewage treatment process based on extended Kalman filter (EKF). First of all, since the sewage treatment process is an extremely complex, uncertain, nonlinear and strongly coupled system, it is very difficult to design a control system using its process model. Therefore, based on the analysis of the sewage treatment process model, a simplified model of the biochemical reaction process of sewage treatment is established; secondly, a multivariable model predictive control method for sewage treatment process based on EKF is designed using the simplified model. The tracking performance of dissolved oxygen concentration and nitrate nitrogen concentration is maintained

by adjusting the two key variables oxygen transfer coefficient and internal recirculation flow in the sewage treatment plant; finally, the proposed method is verified in the benchmark simulation model 1 (BSM1). The simulation results show that the method can achieve the control requirements, improve the effluent quality and reduce the operating energy consumption.

16:20-16:40 **SatA2.4**

Distributed Model Predictive Control for BOG Treatment System in LNG Receiving Terminal

刘智举, 李少远, 郑毅, 黄猛
(上海交通大学)

Liquefied Natural Gas (LNG) inevitably generates Boil Off Gas (BOG) during transportation and storage, necessitating rational recovery and utilization. Traditional BOG treatment processes suffer from high energy consumption and energy waste, especially under low export conditions. We take a domestic LNG receiving terminal as the research object and propose a Distributed Model Predictive Control (DMPC) for the recondensation process in BOG treatment. The approach ensures the safe operation of storage tanks, recondenser, and high-pressure pumps, optimizes compressor operation, reduces compressor load switching frequency and energy consumption, and increases BOG recovery in the recondensation process under low export conditions by elevating recondenser pressure to provide a temperature rise margin for LNG at the high-pressure pump inlet, thereby enhancing the terminal's operational benefits. The proposed DMPC algorithm decomposes the BOG compressor and recondenser into two subsystems for independent control: Subsystem Controller 1 considers the impact of compressor load on storage tank pressure and LNG temperature at the high-pressure pump inlet. By incorporating a compressor energy consumption term into the loss function and using a modified compressor load sequence generation strategy to accelerate integer programming problem solving, it optimizes BOG compressor loads. Subsystem Controller 2 controls recondenser pressure and liquid level by adjusting spray flow rate and liquid level valve opening. It introduces time-varying constraints to calculate the time-varying lower limit of recondenser pressure based on LNG temperature at the high-pressure pump inlet, ensuring the LNG pressure exceeds the saturation vapor pressure. The DMPC algorithm is validated on the K-Spice digital twin platform. Results show that the method maintains stable operation of storage tanks and recondensers, optimizes compressor performance, and significantly increases BOG processing capacity in the recondensation process under low export conditions, bringing greater economic benefits to the receiving terminal.

16:40-17:00 **SatA2.5**

Intelligent Learning-Based Distributed Predictive Operational Optimization Control for Rotary Kiln of Calcination

郑毅, 孟巡, 杨林乐, 李少远
(上海交通大学)

回转窑作为钢铁冶金行业中用于焙烧生产活性石灰、轻烧白云石等关键冶金辅料的核心设备，其工艺效能直接影响炼钢过程中的脱磷脱硫效率、钢水纯净度以及转炉性能，针对回转窑焙烧这过程中原料质量波动引起的工况变化、产品的质量指标波动、以及高负荷运行产生的特殊工况的适应性问题，提出基于学习的优化、分布式预测控制及基于知识的控制决策的全过程智能优化控制方案，并提出设计相应具有性能保证的算法，进行了仿真分析。所提出的方法应用于我国某钢厂的焙烧过程，验证了该方法的控制优化性能和节能、保增产的有效性。

17:00-17:20 **SatA2.6**

基于渐进算法的复杂工业过程非凸鲁棒优化方法

张恩泽, 褚菲, 张勇, 李会军, 王军
(中国矿业大学)

复杂工业过程的鲁棒优化是指在面对复杂工业过程中的不确定性、干扰和模型不精确性时，以运筹学、控制论等为基础，基于鲁棒性分析、数学规划等方法，利用数据分析、机器学习等技术，确保系统的稳定性与经济性。由于该问题本身的复杂性（非凸性），使得传统鲁棒优化方法不能得到良好的优化效果，进行复杂工业过程非凸鲁棒优化的研究具有重要的理论意义与实际价值。最优化理论中的渐进算法是一类通过逐步更新来逼近最优解的算法，通过迭代的方式逐步改进解，能够有效处理大规模优化问题。本文针对不确定环境下复杂工业过程的鲁棒优化问题，基于渐进算法提出一种非凸鲁棒优化方法，该方法能有效解决非凸性对复杂工业过程鲁棒优化带来的影响，在提高收敛效率的同时保证系统的全局最优性。具体而言，我们用变分贝叶斯网络对复杂工业过程进行回归分析，得到优化代理模型，并结合 Barrier 函数将优化模型改写为无约束优化模型，在进行鲁棒对偶分析后，根据已知的凸函数优化结果及相应算法构造新的渐进算法，基于最优性收敛条件对无约束非凸优化问题进行收敛性分析，最后通过数值算例及在煤泥浮选过程中进行实验，验证了我们提出方法的有效性和优越性。

17:20-17:40 **SatA2.7**

基于 *Q* 学习的延时系统无模型最优跟踪控制

王心雁,Jialu Fan , 庞文砚
(东北大学)

在现代工业控制系统中，输入延时现象广泛存在于实际的信号传输、执行器响应及网络控制系统中，严重影响系统的稳定性。传统的最优控制方法依赖于系统动力学模型，但在复杂或不确定环境中，往往很难或不可能获得精确模型。因此，如何在未知系统模型的前提下实现延时系统的最优跟踪控制，成为控制理论与强化学习交叉领域的一个关键挑战。这一问题的解决不仅具有重要的理论价值，也为工业过程控制、智能制造等领域提供了技术支撑。°，即在不依赖系统动力学信息的情况下，通过数据驱动方式求解最优控制策略。基于强化学习框架，本文提出了两种无模型 Q 学习控制算法，分别为同策略（on-policy）和异策略（off-policy）方法。首先，为补偿输入延时对系统稳定性的影响，引入 Smith 预测器，通过历史测量数据对未来状态进行估计。在此基础上，提出 on-policy Q 学习算法，构建 Bellman 方

程与 Hamilton 函数，利用策略迭代在仅使用输入输出数据的条件下学习最优控制策略。进一步针对 on-policy 方法受限于探测噪声对持久激励（PE）条件的要求，提出 off-policy Q 学习算法，通过辅助变量构造等价 Bellman 方程，在噪声干扰下实现无偏估计。两种算法均采用数据批处理与最小二乘实现参数学习。。，两种无模型算法在无延时和有延时系统中均表现出良好的收敛性与跟踪性能，尤其是 off-policy 算法在不同噪声类型下保持了更低的误差范数。实验结果表明，所提算法能有效逼近理论最优解，且在无须系统状态信息的前提下保持稳定控制性能。相比传统基于模型的控制方法，本文无模型控制方法更具鲁棒性，尤其在探测噪声存在时，off-policy 算法展现出比 on-policy 更优的学习稳定性与泛化能力。这与现有的多数研究未处理输入延时问题或对系统模型依赖程度较高的局限性形成对比。。，本文提出的两种基于 Q 学习的无模型最优跟踪控制方法，有效地解决了具有输入延时系统的最优控制器设计问题，为数据驱动控制方法在实际工业场景中的应用提供了理论与方法支持。其中，off-policy 算法可在未知系统结构和探测噪声扰动条件下获得稳定、无偏的控制策略，展示出广泛的实用潜力。该研究为强化学习算法在延时系统、。自适应控制与智能制造系统中的应用提供了新思路。。，本文的主要研究成果包括：1) 针对输入延时问题，提出了结合 Smith 预测器的无模型强化学习控制框架；2) 构建了 on-policy Q 学习算法，该方法考虑了输入延时问题，只使用实测数据学习控制策略而不需要系统模型信息，同时给出了稳定性和收敛性的严格证明；3) 创新性地提出了 off-policy Q 学习算法用于具有输入延时系统的最优跟踪控制，该方法不仅不需要系统模型，且不受探测噪声的影响也可计算无偏控制策略，并给出了该方法收敛性的严格证明。

17:40-18:00 **SatA2.8**

路径约束非线性切换系统的混合智能动态优化方法

李欢, 付俊, 柴天佑
(东北大学)

For the optimal control problem of path-constrained nonlinear switched systems, existing methods often fail to simultaneously guarantee the global optimality of the solution and the strict satisfaction of constraint conditions. To address this issue, this paper proposes a hybrid intelligent optimisation method that combines dual-objective particle swarm optimisation (PSO) and gradient descent (GD) strategies, effectively overcoming the technical bottlenecks of traditional deterministic optimisation methods prone to local optima and heuristic algorithms struggling to strictly satisfy path constraints. First, Control Vector Parameterisation (CVP) technology and Switching-Time Parameterisation (STP) methods are employed to transform the infinite-dimensional discrete dynamic optimisation problem into a finite-dimensional continuous optimisation problem; Then, path constraints in the switched system are discretised, converting them into a series of discrete point constraints. A relaxation factor Epsilon is introduced to transform the original constraint condition of ‘less than or equal to 0’ into ‘less than or equal to -Epsilon’; Subsequently, a dual-objective unconstrained optimisation model is established. The PSO algorithm’s swarm intelligence search mechanism enables particles to dynamically adjust target weights based on their current positions, efficiently exploring potential optimal regions that satisfy discrete point constraints across the global domain; Based on this, the gradient descent method is employed for refined search within the identified optimal region to ensure that the obtained solution strictly satisfies the Karush-Kuhn-Tucker (KKT) optimality conditions. Theoretically, it is proven that this method can converge to a feasible solution satisfying the first-order approximate KKT conditions within a finite number of iterations. Numerical simulation results demonstrate that the designed method can both strictly satisfy path constraints and identify the globally optimal switching time and control input parameters.

先进控制理论与方法

时间: 2025/07/26 15:20 **主 席: 赵志诚 太原科技大学**

地点: 2 楼鸿喜厅

15:20-15:40 **SatA3.1**

Model Predictive Control for Train Convoy Operation: Hardware-in-the-Loop Simulation Performance Validation

haoran zhang ,Debiao Lu ,Bai-gen Cai ,Jian Wang ,Jiang Liu ,Wei Jiang ,Yibo Cui
(Beijing Jiaotong University)

With the growing demand for urban rail transit, traditional train operation methods struggle to meet short-term, unidirectional capacity demands. While train convoy technology improves line utilization by reducing inter-train spacing, challenges remain in safety control, real-time coordination, and experimental validation. This paper investigates the application of model predictive control (MPC) algorithms in train convoy operations based on train dynamics models and convoy-following safety braking models. A train convoy control system was developed using a hardware-in-the-loop (HIL) simulation platform comprising central, ground, and train layers, with the three-station, two-section route of Guangzhou Metro Line 18 serving as the simulation environment for multi-scenario testing. Experimental results demonstrate that the MPC control algorithm effectively enables convoy-following control, while the HIL simulation platform integrated with convoy-following capabilities meets requirements for user-friendly and repeatable testing environments.

15:40-16:00 **SatA3.2**

Conditional Disturbance-Compensation Control of Pneumatic Control Valve System

Zhi Song Wang ,Xing Fang ,Huang Chenxin ,Fei Liu
(Jiangnan University)

As the control core of the regulating valve, the valve positioner determines the adjustment precision and response speed of the pneumatic regulating valve, playing a crucial role in its operation. To enhance the performance of the pneumatic regulating valve system, this paper deeply investigates the conditional disturbance-compensation control of pneumatic control valve system. First, a nonlinear observer is used to estimate the lumped disturbance in the pneumatic regulating valve. On this basis, disturbance characteristic indices are proposed to analyze the lumped disturbance, which is then categorized into beneficial and harmful disturbances. Furthermore, by integrating the backstepping control method, the strategy not only leverages beneficial disturbances and compensates for harmful disturbances but also eliminates the chattering phenomenon caused by switching actions. Finally, a simulation analysis of the pneumatic valve positioning system is conducted to verify the effectiveness and superiority of this method.

16:00-16:20 **SatA3.3**

Development of a Sliding Mode Control Method for Permanent Magnet Synchronous Motors using Time-Sharing Fused Reaching Law

Xiantao Zhu ,Wei Guo ,Ranran Liu
(Jiangsu University of Technology)

Abstract: The Permanent Magnet Synchronous Motor (PMSM) is a nonlinear system characterized by strong coupling and multivariate dynamics. Owing to PMSM’ s insensitivity to disturbances and parameter variations coupled with rapid dynamic response characteristics, sliding mode control (SMC) has been extensively adopted in PMSM control. However, the traditional exponential reaching law (TERL) employed in sliding mode control inherently suffers from a fundamental trade-off between convergence rate and persistent chattering phenomena. To address this issue, a time-sharing fused reaching law (TSFRL) is introduced. This enhancement incorporates a power term of the system state variable to expedite the system’s reaching to the sliding surface. Moreover, the traditional sign function in the exponential reaching law is replaced by a hyperbolic tangent switching function, which is used to mitigate the chattering induced by sign function discontinuities. Verifications of the proposed method are designed by using the Matlab and a real PMSM system. Results from simulations demonstrate the superiority of the time-sharing fused reaching law over the traditional exponential reaching law in enhancing system control performance.

16:20-16:40 **SatA3.4**

存在时滞的高速列车新型动态面速度跟踪控制

谭畅, 谢玟洪
(南京航空航天大学)

为了处理高速列车输入时滞造成的不确定性，本文设计了高速列车的新型动态面 Funnel 控制策略使其在存在时滞的情况下，仍能实现对给定速度曲线的渐近跟踪。首先通过受力分析，建立了存在输入时滞的高速列车非线性动力学模型。其次，采用新型动态面控制方法，构造 Funnel 函数，使系统的瞬态和稳态跟踪误差被限制在给定边界内，再设计时滞补偿动态变量应用在新型动态面控制的最后一步补偿，将时滞系统转换成无时滞的系统，对系统中含未知参数的非线性部分，采用神经网络逼近，使得系统的跟踪误差最终收敛到零。最后，以 CRH380A 型高速列车作为被控对象进行仿真验证，仿真结果表明其具有理想的跟踪性能和收敛速度，验证了本文所提方法的有效性。

16:40-17:00 **SatA3.5**

一种运行 -统计变量融合成像的 *MPC* 系统模型失配诊断方法

李丽娟
(南京工业大学)

模型质量检测是实现模型预测控制 (MPC) 系统性能维护的关键技术，传统基于统计的 MPC 模型质量检测难以表征复杂多变量时空耦合关系，严重影响了 MPC 系统维护的及时性和准确性。鉴于此，本文提出了一种运行 -统计变量的多维特征融合成像结合深度学习的模型质量诊断方法，通过实时计算系统的多维状态信息，并经过特定的成像矩阵加以转化，最后输入到神经网络对系统预测模型的实时状态进行诊断。针对传统基于统计学提出的系统预测模型诊断指标实时性差、受扰动变化影响大的问题，构建了基于运行 -统计的多维系统评价指标，获得系统预测模型的实时状态信息，提升了模型质量诊断的实时性与准确度, 本文针对传统时间序列成像矩阵成像变量单一、成像信息局限，导致图像所表征系统信息不够全面的问题，提出了改进的多变量融合 Gram 成像矩阵，通过针对强耦合时间序列进行特征融合以及多通道组合成像，增强了图像对系统特征的表征能力。对 WoodBerry 精馏塔工艺的图像数据集，在轻量级 Resnet 网络下进行图像分类实验，实验结果表明了所提出系统评价指标和成像方法的有效性。

17:00-17:20 **SatA3.6**

基于双级扩张状态观测器的永磁同步电机转速分层滑模控制

栗毅淼, 赵志诚
(太原科技大学)

针对永磁同步电机 (permanent magnet synchronous motor, PMSM) 驱动中存在多种周期与非周期性扰动导致转速抖动和控制性能下降的问题，提出一种滑模控制 (sliding mode control, SMC) 与扩张状态观测器 (extended state observer, ESO) 相结合的转速分层滑模控制方法。采用分层终端滑模面并结合势垒函数设计新型混合趋近律，实现了滑模面到达时间与转速误差最小化以及系统全局快速收敛，同时设计双级 ESO 并嵌入准谐振控制器，在有限带宽的情况下提高了对非周期性和周期性扰动的估计精度。仿真与实验结果表明，本文所提方法可使转速控制系统具有更好的动态响应性能和抗干扰性能。

17:20-17:40 **SatA3.7**

Neural network-based adaptive iterative learning control for unknown nonlinear nonaffine discrete-time systems

Mingming Lin ,Ronghu Chi
(Qingdao Universtiy of Science Technology)

This paper proposes a novel neural network-based adaptive iterative learning control (NN-AILC) scheme for unknown nonlinear nonaffine discrete-time systems. By leveraging Taylor expansion and the differential mean value theorem, we first derive an equivalent affine representation of the original nonaffine system. Based on this affine model, an NN-AILC scheme is developed, incorporating a dead-zone technique for weight adaptation. The proposed method is data-driven and relaxes conventional requirements such as identical initial conditions and identical reference trajectories. Both theoretical analysis and simulation results demonstrate the effectiveness of the NN-AILC approach.

17:40-18:00 **SatA3.8**

Active Disturbance Rejection Control Based Regulating Valve Control in High-Altitude Chamber

Yize Chen ,HEHONG ZHANG ,Hongyu Lin ,Xiang Xu ,Bo Feng ,Chao Zhai
(Fuzhou University)

The high-altitude chamber regulating valve motion control system faces significant challenges due to high-frequency noise and unknown disturbances during aero-engine testing. It limits its ability to achieve high-response and high-precision in valve position control. To address these issues, this paper proposes a control scheme based on the Active Disturbance Rejection Control (ADRC) algorithm incorporating a fast synthesis tracking differentiator (fst-TD). A Linear Extended State Observer (LESO) is employed to compensate for unknown disturbances within the system, and a tracking differentiator based on the fst control synthesis function is constructed to suppress high-frequency noise. Simulation results show that under various valve opening frequency profiles, the fst-TD exhibits excellent tracking and filtering performance with favorable phase characteristics. The ADRC algorithm enhanced by fst-TD outperforms the conventional PD control method, achieving a steady-state accuracy of 0.02 and reducing the overall response time by 12.08%. These improvements ensure that the high-altitude chamber regulating valve motion control system meets stringent requirements for both high-response and high-precision control.

决策与控制一体化系统

时间: 2025/07/26 15:20 **主 席: 闻继伟 江南大学**

地点: 2 楼登云厅

15:20-15:40 **SatA4.1**

Nonlinear Homotopy-Penalty Interior-Point Method for Six-DoF Powered Landing Guidance

Kai Chen ,Zhenyu Wei ,Zhijiang Shao
(Zhejiang University)

This study presents a Nonlinear Homotopy-Penalty Interior-Point Method (HPOPT), a novel optimization method for addressing degeneracy and indefiniteness in the Six-DoF powered landing guidance. HPOPT integrates homotopy methods with penalty interior-point methods into a three-stage internal-homotopy framework, efficiently solving successive homotopy subproblems while optimizing computational resources. The trajectory planning problem is reformulated by constructing a homotopy problem, where the vertical landing problem serves as the homotopy auxiliary problem. Numerical experiments validate the proposed method, demonstrating its robustness and effectiveness in overcoming trajectory optimization challenges in powered landing scenarios.

15:40-16:00 **SatA4.2**

非线性切换系统的抗攻击无扰切换预测控制

解磊, 闻继伟, 万海英, 高爽, 栾小丽
(江南大学)

本文面向非线性切换系统，在平均驻留时间切换律下，研究抗攻击型预测控制与无扰切换策略。首先，建立由线性部分、非线性部分和不确定分量构成的子系统模型。其次，研究基于平方和优化的二次上界估计方法，将非线性优化问题转化为凸优化问题。最后，借助历史数据设计抗攻击预测控制器。此外，针对切换系统在切换时刻的控制输入颠簸问题，设计具有振幅限制的无扰切换策略，减少切换引起的控制颠簸。数值仿真从抗攻击性能、切换平滑性及系统鲁棒性三个方面验证了所研究方法的有效性。

16:00-16:20 **SatA4.3**

Research on Quality Defect Diagnosis Method for Tire Joints Based on Improved MHA-IDQN

Qingduo Hu ,wei zhang ,Bao-Lin Zhang ,Bingzheng Guan
(Qingdao University of Science and Technology)

In the tire manufacturing industry, the requirements of intelligent industrial production are often not met by existing tire joint defect prediction methods. To enhance the feature extraction and decision-making capabilities of the classification prediction model, an integrated Deep Q-Network model based on the multi-head self-attention mechanism is proposed in this paper. The ability to capture non-linear feature relationships is not only strengthened by the model, but also an integrated framework is successfully constructed. The classification stability and prediction accuracy are improved by the framework through the use of dynamic weighted voting. To further enhance its practical applicability in actual production, the high-dimensional feature representation is improved in this paper. Meanwhile, the state-space exploration rate is increased by introducing double experience replay and dynamic decay strategies, and the error convergence is accelerated by adopting a periodic hard-update strategy. Comparative experiments show that the proposed model can effectively extract defect features, greatly improve decision-making, and has high accuracy and generalization.

16:20-16:40 **SatA4.4**

Dynamic closed-loop constraint identification test for model predictive control

Xiao Zheng ,Zuhua Xu ,JUN ZHAO ,Chunyue Song
(Zhejiang University)

In view of the fact that the parameters of industrial processes models evolve over time due to equipment aging and failures, necessitating re-identification, a dynamic closed-loop constrained identification test method for model predictive control (MPC) is proposed. Starting from a seed model of the process, probabilistic dynamic constraints on the output variables are designed using a power spectral density approach. Based on this, a probabilistic optimization problem for test signal amplitude, satisfying D-optimal design, is developed to maximize the signal-to-noise ratio of the test data. Compared with traditional steady-state model-based amplitude design method, the proposed method can persistently excite the process dynamics and significantly enhance the quality of the test data. An MPC zone control method is then employed to design a test signal tracking controller, which ensures that the optimized test signal sequence is accurately followed while strictly maintaining input and output constraints. This enables an automatic closed-loop constrained identification test method, effectively avoiding safety risks associated with manually set amplitudes in traditional unconstrained open-loop test.

16:40-17:00 **SatA4.5**

基于机理模型的主蒸汽温度内模控制方法

李俊杰, 张奕楠, 杨雨, 道尔吉苏荣, 张翔, 王文海
(浙江大学 NIGCS 大平台)

针对变工况时内模控制系统内部模型失配问题，提出了基于机理模型的主蒸汽温度内模控制方法。首先，开发了集成减温水流量、烟气传热量和蒸汽流量影响的

主蒸汽温度系统机理模型，基于某热电厂运行数据采用差分进化算法辨识了模型参数。然后，将动态机理模型作为内部模型，将正向 PI 控制器和反向静态模型组合，完成了内模控制器设计。最后，测试了控制系统的动态调节性能、鲁棒性和抗扰性，与 PID 控制系统和基于传递函数的内模控制系统对比，证明了所提出方法的有效性。

17:00-17:20 **SatA4.6**

Model Predictive Control Strategy Based on Deep Neural Networks for Inverted Pendulum Systems

Meng Kang Wang ,Han Yang ,Xiaolei Li ,Yukun Shi ,Youqing Wang
(Beijing University of Chemical Technology)

This paper presents a theoretical and experimental study of model predictive control (MPC) strategies based on deep neural networks (DNNs), with an inverted pendulum system as a benchmark platform. This proposed framework replaces traditional analytical dynamic models with data-driven prediction modules constructed by training DNNs, thereby reducing the reliance on explicit system modeling. Within the MPC framework, this approach achieves high-precision control of complex nonlinear systems. Comparative simulations under disturbance-free and disturbed conditions demonstrate that DNN-MPC considerably outperforms conventional MPC, in terms of control accuracy, robustness, and energy efficiency, validating its effectiveness for controlling systems with unknown or difficult-to-model dynamics.

17:20-17:40 **SatA4.7**

Adaptive Iterative Learning Economic Model Predictive Control for Non-repetitive Disturbances

赵宇石, 马乐乐, 刘向杰
(华北电力大学)

Iterative learning model predictive control with strong time-domain tracking performance is an advanced control method for batch processes. However, traditional iterative learning model predictive control can usually only cope with small enough disturbances. For batch processes with large values of disturbances, the control performance of the system is degraded, which poses a challenge for its application. In this regard, this paper proposes a non-repetitive disturbances adaptive iterative learning economic model predictive control strategy. The disturbances with large values are classified into two parts, repetitive and non-repetitive disturbances, through iterative relations, and two economic optimization problems are built at the same time, in which the repetitive perturbations are solved by an batch-to-batch EMPC strategy based on the ILC, and the non-repetitive perturbations are solved by an within-batch EMPC strategy based on the ILMPC. In order to suppress the impact of non- repetitive disturbances on the system, an extended state observer is introduced to estimate the non-repetitive disturbances during the optimization process within the batch to provide a more accurate state to the system. The effectiveness of the proposed algorithm is verified by simulation experiments on a batch reactor.

17:40-18:00 **SatA4.8**

A simplified finite control set repetitive model predictive control method for improving the performance of grid-connected inverters

Shao Yuanyuan ,Aimin An
(Lanzhou University of Technology)

The finite control set model predictive control (FCS-MPC) algorithm is characterized by fast dynamic response, strong multi-constraint control capability and robustness, but the traditional FCS-MPC algorithm for grid-connected inverter control needs to traverse all possible voltage vectors, which results in a large amount of computational work and poor power quality and stability, and restricts its application in real-time control. To address this problem, this paper proposes a simplified finite control set repetitive model predictive control (S-FCS-RMPC) algorithm for T-type three-level grid-connected inverter control, which significantly reduces the number of prediction and traversal searches for the FCS-MPC of the T-type three-level grid-connected inverter from 27 to 10 to 7 times by optimizing the voltage vector selection strategy. The system control performance can be significantly improved, the computational complexity can be reduced, and the harmonic component of the output current can be minimized to improve the power quality and the stability of the system for different operating conditions. Simulation results show that the proposed S-FCS-RMPC control strategy for the T-type three-level grid-connected inverter improves the control performance while significantly reduces the computational complexity, which verifies its feasibility and effectiveness.

信息感知与检测技术

时间: 2025/07/26 15:20 **主 席: 孙兰香 中国科学院沈阳自动化研究所**

地点: 2 楼百瑞厅

15:20-15:40 **SatA5.1**

Design of an Automatic Optical Power Calibration Mechanism and System for Fiber Identifiers

曹非凡, 邵梓康, 杨素林, 谢林柏
(江南大学)

To address the challenges of low efficiency, poor consistency, and significant errors associated with manual optical power calibration of fiber identifiers in production environments, this paper presents a novel method and system for online optical power calibration and testing. Leveraging the measurement principles of fiber identifiers, a task-scheduling-driven modular automatic calibration mechanism is developed. Models for insertion loss compensation, macro-bending loss fitting, and adaptive threshold matching are established. Furthermore, an integrated system architecture featuring hardware-software co-design is designed to form a closed-loop control process encompassing "configurationexecutionverificationregulation." Experimental results demonstrate that the proposed system significantly improves testing accuracy and consistency, establishes a complete data traceability framework, realizes the automation of the testing process and significantly reduces system operation and maintenance costs.

15:40-16:00 **SatA5.2**

Laser-induced breakdown spectroscopy chemical element online analysis technology and equipment

孙兰香
(中国科学院沈阳自动化研究所)

Online analysis of chemical elements is a key enabling technology for the digital transformation of process industries. Laser-induced breakdown spectroscopy (LIBS) is a technique that utilizes laser-excited plasma to analyze atomic emission spectra. It offers unique advantages in applications such as mineral processing, metallurgy, energy, deep space, and deep-sea element detection, with vast application potential. However, it also faces challenges such as poor signal stability, difficulties in quantitative model analysis, and significant environmental interference. This presentation introduces the principles, development history, and scientific issues of LIBS technology, as well as some key technologies studied to address core issues. For example, methods such as plasma image feedback-based spectral fluctuation correction, weak feature extraction and lightweight modeling for complex matrices, and online adaptive calibration under dynamic environmental interference. Based on this, the first domestically developed LIBS online analyzer for ore slurry grade and liquid metal LIBS online analyzer were developed, overcoming environmental adaptability and reliability challenges in harsh operating conditions. These analyzers have been successfully applied in the beneficiation of strategic mineral resources such as iron ore and phosphate ore, as well as multiple metallurgical fields, opening up important avenues for the industrial application of LIBS.

16:00-16:20 **SatA5.3**

基于红外图像的正极材料烧结炉三维温度场重建

綦彪, 陈宁, 陈嘉瑶, 桂瑰, 阳春华, 桂卫华
(中南大学)

三元正极材料的烧结过程是其制备的核心工序，精确获取烧结炉内的三维温度分布对于温度场的调节与优化至关重要。然而，红外内窥设备获取的红外图像与温度矩阵之间存在噪声、动态非线性映射和深度信息缺失等问题，导致传统的基于精确温度与深度信息的三维重建方法难以准确重建炉内温度场。为此，本文提出了一种基于红外图像的烧结炉温度场三维重建方法。首先，基于盲点去噪原理，采用 Noise2Void (N2V) 自监督去噪方法有效减少热辐射噪声和传感器误差。其次，结合长短期记忆神经网络 (LSTM) 与 U 型网络 (U-net) 的灰度-温度映射技术，通过温度矩阵动态范围与归一化温度矩阵分步预测与融合，成功实现了红外图像与温度矩阵之间的动态非线性映射。最后，通过基于图像散焦度的深度信息估计方法，克服了深度信息缺失的问题，实现精确的三维温度场重建。实验结果表明，该方法显著提升了温度感知精度，为烧结过程中的温度调控提供了有效参考。

16:20-16:40 **SatA5.4**

A hyperspectral image compression method based on superpixel segmentation

Xueqian Yu ,Can Zhou ,Yan Sun
(Central South University)

Zinc concentrate is an important raw material for zinc metallurgy. Rapid and accurate estimation of zinc concentrate component content is crucial for production efficiency and equipment safety. Hyperspectral imaging (HSI) can capture abundant spatial and spectral information, providing a key basis for the analysis of material compositions. However, the massive volume of HSI data poses challenges to data transmission and storage. To address this issue, this paper improves the simple linear iterative clustering (SLIC) algorithm and proposes a hyperspectral compression method based on superpixel segmentation with local complexity. A local complexity index is introduced to measure the uniformity of the distribution of HSI data. Based on this local complexity, the non-uniform initialization of

clustering centers and the calculation of dynamic distances are realized. The proposed method achieves more accurate segmentation of zinc concentrate HSI in scenarios with complex spatial distributions. Combined with spectral aggregation, it realizes spectral averaging in homogeneous regions while retaining spectral details in inhomogeneous regions. Consequently, a label map, centroid coordinates, and corresponding average spectra representing the original high-resolution HSI data are obtained, achieving the compression of HSI data. Experimental results demonstrate that our method can compress the original high-resolution data to 10.51% of its original size, while the estimation accuracy of the reconstructed data is only 0.32% lower than that of the original high-resolution data.

16:40-17:00 **SatA5.5**

SASGNN: A Sparse Attention Graph Neural Network for Long Sequence Multivariate Forecasting in Industrial Processes

Wang Yulong ,Xiaoli Wang
(Central South University)

In process industries, achieving timely and effective control is highly challenging due to long material residence times and significant delays in the availability of product index measurements. In comparison, the state variables in the middle of the process can respond to the adjustments with a minor time lag. Consequently, operators often use these state variables in practice to adjust the control variables. Multivariate time-series forecasting (MTSF) provides an alternative by predicting these critical state variables, but existing methods typically neglect the complex inter-variable relationships and suffer from error accumulation in long-sequence forecasting tasks. This work addresses two main challenges in industrial MTSF: (1) constructing accurate variable relationships under complex industrial dynamics, and (2) mitigating the error accumulation over long prediction horizons. The objective is to develop a forecasting model that can accurately predict both middle-state and final product variables over long sequences, thereby enabling timely process adjustments and enhancing control performance.˚propose a novel Sparse Attention Spectral Graph Neural Network (SASGNN), to tackle the aforementioned challenges: (1) Graph Structure Learning Module: This module builds a robust and interpretable graph by combining a domain knowledge-based prior-based adjacency matrix with an adaptively learned matrix from a Sparse Attention Mechanism (SAM). SAM significantly reduces computational complexity from O(L) to O(LlnL), making it efficient for long sequences. (2) Long Sequence Forecasting Module: This module achieves comprehensive feature representation learning. The constructed graph is first transformed into the spectral domain by Graph Fourier Transform for effective graph convolution. A Temporal Convolutional Network (TCN) extracts multiscale temporal patterns of individual variables. Concurrently, a Graph Convolutional Network (GCN) captures spatial associations in the spectral domain. Furthermore, a variant Gated Recurrent Unit (GRU), which incorporates skip connections, is used to effectively extract long-term temporal dependencies and mitigate information loss in long sequences. The synergistic integration of TCN, GCN, and the variant GRU enables the model to comprehensively capture local and long-term temporal patterns as well as spatial correlations, thus achieving accurate long sequence MTSF.˚on a real-world tungsten flotation process and two public benchmark datasets, SASGNN consistently demonstrates significantly superior performance in MAE and RMSE compared to CNN/RNN-based, GNN-based, and Transformer-based models, especially for long sequence forecasts. This performance highlights SASGNN's improved robustness to industrial fluctuations. This work presents SASGNN as a powerful and practical forecasting framework for complex industrial processes, supporting accurate long sequence prediction, advanced predictive control, and digital twin development. Future work will explore dynamic graph structures for process condition drift and further computational complexity reduction for large-scale applications.˚

17:00-17:20 **SatA5.6**

面向工业设备管控的工控数据可视化及实现

刘浩, 吴永建, 刘辉, 吴志伟
(东北大学)

本文主要考虑了在实际工业现场中，一方面由于传感设备、控制设备、执行设备等种类繁多、实时性要求高，另一方面由于各种工业网络协议和机制并存，且同一通信机制下存在帧结构、字段定义等各厂家、各设备、各型号各不相同，难以实现工业设备的泛在接入的情况。解决上述痛点，国内外工控巨头、互联网云平台厂商等，主要通过结合人工智能技术和智能网关等，实现工业异构设备的自适应接入。在工业物联网（IIOT）体系下，分析了异构设备自适应接入的现状，提出了工业自适应接入等级划分，结合具体工业应用分析了工业设备接入体系架构，在云、边、端协同下应用 MQTT 等协议建立设备与工业物联网平台间的联系，并通过该方式进行数据交换以及数据库存储等从而实现工控数据可视化。

17:20-17:40 **SatA5.7**

Quality Index Prediction for Polypropylene Batch Processes Based on Data Features

Jinmiao Wang ,Zhu Wang
(China University of Petroleum)

In polypropylene batch production processes, the lag in testing the quality index of melt flow rate (MFR) prevents production personnel from obtaining timely MFR values for adjustments, resulting in low production efficiency. To address this issue, a quality prediction method for polypropylene batch processes is proposed to improve production efficiency and enable real-time monitoring and adjustments for subsequent batch operations. First, the key factors influencing the quality index within a single batch are identified by analyzing the process mechanism of the polypropylene unit, and

historical batch data is determined. Second, for specific long-time-series data, data features are extracted using Singular Value Decomposition (SVD). In online prediction, a mathematical representation method based on a quasi-fourth-order central moment is introduced to perform quality prediction by comparing the similarity between online and historical batch data. Finally, the proposed prediction method was validated through testing experiments on a polypropylene unit in a refinery and petrochemical plant in China, demonstrating its feasibility.

张钟俊奖评奖

时间: 2025/07/27 08:30 **主 席: 李少远 青岛科技大学、上海交通大学**

地点: 3 楼金江厅

08:30-08:50 **SunA1.1**

A Feedback-Enhanced Soft Actor-Critic Control Method for Industrial Processes

Zhixuan Peng ,Bei Sun ,Fakun Zheng ,Yucheng Ke
(Central South University)

The complex dynamic environment of industrial processes poses significant challenges to the adaptability and generalization capability of control methods. Traditional feedback control, such as proportional-integral-derivative (PID) control, struggles to handle uncertainties in industrial processes due to the model dependency of its control parameters, while data-driven control, such as reinforcement learning (RL) control, shows insufficient generalization in unknown operating conditions caused by the lack of structured guidance in state representation. To address these issues, this paper proposes a feedback-enhanced soft actor-critic (FE-SAC) control method based on state-space feedback augmentation and error dynamics-driven mechanism. Firstly, the control error along with its integral and derivative signals are embedded into the SAC state space, leveraging the structured prior knowledge from classical feedback control to enhance control performance and improve the generalization capability of the controller. Subsequently, a multi-objective reward function is designed based on error dynamic characteristics and statistical features, effectively balancing the system' s transient and steady-state performance. Finally, a case study on pH control in the zinc leaching process (ZLP) demonstrates that the proposed FE-SAC control method achieves more potential performance in handling unknown environments.

08:50-09:10 **SunA1.2**

工业级大型焦炉炭化室 *CFD* 仿真与参数分析

李怀旭, 王超, 李宛格, 韩中洋, 赵珺
(大连理工大学)

针对工业级焦炉炭化室热解过程的复杂传热传质问题，通过自定义耦合传热、煤热解化学反应、水相变等子过程的物理建模，建立基于计算流体力学（CFD）的炭化室二维数值仿真模型. 在此基础上，探究了炭化室的温度分布特征和含水率、热解速率等关键物理量的时空变化趋势；并基于灵敏度分析探究了煤颗粒含水率、加热隔墙温度、堆积密度等关键参数与炭化室中心位置温升趋势及结焦时间之间的关联规律. 研究结果表明：煤颗粒含水率、加热隔墙温度、堆积密度等关键参数的变化会显著影响结焦周期及关键点温升速率，且为非线性影响规律。

09:10-09:30 **SunA1.3**

Global Asymptotic Tracking Control with Input Saturation and Adaptive Performance: A Low-Complexity Approach

Wenxin Lai ,Yuanlong LI ,Bo Yang
(Shanghai jiao tong university)

In this paper, we address the output tracking problem for uncertain MIMO nonlinear systems subject to input saturation and propose a global asymptotic tracking control strategy. A novel global adaptive performance function is introduced, which not only eliminates the dependence on initial conditions but also resolves the conflict between actuator saturation and performance requirements. Based on this function, an adaptive controller is developed using a carefully designed sliding surface. The proposed method does not require any additional structures to approximate unknown nonlinearities or external disturbances, and it avoids recursive design steps, resulting in a low-complexity implementation. Theoretical results show that the asymptotic tracking can be achieved when the actuator no longer saturates. Simulation results are provided to validate the effectiveness of the proposed approach.

09:30-09:50 **SunA1.4**

String-Stable Controller Design for Nonlinear Vehicular Platoons

Weinan Gao ,Nairong Qiao ,Tianyou Chai
(Northeastern University)

The string stability of vehicular platoons can effectively improve both traffic safety and road throughput, which is usually concerned by whether the speed variations of upstream vehicles are attenuated. Different from traditional string stability controller design which assumes the dynamics of vehicles is$^{\circ}$, this paper design a string-stable controller for nonlinear vehicular platoons based on relaxed policy iteration methods. Simulation results validate the effectiveness of the proposed controller.

09:50-10:10 **SunA1.5**

A Dynamic Multi-objective Evolutionary Algorithm based on Difference Prediction

Xiaoli Li ,Anran Cao ,Kang Wang
(Beijing University of technology)

In industrial areas, dynamic scheduling, resource allocation, and metal rolling are typical Dynamic multi-objective optimization problems (DMOPs). Tracking Pareto-optimal solution (PS) and/or Pareto-optimal front (PF) in a constantly changing environment by prediction-based Evolutionary algorithms (EA) is a

common method. Many dynamic multi-objective optimization evolutionary algorithms (DMOEAs) adopt a single predictor to initialize the population when a change occurs, which could result in unsatisfactory performance in some DMOPs. To deal with DMOPs, this paper devises a difference prediction strategy, including first-order prediction and gradual search. The former adopts a first-order difference method to predict the moving distance of population; the latter selects a Gaussian mutation to generate the new individuals. Based on probabilistic selection, two predictions effectively work in dealing with the changing environment. To test the performance of DP, nine classical DMOP benchmarks and three state-of-the-art compared algorithms are selected. The experimental results imply that DP is able to solve different kinds of DMOPs.

10:10-10:30 **SunA1.6**

Semi-Supervised Discriminant Analysis for Out-of-Distribution Detection with Limited Labeled Data

Meng-hui Guo ,Jian-wei Liu
(China University of Petroleum, Beijing)

Out-of-distribution (OOD) detection is crucial for ensuring the reliability of deep learning models in open-world applications; however, existing methods often exhibit limited performance when labeled data is scarce. To address this challenge, this paper proposes a novel OOD detection framework based on Semi-Supervised Discriminant Analysis (SSDA). This framework aims to learn more discriminative feature representations that are sensitive to the intrinsic manifold structure of the data by integrating limited labeled data with abundant unlabeled data information. Specifically, we formulate a joint optimization objective that maximizes class separability using labeled data while preserving the geometric structure of unlabeled data via a manifold regularization term. The method operates directly on the feature representations of pre-trained models, requiring neither model fine-tuning nor reliance on auxiliary outlier data. Extensive experiments on the ImageNet-1K benchmark and multiple OOD datasets demonstrate that the proposed SSDA method significantly enhances OOD detection performance across various backbone networks, including ViT, BiT, and ResNet-50d. Notably, under conditions with limited labeled data (e.g., 20%), it shows marked advantages over fully supervised baselines and other post-processing methods.

10:30-10:50 **SunA1.7**

Physics-Informed Multi-Source Stationary Subspace Analysis for Fault Detection in Blast Furnace Ironmaking

Siwei Lou ,Yi Li ,Chunjie Yang ,Hanwen Zhang ,Ping Wu
(Zhejiang university)

The ongoing digital transformation in steel industry has spurred advancements in multivariate fault detection for Blast furnace (BF) ironmaking processes. However, BF ironmaking's inherent complexity, including strict physical constraints and the hybrid nature of continuous and switching variables, poses significant challenges to reliable fault detection. To address these challenges, this study proposes a novel Physics-informed multi-source stationary subspace analysis (PMSSA) framework. First, we reformulate physical constraints and switching variables into a probabilistic framework using probability truncation and binary encoding, enabling their integration into a unified latent variable model. The solution, derived via an Expectation-maximization (EM) algorithm, jointly optimizes continuous and switching representations while ensuring theoretical guarantees on probability truncation validity and model convergence. Furthermore, to accommodate performance degradation in industrial settings, we develop an incremental model update algorithm that operates in the orthogonal complement of original model space, preserving efficiency while incorporating new data. A rigorous orthogonality analysis ensures geometric consistency between updated and original models. Extensive validation on real-world BF ironmaking datasets demonstrates that PMSSA outperforms both baseline and state-of-the-art methods in reliability and accuracy, providing a robust solution for industrial fault detection.

学生优秀论文奖评奖

时间: 2025/07/27 08:30 **主 席: 周平 东北大学**

地点: 2 楼长乐厅 **王宏 曼彻斯特大学**

08:30-08:50 **SunA2.1**

Dynamic Event-Triggered Consensus of Multi-Agent Systems: New Insights into Event-Separation Properties

Sikang Zhan ,Ruchao Su ,Xianwei Li ,Shaoyuan Li
(Key Laboratory of System Control and Information Processing, Ministry of Education of China, Shanghai 200240, China)

In multi-agent coordination, dynamic event-triggered (DET) sampling mechanisms are a prevailing and effective technique for saving communication burdens, however it is widely accepted that only building on DET mechanisms cannot guarantee designable minimum inter-event times. This paper revisits the consensus problem of multi-agent systems on undirected graphs and (re-)design event-triggered protocols together with distributed DET sampling mechanisms. By introducing new comparison functions for evaluating inter-event times, it is shown that distributed DET mechanisms, even without merging other triggering techniques, are still able to ensure a designable lower bound of inter-event times. This fact reveals enhanced event-separation properties of DET mechanisms, in contrast to existing results where only Zeno-freeness of inter-event times can be claimed. Moreover, both node-based and edge-based DET mechanisms are designed to solve the consensus problem while guaranteeing positive minimum inter-event times. Finally, simulation results are provided to illustrate the theoretical results.

08:50-09:10 **SunA2.2**

Semi-Supervised Detection of Sub-Micron Scratches on Laser Chips via Recursive Texture Entropy Optimization

Pan Liu ,Liang Wang ,Weihua Gui
(Central South University)

Laser chips, pivotal components in optoelectronic systems, demand exceptionally high manufacturing standards for their emission surfaces, as even submicron scratches can severely impair performance. Traditional detection methods are significantly constrained by low-contrast defects and scarce labeled data. To address these challenges, we propose TexRecNet, a semi-supervised network integrating recursive optimization and texture entropy analysis. Our architecture employs a recursive encoder-decoder framework that progressively enhances edge detection accuracy through cyclic prediction refinement and positional encoding updates. To exploit unlabeled data, we introduce a texture entropy consistency metric quantifying edge distribution patterns, enabling reliable pseudo-label generation from unsupervised inputs. A novel recursive consistency constraint loss further stabilizes training by minimizing output sequence variance. Experiments demonstrate scratch detection accuracy of 75.6% and recall of 74.8%, surpassing U-Net by 8.5% and 33.6% respectively. This approach significantly enhances quality control while reducing annotation dependency, offering an effective industrial solution for micro-defect detection.

09:10-09:30 **SunA2.3**

StictionGPT: Detecting Valve Stiction in Control Loops using Large Vision Language Model

Tianci Xue ,Chao Shang ,Dexian Huang
(Xi'an Jiaotong University)

Stiction detection in control valves is a critical challenge in control loop performance assessment and fault diagnosis within the process industry. Existing stiction detection methods often require determining a threshold or rely on large number of data to train deep neural networks. However, they face challenges such as difficulty in threshold determination, poor transferability, and lack of interpretability. Recent advancements in large language models (LLMs) and large vision-language models (LVLMs) offer new possibilities for improving the generalization of detection models by leveraging their multimodal understanding and reasoning capabilities. We propose StictionGPT, an LVLM-based agent for valve stiction detection. To overcome traditional method' s limitations, we leverage LVLMs to mimic human decision-making, combining textual semantics with visual shape features to determine the presence of stiction. First, we transform time-series data into images that contain shape features. These images are time-series plot, PV-OP plot, OP-PV plot and CRD-PV plot. Then, we create a multimodal dataset based on the semantics of these shapes for image-text alignment. Next, low-rank adaption (LoRA) is employed to foundation LVLMs to enable efficient few-shot generalization to stiction detection tasks. Finally, we test the model on the ISDB benchmark and deploy it in a chemical plant. StictionGPT achieves the highest accuracy on the ISDB benchmark and demonstrates excellent performance on the plant dataset.

09:30-09:50 **SunA2.4**

A coal price prediction method based on DeepSeek-R1 fusion of quantitative multi-scale event characterization

Jiang Luo ,yalin wang ,Chenliang Liu ,Xiaofeng Yuan ,Weihua Gui
(Central South University)

Accurate coal price prediction holds strategic significance for production planning optimization, cost control, and market risk mitigation in process industries such as salt lake chemical engineering, power generation, and steel manufacturing. However, unexpected events including extreme weather, geopolitical conflicts, and energy policy adjustments frequently trigger non-linear fluctuations in coal supply-demand relationships, resulting in substantial uncertainties for price forecasting. Existing approaches face multiple limitations: manual analysis relies heavily on expert experience with strong subjectivity and difficulties in quantifying event impacts; traditional statistical models are constrained by linear assumptions and fixed parameters, failing to capture complex market disturbances from multi-factor coupling; while deep learning models can mine latent patterns in structured data, they exhibit delayed responses to sudden events and suffer from reduced interpretability due to the "black-box" nature of internal weight matrices, hindering their trusted application in operational decision-making. To this end, this paper proposes a coal price prediction method based on DeepSeek-R1 fusion with quantitative multi-scale event characterization (QMEC-DS). First, the method designs a two-phase DeepSeek-R1 fine-tuning scheme combining vertical domain knowledge fine-tuning and structured data fine-tuning, establishing an event-driven multi-scale analysis framework to quantify impact intensity and extract explicit reasoning paths for event transmission. Second, impulse response functions are employed to extend event impacts into three temporal dimensions: short-term shocks, medium-term transmission, and long-term trends. Finally, the quantified event impacts are incorporated as external inputs for subsequent numerical tasks, enhancing model responsiveness to sudden event interventions. Experimental evaluations on the Qinhuangdao coal price dataset (2005-2022) demonstrate that compared with baseline models including Prophet, GRU, and Transformer, the proposed method achieves average reductions of 35.9% in RMSE and improvements of 0.0579 in R2, providing novel insights for handling unexpected events in price prediction tasks.

09:50-10:10 **SunA2.5**

Infrared and Visible Image Fusion Method under Scattering Medium Disturbance

李凡训, 潘冬, 蒋朝辉, 余浩洋, 桂卫华
(中南大学)

Image fusion can enhance the expression ability of multi-source information and effectively overcome the problems of information loss and decline in imaging quality caused by the interference of scattering media. At present, the image fusion methods under the interference of scattering media still have problems such as a single fusion scene and poor robustness, which limit their application in complex environments. To this end, this paper proposes an infrared-visible light image fusion method under the interference of scattering media to improve the analysis and perception ability of the target scene. Specifically, this framework consists of a multimodal differential cooperative enhancement module (DCEM) and a deep residual multi-stage fusion module (DRMF). The former effectively enhances the information complementarity and regional feature matching ability between modalities for the problems of information inconsistency and quality degradation of infrared and visible light images. The latter effectively enhances semantic consistency and detail restoration ability in response to the problems of difficult deep semantic alignment and easy loss of details in infrared and visible light images. The qualitative and quantitative evaluation results show that the fusion method proposed in this paper exhibits good robustness under the interference of scattering media, significantly improves the clarity and information expression ability of the fused image, and outperforms the existing nine mainstream SOTA methods in multiple evaluation indicators.

10:10-10:30 **SunA2.6**

Multi-objective Optimization for Effective Drift Motion Control

Bei Zhou ,Lei Xie ,Hongye Su
(Zhejiang University)

Drifting plays a vital role in motorsports by enabling vehicles to maintain high speeds through sharp turns, and it also offers valuable strategies for improving safety in everyday driving under extreme conditions. ˚objectives of drifting are multifaceted: the vehicle must follow a predefined path, maintain stable drifting, and ensure a comfortable driving experience. ˚, the complex dynamics involved, such as large sideslip angles and rear tire saturation, present significant challenges for control algorithms.˚balance these objectives, we propose a multi-objective optimization approach coupled with a model predictive controller (MPC) for effective drift motion control.˚approach strikes a balance between computational efficiency and prediction accuracy, ensuring optimal performance in dynamic driving scenarios. ˚multi-objective optimization serves as a supervisory layer, learning path tracking control laws and drift equilibrium points to guide the low-level MPC drift controller.˚this paper, we compare several optimization techniques—gradient-based optimization, genetic algorithms, particle swarm optimization, and Bayesian optimization (BO)—for controlling the drift vehicle. ˚proposed framework is validated on the Matlab-Carsim platform. ˚results demonstrate that BO yields the best system performance for effective drift motion control.

10:30-10:50 **SunA2.7**

流程模拟嵌套求解模块的混合自动微分框架

张嘉宁, 胡玉洁, 祝慧鑫, 陈曦
(浙江大学)

在工业流程模拟中，复杂模型的导数获取是系统仿真与优化的重要基础。自动微分是一种强大的导数生成

工具，兼具灵活性与准确性，被广泛应用于各类建模求解任务。然而自动微分在处理以热力学计算为代表的含嵌套迭代求解的复杂模型时存在梯度断裂问题。针对此本文提出一种混合自动微分框架，通过融合隐函数微分定理，实现了全流程梯度的无缝集成。案例分析表明：本方法在保证计算精度的同时，显著提升了流程模拟中导数求解的适应性与计算效率，为构建可扩展的工业级仿真系统提供了兼具模块化、灵活性和微分鲁棒性的方法论体系。

故障检测、诊断与决策 1

时间: 2025/07/27 09:10 **主 席: 徐祖华 浙江大学**

地点: 2 楼未央厅

09:10-09:30 **SunA3.1**

基于 *CEEMDAN-SVD-MEAE* 的抽油机电机声音异常检测

詹汶鑫, 李康, 高小永, 任桂山
(中国石油大学)

抽油机电机的异常声音检测是油田安全生产的关键环节，但由于环境噪声的干扰会掩盖有效声学特征，导致自编码器对声音样本的表征能力下降，进而引发漏检风险。本文提出一种基于 CEEMDAN-SVD-MEAE 的联合异常检测方法。首先，通过 CEEMDAN-SVD 算法对原始音频信号进行自适应噪声分解与奇异值筛选，有效抑制环境噪声对声学特征提取的干扰；然后，设计具有记忆原型库的增强型自编码器（MEAE），通过稀疏机制约束重构过程，改善模型在异常样本上的表征偏差；最后，利用重构误差分布差异实现异常检测。实验采用油田现场音频数据，结果表明：所提方法的准确率、召回率及 F1 分数分别达 98.85%、97.01% 与 97.92%，优于传统卷积自编码器（CAE）与机器学习模型（CNN、LSTM、SVD）；异常样本的重构误差较正常样本明显增加，验证了方法的鲁棒性。本研究为复杂环境噪声场景下的设备异常检测提供了有效解决方案。

09:30-09:50 **SunA3.2**

基于电流基波幅值波动的牵引逆变器故障分类方法

刘紫辉, 陶宏伟, 余运俊, 宋运泉, 华欣兰, 龚宇波
(南昌大学)

针对功率器件开路故障和传感器故障相互影响的问题，本文提出了一种牵引逆变器故障分类方法，首先，将牵引电机定子三相电流经过 Park 变换获取旋转坐标系的电流，并获取电流基波幅值。然后基于理论分析，确定不同类型故障对基波幅值的影响。之后，使用幂指数放大故障对基波幅值的影响，并统计放大后基波幅值在一个电流周期内的方差，最后根据方差在数量级上的不同，确定牵引逆变器的故障类型。仿真结果验证了本文所提方法的有效性。

09:50-10:10 **SunA3.3**

Process monitoring based on Autoregressive-JITL-MSET Method for air separation unit

Yiyang Shou ,Yan Liu ,Zuhua Xu ,JUN ZHAO ,Ruqiang Xue ,Kai Wang
(Zhejiang University)

Conventional MSET-based fault detection methods suffer from underdetermined problems due to insufficient equations for multiple parameters. To address this, we propose a process monitoring method for air separation unit based on Autoregressive-JITL-MSET. Through the Just-in-time learning method, top-k similar samples are selected according to the similarity weighted distance. Applying autoregressive reconstruction, we reconstruct the dataset from memory matrix to improve estimation accuracy. Multi-way Partial Least Squares modeling is then used for online state estimation. A health index (EHI) is introduced to evaluate system status based on residuals from normal operation. Industrial case studies on a real air separation unit demonstrate that the proposed method achieves superior fault detection performance and meets practical operational requirements.

数据驱动建模 1

时间: 2025/07/27 09:10 **主 席: 潘天红 安徽大学**

地点: 2 楼鸿喜厅

09:10-09:30 **SunA4.1**

GammaVAE: Generation of Time-Series Data for Constrained in Fermentation Processes

chengcheng liu ,Zhao Shunyi ,Fei Liu
(jiangnan university)

Although existing synthetic data generation techniques have made some progress, they often fail to adequately satisfy the stringent process constraints inherent in fermentation systems. This study introduces an enhanced variational autoencoder based on the Gamma distribution (GammaVAE) for generating multivariate time-series data that meet minimum value constraints. By introducing the Gamma distribution as the prior and employing a rejection sampling-based reparameterization technique, the method effectively captures the non-negativity and asymmetry characteristics of fermentation data. Compared to existing constraint enforcement approaches that impose constraints by incorporating penalty terms into the loss function or applying post-processing to the generated data, the proposed method provides a more principled framework by integrating the constraint-aware prior directly into the generative process. Experimental evaluations on penicillin and succinic acid fermentation datasets demonstrate that the proposed approach outperforms existing methods in terms of constraint satisfaction, with generated data aligning more closely with industrial requirements while preserving the statistical properties and temporal dynamics of the original data.

09:30-09:50 **SunA4.2**

Battery Inconsistency Detection using K-means Clustering with Center Optimization

Hu Yang ,Tianhong Pan ,Jiaqiang Tian
(Anhui University)

Lithium-ion batteries are widely used in energy storage systems due to their high energy density and long cycle life. However, inconsistencies among individual battery cells in large-scale battery packs can significantly impact performance, safety, and lifespan. Traditional methods for detecting these inconsistencies often rely on manual inspection or threshold based approaches, which are time-consuming and prone to errors. This paper proposes an improved K-means clustering algorithm to identify inconsistencies in battery packs by analyzing voltage data. The improved algorithm optimizes the selection of initial cluster centers and effectively excludes outliers, enhancing clustering accuracy and efficiency. Voltage-based features, such as mean and variance, are extracted from the voltage curves of individual battery cells to characterize their behavior. The proposed method is validated using real-world data from a power station, which has better clustering performance, reducing SSE by 8.9%, DB by 2.5%, and increasing CH by 16.5% compared with the traditional algorithm. This approach provides a robust solution for detecting inconsistencies in battery packs and improving maintenance efficiency and system reliability.

09:50-10:10 **SunA4.3**

Water Body Remote Sensing Image Augmentation and Eutrophication Prediction Based on Multimodal Fusion of Atmospheric and Water Quality Information

孙艺涵, 王立, 王小艺, 刘载文
(北京工商大学)

In existing studies on the prediction of water eutrophication based on remote sensing images, the original water quality remote sensing data often suffer from unequal sampling intervals and low sampling frequency, resulting in uneven time gaps between data samples and a limited dataset. This makes it difficult to directly use the original data samples for modeling and prediction. Additionally, there is a strong correlation between the dry and wet deposition of atmospheric pollutants and the eutrophication levels of target water bodies. However, current research on water eutrophication prediction has not yet considered atmospheric pollutant factors. To address these two issues, this paper introduces atmospheric pollutant factors into the study of water eutrophication prediction based on remote sensing images and proposes a method for water remote sensing image augmentation and eutrophication prediction based on the fusion of atmospheric-water quality multimodal information.First, atmospheric pollutant images and semantic maps of the target water body are superimposed to construct a transfer learning-based multi-channel attention cascaded semantic selection network model for augmenting water remote sensing images.On this basis, the augmented water remote sensing images and the spatiotemporal features of atmospheric pollutant data are aligned to construct a cross-attention convolutional long short-term memory generative adversarial network model for water eutrophication prediction. Simulation results using actual water remote sensing images show that the proposed prediction model outperforms the original GAN model, with average improvements of 6.51% in SSIM, PSNR, and COSIN metrics for the predicted images.

机器学习算法及应用 1

时间: 2025/07/27 09:10 **主 席: 代伟 中国矿业大学**

地点: 2 楼登云厅

09:10-09:30 **SunA5.1**

Gaussian reinforcement learning for optimal tracking control of unknown systems with random disturbances

Xincheng Li ,Yiqing Gang ,Jinna Li
(Liaoning Petrochemical University)

This paper investigates a Gaussian reinforcement learning (RL) method integrated the Proportional-Integral-Derivative (PID) control to solve the linear quadratic tracking (LQT) problem of unknown systems. Accurate modeling of real-world systems is challenging, and complex systems are generally represented as linear models with unknown perturbations. Thus, an intractable issue appeared when solving the LQT is to design the optimal policy that accounts for random perturbations for an unknown systems. To this end, a novel Gaussian RL is developed based on the Gaussian prediction theory and RL techniques, resulting the optimal control policy can be found referring to the expectation and variance of system states. This is the highlighted contribution of this paper. Further, the rigorous theoretical proof of the system stability under the found the control policy is provided. Simulation results verify the effectiveness and advantages of the proposed method.

09:30-09:50 **SunA5.2**

基于动作注入状态预测模型的强化学习框架及其在路径跟踪中的应用研究

黄道缘, 杨杰龙
(江南大学)

本文针对动态环境中强化学习策略预测精度不足及对奖励函数依赖性过强的问题，提出了一种基于动作注入状态预测模型（Action-Injected State Prediction Model, AISPM）的强化学习框架。AISPM 通过动态特征掩码机制显式建模动作与状态演变的关联，有效解决了多模态输入场景下的预测精度问题。在此基础上，设计了预测驱动的训练范式，利用状态预测误差替代传统奖励函数，驱动策略网络优化。在 Autocar 仿真环境中的实验结果表明，该框架在部分观测场景下能够实现高精度状态预测，在平均奖励、横向偏差、航向角偏差与转向角变化率等指标上均优于 Dream、Import、Varibad 等基线方法，验证其在动态环境中的决策能力与控制精度。本研究为部分可观测场景下的自主决策任务提供了新的技术路径。

09:50-10:10 **SunA5.3**

Template for Preparation of Papers for Chinese Process Control Conference

刘浩然, 刘艳涛, 刘鑫, 南静, 代伟
(中国矿业大学)

Aiming at the problems of high model complexity and poor gangue detection in infrared coal gangue sorting, a coal gangue infrared image recognition algorithm SCAF-YOLO based on multi-scale attention and lightweight convolution is proposed. SCAF algorithm is based on the modular improvement of the YOLOv8 network model, which significantly improves the performance under the complex scene on the basis of keeping the original efficient detection framework. Firstly, for the problem of target localisation bias of YOLOv8 in complex scenes, the SIoU loss function is introduced as the YOLOv8 loss function, and the detection accuracy of the algorithm in complex scenes is improved by constructing an angle-aware mechanism between the predicted bounding box and the real bounding box; secondly, in order to solve the problem of insufficient multi-scale feature extraction in the detection of gangue targets, the C2f module is introduced with a MLCA attention mechanism, the formation of C2f-MLCA multi-scale feature fusion architecture, through the multi-layer convolution of the local details of the reinforcement and lightweight attention mechanism of the global context-aware idea, to enhance the algorithm of the coal gangue target multi-scale feature expression ability to improve the ability of feature extraction; Finally, for the traditional convolution operation in the process of feature extraction in the loss of information and computationally inefficient problems. SPD-Conv module is introduced as the basic convolution unit, combined with spatial pyramid pooling and depth-separable convolution ideas, to improve the feature extraction capability and operation efficiency through multi-scale feature fusion and computational efficiency optimisation. Tested on the dataset collected by the infrared platform, the experimental results show that the SCAF-YOLO algorithm exhibits excellent performance and achieves significant improvement in both mAP50 and mAP50-95 indexes. Meanwhile, the model has made important breakthroughs in lightweight design, and its model scale, number of parameters and computational complexity are all significantly reduced compared with mainstream methods, and resource consumption is significantly reduced. Compared with similar advanced algorithms, this algorithm achieves a better balance between detection accuracy and lightweight performance, which avoids the redundant computation caused by over-parameterisation and effectively improves the recognition ability of small and fuzzy targets. This design enables it to show greater practicality and deployment potential in industrial sorting scenarios, providing reliable technical support for downhole environments with high real-time requirements and resource constraints.

参数估计与系统辨识

时间: 2025/07/27 10:50 **主 席: 陈伟锋 浙江工业大学**

地点: 2 楼长乐厅

10:50-11:10 **SunB1.1**

Product Quality Prediction of Deisobutanizer Column Based on Attention Mechanism and Bidirectional Long Short-Term Memory (Bi-LSTM) Network

Zehui Li ,Renchu He
(China University of Petroleum)

Aiming at the problems of difficult real-time monitoring of the product composition of the deisobutanizer column, the lag of traditional laboratory analysis, and the insufficient accuracy of a single modeling method, a soft sensing method integrating mechanism and data-driven is proposed. A mechanism model based on the mass-transfer and heat-transfer equilibrium equations is constructed. Process data is generated through Aspen Plus simulation and is fused at the feature level with the data collected by the on-site DCS system (including variables such as temperature gradient, bottom pressure of the column, and top pressure of the column). The Pearson hybrid correlation coefficient is used to screen out key variables as the model input. In view of the non-Gaussian noise and nonlinear time-varying characteristics existing in the fused data, a bidirectional LSTM network based on the attention mechanism is developed. Experiments show that the MAE of this model for predicting the concentration of components is 0.264, which is 65.8% and 55.9% lower than that of the traditional LSTM method and the bidirectional LSTM method respectively.

11:10-11:30 **SunB1.2**

基于神经网络无迹卡尔曼滤波的全钒液流电池 *SOC* 估计

曹力丰, 肖舒怡, 任密蜂, 阎高伟
(太原理工大学)

精确估计电池荷电状态（SOC）对防止过充/过放现象、优化能量管理系统具有重要工程价值. 尽管无迹卡尔曼滤波（UKF）在 SOC 估计中展现良好适应性，但其性能高度依赖噪声先验统计特性，在复杂工况下面临不确定性量化难题. 为此，本研究提出一种长短期记忆神经网络（LSTM）与 UKF 的协同估计框架（LSTM-UKF）. 首先基于确定性权重生成对称西格玛点集合，以准确表征系统状态的概率分布；然后构建 LSTM 网络动态学习卡尔曼增益矩阵中的噪声统计特性，从而避免了传统方法中复杂的不确定性量化与近似过程。通过在全钒液流电池数据集上的验证实验表明，相较于传统 UKF 方法，所提出的 LSTM-UKF 模型在二阶等效电路模型中的 SOC 估计具有较高的预测精度，为复杂工况下的电池管理系统提供了新的解决方案.

11:30-11:50 **SunB1.3**

Branch and Bound Identification Method for Time Delay Systems

刘强, 陈伟锋
(浙江工业大学)

An branch-and-bound identification method based on the redundancy rule and first-order difference strategy is proposed in this study for a class of systems with unknown time delays. The original time-delay model is first transformed into an augmented model by utilizing the redundancy rule, and the parameters of the model are preliminarily estimated using the branch-and-bound algorithm. Subsequently, a novel time-delay determination method is introduced to identify the system delay, which is then incorporated into the original system. Afterwards, the branch-and-bound algorithm is applied again to obtain the final parameter estimates. Simulation experiments indicate that, compared with the recursive least squares with redundant parameters method and the adaptive momentum gradient descent algorithm, the proposed identification method demonstrates superior performance in terms of parameter estimation accuracy for time-delay systems.

11:50-12:10 **SunB1.4**

Parameter Transfer identification for NARX model based on sparse Bayesian learning.

Siyuan Li ,Shuang Gao ,Xiaojing Ping ,Xiaoli Luan ,Feng Ding ,Fei Liu
(Jiangnan university)

Abstract:˚System identification aims to capture the dynamic behavior of a system from measurements. In practical applications, the nonlinear autoregressive model with exogenous inputs (NARX), characterized by its concise representation and flexibility through various nonlinear functions, has been widely employed for modeling nonlinear systems. Considering the characteristics of the NARX model, one of the primary challenges in the identification process is selecting appropriate basis functions from a redundant model set, a procedure known as structure identification. Recently, sparse identification methods have emerged as effective solutions to this challenge, simultaneously addressing structure identification and parameter estimation. These methods include, but are not limited to, subset selection, Bayesian modeling, and sparse learning. However, some existing approaches often rely heavily on abundant and high-quality measurements to achieve reliable identification accuracy[1]. Nevertheless, real-world processes frequently yield limited quantities of poor-quality measurements due to equipment limitations, operational conditions, and ex-

ternal disturbances[2]. Additionally, precisely identified models of similar but distinct systems are often readily available[3]. To address these issues, this paper proposes a parameter transfer identification method based on sparse Bayesian learning (PTI-SBL). Without performing the identification from scratch, the proposed method leverages useful prior knowledge from similar systems, enabling effective identification with fewer measurements, thereby significantly enhancing identification accuracy at a reduced cost.˚Given that the source system is identified using abundant and high-quality measurements, whereas the target system relies on only a small number observations, a transfer identification method is proposed, which transfers the knowledge from the source system in the form of a probability distribution. First, based on Bayes' theorem, the transfer posterior distribution of the target system conditioned on the source knowledge can be derived. It is proportional to the product of the transfer likelihood and the transfer prior both conditioned on the source knowledge. In order to derive the unknown transfer posterior distribution conditioned on the probability distribution of the source knowledge, the posterior distribution of the source system, obtained via the SBL method, is incorporated to characterize the transfer likelihood distribution. Consequently, the transfer likelihood distribution is fixed, and the transfer prior serves as the only variational factor within the transfer posterior distribution. According to the description of probability density functions (PDFs)[4], the transfer distribution is defined as an admissible set, where the transfer likelihood remains fixed and variations are only allowed in the transfer prior within the transfer posterior distribution. At this point, the first step of the PTI-SBL method, namely the construction of the transfer model, is completed. Given that the source system and the target system are similar but not identical, transferring source knowledge may introduce unknown biases into the target system identification process. In the cases where the discrepancy is substantial, such transfer may even result in negative transfer effects. To address this, the KullbackLeibler (KL) divergence is adopted to quantify the discrepancy between the source and target systems, and the optimal distribution of the target system is determined by minimizing this divergence. Before proceeding, it is necessary to establish a reference, also referred to as the ideal model. Specifically, the ideal distribution is obtained by applying the SBL method to the target system identification process without incorporating any source knowledge. Subsequently, minimizing the KL divergence between the transfer model and the ideal model yields the optimal transfer distribution of the target parameters conditioned on the source knowledge. This process effectively discards inappropriate source knowledge, thereby minimizing the discrepancy between the transfer model and the ideal model. The resulting optimal transfer distribution not only resides within the knowledge-constrained set but also reflects the preferences of the ideal model. Finally, a numerical example is simulated to demonstrate the superiority of the proposed method.˚and Discussions We conduct numerical simulations to evaluate the identification performance of the PTI-SBL algorithm. By setting up the similar NARX models for the source and target systems, the simulations are designed to highlight the cost-effectiveness advantage of the transfer identification method by using a limited number of target samples under relatively high noise level. In the simulations, the Bayesian Lasso, the SBL algorithm, and the proposed PTI-SBL algorithm are employed to identify the target system, with the mean squared error (MSE) used as the performance evaluation metric. The simulation results show that the PTI-SBL algorithm achieves the lowest MSE. Interestingly, even when the SBL algorithm fails to correctly identify the system structure, the PTI-SBL algorithm successfully recovers the correct structure. Furthermore, to investigate the impact of the target dataset size and data quality on identification performance, we conduct 100 Monte Carlo experiments under different dataset sizes and noise levels, recording the MSE for each method. The results demonstrate that across various dataset sizes and noise levels, the PTI-SBL algorithm consistently achieves better identification accuracy and lower dispersion. In particular, under conditions of smaller datasets and higher noise levels, the PTI-SBL method exhibits significantly superior identification performance.˚The proposed PTI-SBL algorithm effectively leverages knowledge from similar yet different source systems to achieve high-accuracy identification, even when only a small number of poor-quality measurements from the target system are available. In the case where the baseline algorithm misidentifies the system structure, the proposed method leverages source knowledge to accurately identify the correct structure and enhance the precision of parameter estimation.˚Words: Nonlinear autoregressive model with exogenous inputs, sparse identification, sparse Bayesian learning, transfer learning, Kullback-Leibler (KL) divergence.˚˚˚[1] X. Luan, X. Ping, S. Zhao, F. Ding, F. Liu. A highly-accurate identification method for linear systems using transferred knowledge, Automatica, 2025, 173: 112016.˚[2] J. Xie, B. Huang, S. Dubljevic. Transfer learning for dynamic feature extraction using variational Bayesian inference, IEEE Transactions on Knowledge and Data Engineering, 2022, 34(11): 5524-5535.˚[3] X. Ping, X. Luan, S. Zhao, F. Ding, F. Liu. Parameter transfer identification for nonidentical dynamic systems using variational inference, IEEE Transactions on Systems, Man, and Cybernetics: Systems, 2025, 55(1): 712-720.˚[4] A. Quinn, M. K, TV. Guy. Fully probabilistic design of hierarchical Bayesian models, Information Sciences, 2016, 369: 532-547.˚

12:10-12:30 **SunB1.5**

An Expectation Gradient Descent Samples-Transfer Identification Method for Dynamic Systems with Non-Ideal Data

Yan Huang ,Shuang Gao ,Xiaojing Ping ,Xiaoli Luan ,Fei Liu
(Jiangnan University)

Abstract:˚Traditional parameter identification methods such as least squares (LS) and maximum likelihood (ML) have dominated dynamic system modeling owing to their simplicity and theoretical guarantees. However, these techniques rely on large, high-quality datasets that follow identical distributions, a condition seldom met in industrial scenarios. In practice, non-ideal data, including noise contamination, missing values, and distribution shifts, significantly degrade performance. To address the challenge of high-precision identification under non-ideal data conditions, recent studies have explored samples-transfer identification (STI) techniques that leverage knowledge from source systems to enhance target system identification[1-2]. Although existing STI methods improve parameter estimation accuracy through the transfer of gain matrices and dynamic weighting strategies, they still suffer from high computational complexity, sensitivity to differences in source-target domain distributions, and risks of negative transfer. To improve the above problems, this paper proposes an expectation gradient descent samples-transfer identification (EGD-STI) algorithm, which explicitly models the source-target domain distribution difference as a latent variable by establishing a unified probabilistic framework for transfer identification. It integrates gradient-driven optimization with transfer learning principles to mitigate distribution discrepancies and resist data anomalies. The proposed method aims to achieve robust parameter identification for dynamic systems under non-ideal data conditions, ensuring high accuracy even with limited samples, significant noise interference.˚First, cross-system modeling and discrepancy quantification establish a probabilistic foundation for knowledge transfer. Two structurally analogous systems, designated as the source system and target system, are formulated under zero-mean Gaussian white noise conditions. While both systems share identical model structures, their parameter vectors and noise characteristics diverge, reflecting real-world discrepancies in data distributions. The source system, with known historical data, serves as a reference for transferring knowledge to the target system. The key innovation is to quantify the inter-system differences through a latent variable framework that is able to match the prior knowledge acquired from the source system with the target system data, which is a key step for robust identification under non-ideal conditions. Second, the expectation gradient descent (EGD) framework is introduced to iteratively refine parameter estimates. Traditional expectation maximization (EM) algorithms alternate between expectation (E) steps, which compute posterior distributions of latent variables, and maximization (M) steps, which optimize parameters by solving analytical equations[3-4]. In complex scenarios, particularly those involving high-dimensional parameter spaces or non-convex objective functions, the derivation of closed-form solutions for the M-step proves computationally infeasible. To overcome this, the proposed method replaces the explicit M-step with a gradient-driven update rule. During the E step, the conditional distribution of latent variables is derived using Bayesian inference, leveraging the Gaussian properties of noise to simplify posterior calculations. Subsequently, in the gradient descent (GD) step, parameters are updated incrementally by ascending the expected log-likelihood gradient, circumventing the need for analytical maximization. This fusion retains EM' s ability to handle latent variables while incorporating the flexibility of gradient-based optimization. Third, convergence guarantees and gradient optimization strategies ensure stability and efficiency. A key challenge of the EGD-STI algorithm is to balance the step size to avoid divergence or slow convergence. The method uses a spectral radius criterion to limit the learning rate and ensure that the iterative updates shrink to the optimal parameters. Specifically, the step size is dynamically adjusted based on the eigenvalues of the gradient Jacobian matrix.˚and Discussions The estimation performance of the proposed EGD-STI algorithm is evaluated under non-ideal conditions, including scarce sample numbers and significant noise interference. To assess robustness, the mean square error (MSE) served as the primary evaluation metric. Simulation results demonstrate that the EGD-STI algorithm achieves stable convergence across diverse scenarios. Although initial MSE values are moderately higher due to randomized parameter initialization and the iterative nature of gradient-based optimization, the errors exhibit a consistent decline as iterations progressed, ultimately converging to a steady state. The EGD algorithm effectively improves computational efficiency by avoiding the explicit matrix inversion operation involved in the parameter estimation process of the classic EM algorithm. However, in high-dimensional parameter space, its limited iterative step size reduces the convergence speed. Comparative analysis with traditional LS and TI algorithms reveals the superiority of the EGD-STI algorithm. The expectation-driven latent variable inference combined with gradient optimization effectively reduces the impact of distribution differences. In addition, the algorithm shows enhanced robustness in high-noise environments and with limited sample sizes, and is able to leverage the migrated knowledge from the source system to alleviate the challenges of data scarcity.˚The results demonstrate that the proposed EGD-STI algorithm enables accurate parameter estimation for dynamic systems with non-ideal data. By modeling distributional discrepancies as latent variables and iteratively optimizing parameters through expectation-driven gradient descent, the algorithm adjusts transfer weights and mitigates negative transfer effects. Theoretical convergence guarantees and simulation validations confirm its superior accuracy and robustness under high noise and limited samples.˚Words: expectation gradient descent, transfer learning, system identification, samples-transfer identification, non-ideal data˚˚[1]X. Luan, X. Ping, S. Zhao, F. Ding, and F. Liu, "A highly accurate identification method for linear systems using transferred knowledge," Automatica, vol. 173, Art. no. 112016, Mar. 2025.˚[2]L. Xin, L. Ye, J. Chius, and V. Sundaram,

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多智能体协同控制 1

时间: 2025/07/27 10:50 **主 席: 何大阔 东北大学**

地点: 2 楼长乐厅

10:50-11:10 **SunB2.1**

Observer-Based Active Disturbance Rejection Control for Multi-Agent Leader-Following Consensus via Dynamic Event-Triggered

张奎, 何平, 李杰泰, 谢锦玮
(四川轻化工大学)

For multi-agent leader-following systems subject to unknown external disturbances and constrained communication resources, this paper proposes an active anti-disturbance consensus control method integrating an observer and dynamic event-triggered mechanisms. To address the incomplete measurability of follower agents' states, a distributed state observer is designed for dynamic state estimation. Aiming to alleviate resource waste in traditional periodic communication, a dynamic event-triggered mechanism is developed by incorporating a state-dependent dynamic threshold function, which adaptively adjusts triggering intervals to significantly reduce communication frequency while guaranteeing consensus. To counteract the stability impacts of external disturbances, a distributed disturbance observer is constructed for estimating each follower's disturbance, accompanied by an active compensation strategy that dynamically neutralizes disturbances. Theoretical analysis demonstrates that the proposed approach prevents Zeno behavior and ensures uniform ultimate boundedness of all closed-loop system signals. Finally, simulation results validate the effectiveness of the theoretical findings.

11:10-11:30 **SunB2.2**

The finite-time distributed formation control of USVs based on FTESO

Lulu Wang ,Ao Xu ,Ning Yang ,Ge Song
(Harbin University of Science and Technology)

This paper deals with the distributed formation control problem for unactuated vessel. Firstly, a finite-time extended state observer (FTESO) is designed to quickly observe the compound disturbances and velocity information at the same time. Secondly, the coupling term of surge velocity and heading angle is taken as the control input in the kinematic equation, and the velocity of the virtual leader does not need to be assumed to be non-zero, that is, the containment control of the virtual leader in any state can be realized. Then, based on the observations of velocity and compound disturbances, the finite-time virtual control law and the finite-time containment controller of distributed formation are designed in combination with the containment control method. Then, the system stability analysis proves that all signals of the closed-loop system are consistent and ultimately bounded. Finally, two sets of simulation experiments are given to verify the effectiveness of the proposed formation control method.

11:30-11:50 **SunB2.3**

Multi-Agent Resilient Coverage Control in Unknown Dynamic Environments

Zheyuan Ning ,Hao Luo ,hao wang ,YunFeng Zhang ,Yuchen Jiang
(Harbin Institute of Technology)

Multi-agent coverage control is critical for applications like environmental monitoring, but sensor faults may distort environmental parameter estimation and degrade coverage performance. Existing methods assume ideal sensor conditions, failing to address practical scenarios with sensors failures or cyber attacks. A distributed resilient coverage control algorithm is proposed to achieve joint estimation and control via dynamic environmental parameter modeling. Theoretical proof demonstrates convergence of parameter estimation. Simulation shows lower coverage cost compared to conventional method with final performance matching fault-free scenarios

11:50-12:10 **SunB2.4**

Observer-based adaptive neural network control for multi-agent systems with input delay and input saturation

li xin ,dakuo he
(Northeastern University)

In this paper, an adaptive neural network control scheme based on state observer is studied for multi-agent systems with input delay and input saturation. Compared with existing literature, this paper considers both input delay and input saturation in multi-agent systems, which poses difficulties for controller design. On this basis, the Pade approximation combined with Laplace transform and the introduction of auxiliary variables respectively eliminate the effects of input delay and input saturation. In addition, a state observer based on radial basis function neural networks are designed to approximate unknown nonlinear functions and estimate unmeasurable states. Finally, it is demonstrated through adaptive backstepping techniques and Lyapunov stability theorem that multi-agent systems can achieve consensus tracking control objectives. The estimation error of the state observer and tracking error converge within a small range of zero. The effectiveness of the proposed method are verified through simulation.

12:10-12:30 **SunB2.5**

Distributed Game-Based Dynamic Formation Control and Obstacle Avoidance for Multiple UAVs

Yong Xiao ,Xiaoxiang Hu ,chen yang ,Bing Xiao
(Northwestern Polytechnical University)

This paper presents a collaborative obstacle avoidance control algorithm for multi-UAVs formation in dynamic environments, which integrates gradient descent optimization, game theory, and distributed observers. By modeling the formation problem as a non-cooperative game, a Nash equilibrium solution strategy based on local cost functions and implement neighbor state estimation through a consensus protocol is developed. This algorithm innovatively incorporates a nonlinear potential fieldbased obstacle avoidance mechanism, ensuring that UAVs consistently maintain a safe separation distance. Simulation results demonstrate the algorithm's effectiveness through three operational phases: initial formation assembly (0-30s), cruising stability maintenance (30-60s), and fault-tolerant hexagonal reconfiguration (60-90s) under communication failures. Compared with conventional methods, our approach significantly reduces communication load while maintaining excellent reconfiguration capability during mission transitions, offering both theoretical insights and practical solutions for complex UAV swarm control scenarios.

故障检测、诊断与决策 2

时间: 2025/07/27 11:10 **主　席: 侍洪波　华东理工大学**

地点: 2 楼未央厅

11:10-11:30 **SunB3.1**

解决工业故障诊断中的域偏移和类失衡问题的可迁移特征提取方法

张一铭, 侍洪波
(华东理工大学)

流程工业过程由于操作条件的变化，会引起未来数据的分布偏离于历史数据。此时建立在历史数据上的故障诊断模型不能很好的适应这种新变化。从多源数据中提取可迁移特征为这个问题提供了思路，并取得了一定的成效。然而已有的基于不变特征的多域特征对齐方法假设源域数据的故障类别平衡，在实际工业中，不同工况下故障发生的频率不同，难以获得平衡故障数据集。因此，为了解决域间分布偏移及类别不平衡问题，本文提出了一种面向不平衡多域数据的可迁移特征提取方法(PETS)，有效减小源域分布差异，同时保持类别判别性信息；并在训练过程中引入了类别平衡加权策略，以缓解源域类别不平衡对模型性能的影响。在 Tennessee Eastman 过程（TEP）数据集上的实验验证了 PETS 在多个工况下的优越分类性能。并与多种方法对比，PETS 在中间类与少数类故障诊断任务中均取得了显著提升，充分证明了所提方法在实际工业应用场景中的有效性与鲁棒性。

11:30-11:50 **SunB3.2**

化工过程多变量系统的互耦合度与模型失配判别

李炫哲, 范闻轩, 方劲舟, 许锋
(中国石油大学)

在化工生产过程中，受到设备老化、工艺条件变化或外界干扰等因素的影响，被控对象的工作点将会发生改变，系统的动态特性也随之变化，被控对象的数学模型将会出现失配的情况，达到一定程度时就需要对控制结构进行重构。针对存在的这种问题，本文提出了一种基于互耦合度的模型失配判别方法，为多变量分散 PID 控制系统的在线重构提供理论依据。首先，引入互相对增益和互耦合度的概念，表达多变量系统中任意两个 PID 控制回路之间的耦合特性。然后进一步提出闭环互相对增益与闭环互耦合度，通过闭环测试减小工作量，并解决不对称的问题。闭环互耦合度变化量能够体现模型失配程度，根据系统幅值稳定裕度计算出闭环互耦合度的阈值，进而实现控制系统是否需要重构的判断。最后，通过三个实例的仿真，验证了判别方法的有效性。

11:50-12:10 **SunB3.3**

面向小样本问题的集成元学习工业过程故障诊断方法研究

陈相池, 侍洪波, 汤思昱
(华东理工大学)

现有的数据驱动故障诊断方法对于工业过程完备的高质量数据具有较强的依赖性，而在实际工业过程中，为避免设备长时间处于故障状态对系统正常运行造成的严重危害，故障数据的获取往往会受到限制，这导致了故障数据不足的小样本故障诊断问题. 为解决上述问题，本文提出了一种集成元学习的小样本工业过程故障诊断方法，将原始小样本数据分别送入弱学习器中进行特征提取，提取到的特征被进一步送入多层感知机（MLP）特征融合模块并输出融合特征. 设计任务相关性自适应元损失加权机制，动态调整每个任务的学习重点，得到元学习分类器，并与先前训练好的弱学习器进行集成得到最终的集成分类器，故障诊断结果通过对集成分类器的输出进行软投票得到. 该诊断方法利用了不同模型间的优势，减少小样本情况下的过拟合，能够得到较好的小样本故障诊断结果. 使用工业过程故障诊断领域的通用数据集田纳西伊斯曼过程 (TEP) 数据集验证了所提出方法的有效性.

数据驱动建模 2

时间: 2025/07/27 11:10 **主 席: 杨慧中 江南大学**

地点: 2 楼鸿喜厅

11:10-11:30 **SunB4.1**

未知模型下深度 *Koopman* 卡尔曼滤波

肖媛媛, 徐琛, 谢莉, 杨慧中
(江南大学)

随着工业系统复杂度的不断提高，非线性状态估计器的设计变得尤为重要。本文提出了一种基于 Koopman 算子理论的深度卡尔曼滤波方法，以应对具有未知模型非线性系统的状态估计问题。传统方法通常依赖精确的系统模型，而本方法利用 Koopman 算子提取系统的关键特性，并结合深度神经网络学习系统特征，在无需系统模型信息情况下获得深度 Koopman 线性模型；然后，将卡尔曼滤波器嵌入到深度 Koopman 线性模型，以得到未知非线性系统的估计状态。仿真结果表明，该方法在无需系统模型先验知识的情况下，能够实现比传统滤波方法更优的估计性能。

11:30-11:50 **SunB4.2**

TCGA-Net: A Temporal Convolution and GRU Based Dual Attention Network for Multiscale Soft Sensor Modeling

Huanqi Sun ,WeiLi Xiong ,Junxia Ma ,Xudong Shi
(Jiangnan University)

The multilevel coupling of reaction units in industrial process technologies results in processes exhibiting distinct multiscale characteristics and complex dynamic behaviors. Moreover, the presence of long-term dependencies among process variables poses significant challenges for effective temporal feature extraction. To address these issues, a multiscale soft measurement model based on a two-stage attention framework is proposed. First, a two-stage feature extraction strategy is designed to simultaneously capture local coupling relationships and global temporal dependencies, thereby enhancing the model’ s ability to characterize complex process dynamics. Second, a two-stage attention enhancement mechanism is introduced to dynamically explore potential correlations between input and target features, highlight critical feature representations, and evaluate the importance of different historical time points for more accurate prediction. Finally, the proposed method is applied to a wastewater treatment process, and experimental results demonstrate its superior predictive performance compared to existing approaches.

11:50-12:10 **SunB4.3**

A Topology-Enhanced Hierarchical Spatio-Temporal Decoupled Attention Architecture for Soft Sensing of Key Water Quality Indicators in Wastewater Treatment

朱红求, 李宗宸, 夏斯博
(中南大学)

The wastewater treatment process is characterized by multivariable coupling, dynamic time-varying operational states, and complex topological relationships among variables, posing significant challenges to improving the performance of soft sensor models. To address these challenges, this paper proposes a soft sensing method for key water quality indicators based on a topology-enhanced hierarchical spatio-temporal decoupled attention architecture. First, to resolve the difficulty in effectively extracting features caused by multivariable coupling and dynamic operational states, we design a spatio-temporal decoupled attention mechanism based on Transformer, which separately extracts decoupled temporal and spatial features through two parallel branches. Second, to comprehensively capture feature variation patterns across different scales, we construct a hierarchical pyramid structure that utilizes convolutional downsampling operations to extract cross-scale joint representations. Finally, to overcome the insufficient characterization of implicit topological relationships among variables in the absence of prior knowledge, we introduce an adaptive topology learning module that builds an end-to-end trainable graph attention network. Experimental results demonstrate that the proposed method significantly improves the online estimation accuracy for three key indicators: BOD, TN, and COD.

机器学习算法及应用 2

时间: 2025/07/27 11:10 **主 席: 曹雨齐 浙江大学**

地点: 2 楼登云厅

11:10-11:30 **SunB5.1**

Bone Marrow Cell Classification Based on Multi-scale Feature Fusion

兰倩, 谢莉, 杨慧中, 徐琛
(江南大学)

Morphological classification of bone marrow cells constitutes a critical step in hematological disease diagnosis. However, the current gold-standard manual microscopy method remains time-consuming and inefficient due to cellular diversity and high inter-class feature overlap, failing to meet clinical demands for timely patient assessment. To address the insufficient feature representation in existing deep learning approaches for bone marrow cell classification, this study proposes a model based on residual neural networks with feature enhancement mechanisms. The framework incorporates three key innovations: First, cross-scale feature compression units are integrated into residual blocks through pyramid-structured modules to enable multi-receptive field feature interaction. Second, a cell feature enhancement module is designed to strengthen the model's capability in capturing critical morphological parameters. Third, dynamic feature fusion channels are constructed with deformable attention mechanisms to achieve hierarchical feature integration. Comparative experiments on public bone marrow cell image datasets demonstrate that the proposed model achieves a 3.1% accuracy improvement over baseline networks, establishing a novel technical pathway for digital bone marrow cell analysis.

11:30-11:50 **SunB5.2**

PatchX-MLP：一种用于 *SCR* 入口 *NOx* 浓度预测的时序预测算法

杨仙林, 钱金传, 张新民, 宋执环
(浙江大学)

为了有效预测选择性催化还原（SCR）系统中入口 NOx 浓度，本文提出了一种基于多层感知器（MLP）与多尺度补丁嵌入的时序预测模型——PatchX-MLP。该模型融合了 PatchTST 的补丁分割思想与 X-MLP 的通道交叉机制，能够从不同尺度捕捉时间序列中的季节性与趋势性特征。PatchX-MLP 通过三个维度的 MLP 子模块实现局部模式、长期依赖和多变量协同建模，并引入频域损失函数以提升模型泛化能力。在六个公开数据集和实际 SCR 工业数据上的实验结果显示，PatchX-MLP 在均方误差（MSE）与平均绝对误差（MAE）指标上均优于多种主流时序预测模型，验证了其在 NOx 浓度预测任务中的先进性与实用性。

11:50-12:10 **SunB5.3**

A Study on Spartina Alterniflora Monitoring Method Based on Deep Learning and UAV Images

Ziang Li ,Baiyu Zhu ,Pingjie Huang ,Hongjian Zhang ,Yuqi Cao
(Zhejiang University)

Currently Spartina alterniflora is considered an invasive alien species in many places. How to dynamically monitor Spartina alterniflora in the coastal mudflat area has become a task that needs to be solved. Traditional satellite remote - sensing monitoring methods face limitations such as low temporal resolution and susceptibility to environmental factors. To address these issues, this study integrates deep - learning techniques with unmanned aerial vehicle (UAV) imagery to inspect the growing situation of Spartina alterniflora. Firstly, based on Sentinel - 2 NDVI time - series data from 2021 to 2023, we combine the Harmonic Analysis of Time Series (HANTS), Savitzky - Golay (S - G) filtering algorithms, and the Jeffries - Matusita (J - M) discriminant algorithm to determine the critical detection period for Spartina alterniflora in early May. During this period, we collect UAV aerial images and preprocess them. Then, we design an improved YOLOv5 object - detection algorithm by embedding the Convolutional Block Attention Module (CBAM) after the lower and middle C3 blocks of the CSPDarknet framework. Experimental results on a dataset of approximately 1000 images show that the improved algorithm significantly outperforms the original YOLOv5 in terms of mean Average Precision (mAP) and F1 - score, especially in detecting small targets and reducing misclassification rates. This research provides a reliable technical approach for the efficient monitoring of Spartina alterniflora in coastal wetlands.

工业过程管理与决策系统

时间: 2025/07/27 13:30 **主 席: 潘冬 中南大学**

地点: 3 楼金江厅

13:30-13:50 **SunC1.1**

Research on multi-objective optimization method for continuous casting and hot rolling production scheduling

华明清, 蒋朝辉, 潘冬, 余浩洋, 桂卫华
(中南大学)

: As the key links in the steel production process, the production scheduling level of continuous casting and hot rolling processes is of great significance to the energy conservation and consumption reduction, intelligent transformation and upgrading of steel enterprises. Most of the existing studies on continuous casting and hot rolling production scheduling are single-objective optimization modeling, which does not consider the synergistic relationship between steel production indicators and energy consumption emissions. Based on the hot rolling process constraints, this paper establishes a vehicle path planning model that considers the length constraints of slabs with the same width and the arrival order of slabs for the two goals of optimal hot rolling production indicators and minimum energy consumption. A real-time solution method based on graph attention neural network is proposed. By adjusting the selection window to limit the decision space of the slab, the optimal Pareto frontier is obtained, and experimental verification is carried out on the actual production data of a steel plant. The results show that the design method in this paper can effectively balance the conflict between production quality and energy consumption, and can provide guidance for the real-time scheduling of continuous casting and hot rolling production in steel enterprises.

13:50-14:10 **SunC1.2**

Optimization scheduling of electrolytic copper foil production process based on hierarchical genetic algorithm

赵宣茗, 裘智峰, 孙思祖, 黄大建
(中南大学)

The foil production process is a key step in the manufacturing of electrolytic copper foil, characterized by high energy consumption and strong continuity. Optimizing energy consumption and production scheduling under the time of use electricity pricing policy is an effective path for electrolytic copper foil enterprises to reduce costs and increase efficiency, and achieve sustainable development. The actual foil production process mainly relies on manual experience for scheduling decisions, and there are problems such as insufficient dynamic electricity price response, low energy efficiency, and lack of data model support. Meanwhile, there are three limitations in research based on traditional optimization scheduling models: static parameterization of current intensity, neglect or simplification of production process soft constraints, and insufficient consideration of energy cost optimization. Therefore, in the context of time of use electricity pricing, this paper considers the process soft constraints that reflect the actual production elasticity demand, establishes a cost optimization model for foil production electricity, and uses the current intensity closely related to production efficiency as the decision variable to achieve three variable collaborative decision making for equipment selection, process sorting, and current configuration. A hierarchical genetic algorithm based on a dual chromosome hierarchical coding mechanism is designed for solving the problem. Experiments have shown that compared to the original production plan, the designed scheduling optimization reduces energy costs by 15%. At the same time, compared to the other four algorithms, the designed hierarchical genetic algorithm has the lowest energy cost for optimization. This study provides an intelligent optimization approach that integrates process constraints and power scheduling for high energy consuming process industries, providing theoretical support and technical pathways for the green transformation of electrolytic copper foil production.

14:10-14:30 **SunC1.3**

Optimization of Integrated Energy System Scheduling Based on Multi-Strategy Collaborative Presolve Approaches

贾健, 陈伟锋
(浙江工业大学)

In Integrated Energy Systems (IES), the strong coupling between various energy forms and the introduction of discrete decision variables lead to issues such as severe constraint redundancy and overly large variable bounds in the Mixed-Integer Programming (MIP) models. A multi-strategy collaborative presolve process is proposed in this paper. Techniques such as redundant constraint removal, boundary strengthening, and single-element equality substitution are applied to simplify the model and improve solution efficiency. Experimental results show that, when the Gurobi, CPLEX and SCIP solvers are used to optimize IES systems, the proposed method reduces the solution time while maintaining the accuracy of the optimal solution. The effectiveness of the proposed presolve process for efficient modeling and real-time scheduling of IES is verified.

14:30-14:50 **SunC1.4**

数据与机理融合的换热网络基准能效建模与监测

张哲, 孙琳, 罗俊
(中国石油大学)

换热网络作为过程工业中节能减排的关键环节，其能效监测对提升能源利用效率具有重要意义。针对现有能效监测方法中机理模型参数求解困难与数据驱动模型解释性不足的问题，本文提出一种基于数据与机理融合的换热网络能效监测方法。通过物理信息神经网络(PINN)构建能效模型，结合数据驱动与物理守恒约束，在降低数据依赖性的同时增强模型的物理一致性；采用粒子群算法优化求解换热网络基准能效，确定最佳运行工况；通过对比实际运行参数与基准模型，量化能效偏差并识别节能潜力。案例分析表明，本文所提方法能够准确量化能效偏差，及时发现潜在节能机会，对实际工业生产具有重要的指导意义。

14:50-15:10 **SunC1.5**

A Multi-Parameter Fusion Intelligent Decision-Making Framework for Mixed Oil Cutting

Huajun Xu ,YONG LI ,Tao Wang ,Jinghao Guo ,Xiaoyong Gao
(China University of Petroleum)

In multi-product pipeline transportation systems, accurately predicting the interface of mixed oil segments and executing timely cutting operations remain significant challenges. Traditional decision-making methods, which rely solely on densitometer readings, often suffer from limited accuracy and robustness. This paper proposes an intelligent decision-making framework that integrates a Kolmogorov-Arnold Network (KAN) with a Long Short-Term Memory (LSTM) network and an attention mechanism. By leveraging both expert knowledge and multi-sensor time-series data, the model effectively predicts key flow parameters and supports proactive intervention by the SCADA system. Experimental results demonstrate that the proposed KAN-LSTM-Attention model achieves a 15% improvement in prediction accuracy over traditional approaches (e.g., ARIMA, LSTM), and a 3% gain over CNN-LSTM models. The framework offers a reliable and interpretable solution for real-time mixed oil monitoring and decision-making in long-distance, multi-product pipelines.

多智能体协同控制 2

时间: 2025/07/27 13:30 **主 席: 王标 沈阳航空航天大学**

地点: 2 楼长乐厅

13:30-13:50 **SunC2.1**

Simulated Annealing-Optimized Artificial Potential Field Method for Multi-Agent Collision Avoidance

Liu Xianghang ,Aimin An
(Lanzhou University of Technology)

The problem of collaborative multi-agent path planning in complex multi-obstacle environments is a current research hotspot in academia. However, achieving efficient obstacle avoidance, smooth path generation, and environmental adaptability for collaborative multi-agents in such scenarios remains a challenging task. This paper proposes a novel formation obstacle avoidance control strategy that integrates the leader-follower approach with the artificial potential field method, optimized using a simulated annealing algorithm. We introduce the simulated annealing algorithm and combine its objective function optimization results with the improved artificial potential field method to enhance agents' capability of escaping local optima in complex obstacle environments, thereby improving the overall performance of agent path planning. Simulation results demonstrate that the artificial potential field method optimized by simulated annealing exhibits stronger adaptability, generates smoother leader paths, achieves higher path planning efficiency, and better addresses complex multi-obstacle environments.

13:50-14:10 **SunC2.2**

Trajectory Tracking Control for Flexible Manipulator Based on Combined Neural Network Control

yongquan Li ,Aimin An
(Lanzhou University of Technology)

Trajectory tracking control of flexible robotic manipulators is a research hot spot in the current academic field. However, the insufficient tracking accuracy and poor anti-disturbance performance caused by the highly nonlinear characteristics of flexible manipulator systems remain a critical challenge that requires urgent breakthroughs. This paper focuses on the challenging issue of improving trajectory tracking accuracy for flexible robotic manipulators, where control precision is inherently constrained by highly uncertain nonlinear dynamics. The flexible manipulator system is a high-order nonlinear system, possessing strong coupling characteristics. During the processing of establishing the dynamic model, highly uncertain nonlinearities will be generated. Regarding the problem that the trajectory tracking control accuracy of flexible manipulators is difficult to be improved due to the highly unknown nonlinearity. Design a neural network controller , employing an RBF NN as a compensator to realize compensation for the unknown nonlinearities of the system , and by using the sliding mode control to reduce the approximation error. The designed control method is implemented using Radial Basis Functions (RBF), combined with a Error Feedback Neural Network (NN), where the Neural Network serves as a policy network. Compared to traditional neural networks, in the feedback framework, the Error Feedback Neural Network can learn and provide feedback on the system's states, while the RBF NN can rapidly update its weights based on the real-time feedback from the Error Feedback Neural Network, further adjusting the control policy to adapt to the dynamic changes of the system. This results in a higher capability to approximate the system's nonlinearities, thereby achieving fast and precise control of the system. Additionally, the feedback frame, through the feedback mechanism of the Error Feedback Neural Network, can reduce the variance of policy updates to some extent, enhancing the robustness of the system and significantly improving its ability to resist external disturbances. The stability of the system is proven through the Lyapunov stability theorem, and the effectiveness of the proposed method is ultimately demonstrated by simulation results.

14:10-14:30 **SunC2.3**

基于深度强化学习的无人机空战自主决策方法研究

周铭哲, 刘利智, 孟光磊, 王标
(沈阳航空航天大学)

为提高无人机在未来智能空战中的自主决策问题，提出了一种混合近端策略优化（Mix Proximal Policy Optimization，M-PPO）算法，该方法在 PPO 的在线策略框架中引入重要性采样机制，复用历史经验池数据，同时通过动态裁剪阈值平衡新旧策略差异，提升数据利用率。仿真结果表明，在典型的空战实验场景中，分层框架下的 M-PPO 算法能够缩短探索时间，避免陷入局部最优，有效引导无人机在不同态势下自主学习机动决策并快速到达优势位置，完成空战任务，其收敛效果与机动决策表现均显著优于传统深度强化学习方法下的 PPO 算法，有效提高了无人机作战能力，并通过复杂多场景测试验证该算法具有良好的泛化性。

14:30-14:50 **SunC2.4**

A Hierarchical Framework for Event-Triggered Fault-Tolerant Consensus Control of Multi-Agent Systems Under DoS Attacks

Yunan Qu ,Xiaoli Luan ,Haiying Wan ,Fei Liu
(Jiangnan University)

Objective Distributed consensus control, as a fundamental core issue in multi-agent systems (MASs),

aims to synchronize the states of all agents by enabling each agent to exchange information only with its neighboring agents, based on a predefined communication protocol. To achieve the goal of consensus control, an important issue is the design and implementation of distributed coordination control protocols with limited network resources. Traditional controllers are impractical because they require continuous communication between agents and constant updates to the controllers. In contrast, event-triggered schemes can minimize communication resource usage in networked control systems while maintaining good performance[1]. However, agents often do not operate under ideal conditions. External disturbances, network attacks, and actuator faults can lead to a degradation in system performance, even affecting system stability. Current research methods for actuator faults mainly focus on post-fault remedies, often only taking effect once the cooperation process in the MAS has already been impacted by actuator faults. Unlike existing methods, this paper proposes a fault-tolerant consensus control method for MASs under denial of service (DoS) attacks based on a hierarchical strategy. The goal is to enable the MASs pre-prevent the propagation of fault effects, while implementing dual security guarantees of fault tolerance and attack resilience in cyber-physical MASs.˚Firstly, we decouple the cooperation rule and the individual regulation of the MAS into two layers. The upper layer consists of a virtual reference system with a dynamic event-triggered mechanism, while the lower layer is an adaptive tracking controller for the actual agents. Specifically, the virtual system is composed of several nodes, each corresponding to an actual agent. These nodes play the role of virtual agents, completing the consensus cooperation tasks in advance, while the actual agents track the trajectory signals of the virtual system through their tracking controllers. This two-layer structure not only simplifies the design of the control scheme but also pre-prevents the propagation of fault effects. Secondly, to address DoS attacks in the communication network and the limitation of communication resources, a dynamic event-triggered mechanism based on DoS attacks is designed in the upper layer. Virtual agents only exchange information with neighbors when the event-triggering conditions are satisfied, effectively saving communication resources. And an internal dynamic variable is introduced in the event-triggering condition, which evolves with the cooperation process and can prevent the occurrence of Zeno behavior. Then, by combining Laplacian matrix decomposition and graph theory with matrix theory, the conclusions of undirected graphs are extended to more general directed graphs containing a spanning tree. Thirdly, an adaptive fault-tolerant tracking controller is proposed to help the lower-layer actual agents track the trajectory signals of the upper-layer virtual system. The model reference adaptive control is used to estimate the unknown and time-varying bias faults and partial loss of effectiveness (PLOE) parameters. The adaptive law for the PLOE parameters is based on the projection operator method[3], which allows for quick adaptive updates of the fault parameter values under parameter constraints, while maintaining system stability. Finally, through numerical simulations, the effectiveness of the proposed method is verified compared to traditional single-layer control methods.˚and Discussions The performance of the proposed hierarchical method in MASs under DoS attacks and actuator faults is analyzed. To verify the effectiveness of the proposed method, bias faults and PLOE in the agents are considered, and DoS attacks are introduced into the communication network. Simulation results show that the states of all agents gradually achieve consensus, demonstrating that the proposed method can achieve event-triggered fault-tolerant consensus control for MASs under DoS attacks. Compared with traditional event-triggered mechanisms, the communication interval of the upper-layer dynamic event-triggered mechanism is significantly increased, effectively saving communication resources. Compared to traditional fault-tolerant control methods, it is found that only the dynamics of agents experiencing actuator faults are affected in the proposed method. However, with the help of the adaptive law, the fault parameters are quickly compensated, and the agents' states reach consensus with their neighbors, meaning that the cooperation process of the MAS is not affected. ˚The results show that under DoS attacks and actuator faults, the proposed hierarchical approach helps the MASs achieve consensus while pre-preventing the fault propagation. The upper-layer dynamic event-triggered mechanism assists the virtual reference system in completing cooperation tasks in advance under DoS attacks, effectively saving communication resources while excluding Zeno behavior. The lower-layer adaptive tracking controller quickly compensates for bias faults and PLOE. The proposed method is practical, simple in structure, and robust.

故障检测、诊断与决策 3

时间: 2025/07/27 13:30 **主 席: 刘峥 北京工业大学**

地点: 2 楼未央厅

13:30-13:50 **SunC3.1**

Few-shot Fault Diagnosis for Electric Submersible Pump Based on Transformer-enhanced Prototypical Network

Liang Cheng Wang ,Kang Li ,Xiaoyong Gao
(China University of Petroleum, Beijing)

Electric submersible pumps are important lifting tools in oil fields, and real-time fault diagnosis is an important measure to ensure economic benefits. However, the current fault diagnosis of submersible pumps faces the problems of scarce samples and difficulty in extracting features from dynamic data. In recent years, meta-learning has gradually become a potential solution to the problem of small sample fault diagnosis. To this end, based on existing research results, we integrated the advantages of prototypical networks and Transformers to develop a set of submersible pump fault diagnosis procedures.

13:50-14:10 **SunC3.2**

基于融合特征迁移的污水处理膜污染零样本故障诊断

蔡国庆, 刘峥, 韩红桂
(北京工业大学)

针对污水处理膜污染故障样本稀缺、难以准确诊断的问题, 提出一种基于融合特征迁移的零样本故障诊断方法. 首先, 研究基于粗细粒度的故障描述方法, 设计基于信息熵的故障特征信息提取策略, 动态获取故障特征知识; 其次, 提出基于多尺度聚类的故障特征知识融合方法, 建立基于特征迁移的模糊神经网络, 实现未知类故障属性准确预测; 最后, 设计基于属性相似度的模糊推理策略, 采用隶属度量化未知故障与已知故障属性的语义相似性, 实现未知故障类型在线诊断, 并应用于实际的污水处理膜污染过程中. 实验结果表明, 该方法能够实现膜污染未知故障的实时准确诊断, 保障污水处理过程安全稳定运行.

14:10-14:30 **SunC3.3**

Cascading Failure-Oriented SGC Critical Topology Identification for Renewable Energy Grids

Min Yin ,Xiaomin Wang ,Jianrong Wang ,Xinchun Jia ,Yunfei Xie ,Yuhang Wang
(Shanxi University)

The power supply under the high penetration of renewable energy has become an important guarantee for the smooth development of modern society and economy, and it is of great practical significance to quickly and accurately identify the critical topologies in renewable energy grids to prevent large-scale blackout accidents. In this paper, a data-driven method based on the Simplified Graph Convolutional Network (SGC) algorithm is proposed to quickly identify critical topologies that trigger grid cascading failures. First, cascading failures are modeled under various renewable energy penetration scenarios using the N k failure propagation mechanism of the grid, and the critical topologies are defined based on risk theory. Then, a fine-tuned SGC algorithm is used for the design of the critical topology recognizer. Finally, the functional validation of the recognition model is carried out on the IEEE39 and IEEE57 systems containing different proportions of renewable energy. Case studies show that the proposed method can effectively realize the critical topology identification task for grid cascading failures under renewable energy penetration and facilitate the efficient deployment of modern grid security measures.

数据驱动建模 3

时间: 2025/07/27 13:30 **主 席: 陶宏伟 南昌大学**

地点: 2 楼鸿喜厅

13:30-13:50 **SunC4.1**

Individual Thermal Comfort Assessment Based on Infrared and Linear Skin Temperature Data-driven Modeling

向晓争, 胡嘉文, 万晓凤, 余运俊, 郑志斌, 陶宏伟, 张欢
(南昌大学)

Accurate and individualized thermal comfort assessment is important for improving the comfort and energy efficiency of the building environment. However, traditional methods mostly rely on single-modal data, which are susceptible to individual differences, uncertainties in data collection and application scenarios, and are difficult to take into account the stability and generalization ability of the model in known groups (trained members) and unknown groups (unfamiliar members). To address the above problems, this paper proposes a bimodal data-driven thermal comfort assessment method based on infrared thermography and linear skin temperature. By introducing a multi-scale weight proportion allocation strategy, the RF and EfficientNet-B1 models are used to learn the features of linear temperature data and infrared thermography data, respectively, and combined with SHAP and Grad-CAM graph parsing to validate, e.g., the radial artery of the arm, the dorsum of the hand, and the nasal region and cheek of the face in the key temperature-sensitive regions. The experimental results show that the model can synergize the two types of modal advantages when the modal fusion weights are 5:5. High accuracy is maintained in trained members (all 92.68%), while for unfamiliar members, the maximum performance enhancement after bimodal fusion reaches 35.02%. This method provides a solution for thermal comfort assessment that balances intra-group accuracy and cross-individual adaptability, and is expected to achieve large-scale application in smart cities in the future, promoting the synergistic development of low-carbon buildings and human health.

13:50-14:10 **SunC4.2**

Learning Spatiotemporal Dependencies for Time Series Imputation via Adaptive Multi-task Gradient Guidance

guodong Li ,yalin wang ,Chenliang Liu ,Jiang Luo ,Yitao Chen ,Hongrui Liu
(central south university)

Multivariate time series data are widely utilized across numerous domains; however, irregular missing values frequently occur in real-world time series due to various issues during data acquisition, which limits the effective extraction of temporal features. Conventional imputation frameworks, such as the dual-task structure, demonstrate excellent feature mixing and learning capability but often overlook the correlation between multiple training tasks and lack an adaptive multi-task association mechanism. To address these limitations, this paper proposes a time series imputation method via adaptive multi-task gradient guidance for learning spatiotemporal dependencies. The proposed model incorporates both spatial and temporal perspectives: it adaptively learns the spatial relationships between different tasks, thereby optimizing the direction of network training gradients while simultaneously leveraging historical information in the temporal dimension to reduce abrupt changes and oscillations during training. The effectiveness and broad applicability of the proposed approach are validated through integration with various deep learning methods and extensive experiments on datasets from multiple domains.

14:10-14:30 **SunC4.3**

Optimization of Structural Parameters of Multi-step Prediction Neural Network Based on Sequence Similarity Evaluation

Jiawang Zheng ,Zhu Wang
(China University of Petroleum-Beijing)

To address the issue that traditional metrics (e.g., MSE) in industrial process soft sensing fail to comprehensively consider both trend consistency and numerical proximity during multi-step prediction evaluation, this paper attempts to use sequence similarity metrics as alternative indicators. Sequence similarity metrics excel at capturing whether predictions accurately reproduce the key dynamic features of sequences, as they are more tolerant to phase deviations. First, via Monte Carlo experiments combined with Rank-Biased Overlap (RBO) analysis, it is verified that DTW with the constrained Sakoe-Chiba Band (r=0.1) achieves the best consistency with expert judgment among candidate time-series similarity metrics, and its sensitivity to minor sequence deformations significantly outperforms metrics like Euclidean distance. Second, by employing DTW with the constrained Sakoe-Chiba Band (r=0.1) as the fitness function of the Particle Swarm Optimization (PSO) algorithm, the structural parameters of the Gated Recurrent Unit (GRU) are optimized. On the noisy dataset of the series-connected continuous stirred tank reactor (CSTR), 200-step prediction experiments show that the DTW-PSO framework can effectively complete the convergence task of model optimization, and the prediction trajectory fits well with the ground-truth data.

14:30-14:50 **SunC4.4**

A Study on the Modeling and Prediction Method of the FCC Fractionation System Based on ISSA-AM-LSTM

Shaowei Han ,Jingjing Han ,Jun Tong ,Xiaoyong Gao
(China University of Petroleum)

Data-driven modeling plays a vital role in the petrochemical industry, especially in the modeling and prediction of the Fluid Catalytic Cracking (FCC) process. However, FCC units are characterized by long operating cycles, a large number of variables, significant signal lags, and complex coupling of operating conditions, which limit the prediction accuracy of traditional time series neural networks when dealing with raw high-dimensional data. To address these challenges, this paper proposes an improved prediction framework that integrates feature selection and time series modeling —ISSA-AM-LSTM. This method first employs Extreme Gradient Boosting (XGBoost) combined with mutual information to conduct an initial assessment of variable importance, reducing model redundancy and overfitting risk from the outset. Subsequently, an LSTM network is introduced to construct the predictor, and an Attention Module is integrated to model the nonlinear dynamic relationships between the target variable and its historical time steps. Additionally, to further enhance the model' s adaptability and generalization capability, an Improved Sparrow Search Algorithm (ISSA) is employed for global optimization of hyperparameters. Experimental results demonstrate that the proposed model outperforms traditional LSTM, AM-LSTM, and modeling schemes without feature optimization in terms of prediction accuracy and stability, showing great potential for industrial application and promotion.˚

机器学习算法及应用 3

时间: 2025/07/27 13:30 **主　席: 朱红求　中南大学**

地点: 2 楼登云厅

13:30-13:50 **SunC5.1**

基于 *VMD-ALA-Transformer-BiLSTM* 的短期风电功率预测模型

侯益明, 叶昌燕, 高小永
(中国石油大学)

针对风能具有间歇性和波动性问题，风电功率预测面临着显著挑战。本文提出了一种变分模态分解算法 (VMD) 结合人工旅鼠算法 (ALA) 优化 Transformer 和双向长短期记忆网络 (BiLSTM) 的混合预测模型。该模型首先利用 VMD 对原始风电功率序列进行分解，提取不同频率成分的特征。随后，采用 ALA 对 Transformer-BiLSTM 模型的关键超参数进行智能优化，提升模型的预测性能。最后，结合 Transformer 的全局特征提取能力和 BiLSTM 的时序依赖建模能力，构建了高精度的风电功率预测模型。实验结果表明，所提出的混合模型在均方根误差 (RMSE)、平均绝对误差 (MAE) 和决定系数 (R) 等评价指标上均显著优于对比模型，验证了 VMD 和 ALA 的引入能够有效提升 Transformer-BiLSTM 在风电功率预测中的性能，为电力系统调度和能源管理提供了更可靠的预测基础。

13:50-14:10 **SunC5.2**

基于 *ACE-Match* 的伪标签生成方法及在文本分类中的应用

钟国亮, 李勇刚, 王金峰, 朱红求
(中南大学)

摘要: 在自然语言处理领域，文本分类是一项基础且重要的任务。然而，实际应用中常面临标注成本高、类别极度不平衡以及文本数据噪声严重等挑战，导致传统有监督学习方法难以满足需求。为了解决上述问题，本文提出了一种基于多策略伪标签生成的半监督学习框架——交叉集成匹配 (Adaptive Cross-Ensemble Match, ACE-Match)。该框架采用双 BERT 网络结构，通过交叉伪标签机制有效降低确认偏差，并设计了类别感知的自适应伪标签筛选方法，动态调整不同类别的伪标签筛选标准，以提高难分类少数类样本的训练参与度。同时，提出了基于模型预测分歧程度的动态加权策略，以自适应地抑制低质量伪标签的负面影响。为了验证框架的有效性，本文在公开数据集 AG-News 上进行了实验。结果表明：在极少标注样本条件下，ACE-Match 在文本分类任务中实现了 88.57% 的准确率，较基线方法 SAT 提升了 2.03%，展现出优异的分类性能。

14:10-14:30 **SunC5.3**

基于 *ECI-YOLO* 的浅近水域目标检测算法

崔山虎, 顾飞, 杨益, 刘晓生, 徐文星, 朱群雄
(北京石油化工学院)

针对浅水及近岸水域环境中水下目标检测精度低、干扰抑制能力不足的问题，本研究提出基于改进 YOLOv7 框架的水下目标检测模型 ECI-YOLO。首先，在扩展高效层聚合网络（Efficient layer aggregation networks，ELAN）中引入部分卷积（Partial Convolution, PConv），构建轻量化的 ELAN-PF 模块，通过部分替换传统卷积层，在保证特征表达能力的同时将计算复杂度降低；其次，设计双路协同的通道 -空间增强注意力模块（CASE），通过强化主干网络与颈部网络间的特征交互机制，有效抑制水下环境中背景噪声的敏感性；最后，设计基于内部交并比优化的 Inner-DIoU 损失函数替代 CIoU 损失函数，通过引入辅助边框的动态尺度调整机制，提升小目标检测精度。实验表明，ECI-YOLO 模型的检测精度达到了 90.2%，其中 mAP@0.5 与 F1-score 分别达到 82.3% 和 80.26%，相较于基准模型 YOLOv7 分别提升 3.7 和 3.73 个百分点。消融实验系统验证了各模块的协同优化效应，与 Faster R-CNN、SSD、RetinaNet 等 9 种主流检测模型的对比分析表明，ECI-YOLO 在复杂水下场景中具有显著的性能优势（mAP@0.5 提升 5.1-21.8 个百分点），证明其在水下复杂环境中的工程适用性。

14:30-14:50 **SunC5.4**

Online Accelerated Gradient Algorithm Based on Typical Samples for Self-Organizing RBF Neural network

YanNi Su ,Miaoli Ma ,Bin Wang ,Zhaofeng Zhao
(Beijing Institute Of Petrochemical Technology)

This study builds upon previous research on acquiring effective gradient information to enhance learning performance in online learning processes. In this paper, an Online Accelerated Gradient Algorithm (OAGA) is designed to train Radial Basis Function Neural Network (RBFNN). First, a Typical-Sample-based Improved Levenberg-Marquardt (TS-ILM) algorithm is proposed, incorporating a variance reduction mechanism to reduce computational complexity and accelerate convergence. Second, an Adaptive Structure Adjustment Strategy (ASAS) is developed, leveraging sample residuals and neuronal orthogonality to maintain a compact network architecture while effectively assimilating sample information. Third, a closed-loop collaborative optimization framework integrating TS-ILM with adaptive network structure adjustment is established, resolving the conflict between parameter and structural optimization objectives inherent in traditional methods. Finally, experimental studies on OAGA-SORBFNN and comparisons with existing methods demonstrate its superior performance in both learning speed and prediction accuracy.

优化控制

时间: 2025/07/27 13:30 **主 席: 段敬业 四川轻化工大学**

地点: 2 楼百瑞厅

13:30-13:50 **SunC6.1**

基于自适应动态策略差分算法的研究与应用

汪奇, 谭飞, 熊兴中, 段敬业
(四川轻化工大学)

针对传统差分进化算法存在全局性差，容易陷入局部最优等缺陷，提出自适应动态策略差分算法。首先，初始化种群采用拉丁超立方采样策略，增加初始种群多样性，有利于后续进化。其次，采用多变异思想，采用 best/1 和 rand/1 混合变异，同时引入全域随机可达变异，增强算法跳出局部极值能力。然后，融入黑翅鸢算法迁徙行为思想构建多交叉策略，同时对控制参数进行自适应以满足算法不同进化阶段需求。以模型辨识问题为例，通过仿真实验对比，结果表明改进算法应用于上述问题可行且有效。

13:50-14:10 **SunC6.2**

Multi-Objective Optimization Method for Optimal Excitation Parameters of Controllable Active Seismic Source

洪利, 田可文, 张强, 张晓东, 刘哲
(防灾科技学院)

To address the dual-objective optimization problem of maximizing excitation performance and energy efficiency in existing Controlled Active Seismic Source (CASS), this study proposes a multi-objective optimization-based design method for vibrator parameters. Focusing on an eccentric vibrator, a coupled mathematical model linking excitation force, servo motor driving power, and geometric parameters (including radius, thickness, and eccentric distance) is established. Considering load constraints, structural constraints, and operational constraints of the seismic source, a multi-objective optimization problem incorporating inequality and boundary constraints is formulated and solved using the NSGA-II algorithm. This work is the first to achieve synergistic optimization of vibrator parameters and servo motor driving power for CASS. Simulation experiments on a 50 kg seismic source demonstrate that, while maintaining an excitation force of 490.5 N, the driving power is reduced from 22.17 W in conventional designs to 17.94 W, achieving a 19.07% improvement in energy efficiency. The proposed methodology provides theoretical support for optimal parameter design of precision seismic sources and enhances the exploration performance of CASS in resource exploration and engineering detection applications.

14:10-14:30 **SunC6.3**

Optimization Method for Hammer Impact Excitation of Controllable Active Seismic Source

洪利, 郭宏鑫, 张强, 张晓东, 刘哲
(防灾科技学院)

To address the issue of low energy output in low-frequency excitation of controllable active seismic sources, this study proposes a hammer-impact excitation method based on dynamically varying angular velocity. By constructing a dual-eccentric-body model with time-varying angular velocity, the system enables kinetic energy accumulation and concentrated release at the target phase, thereby forming a pulse-like impact excitation response. First, the relationships among excitation force, angular acceleration, and driving torque are derived in the time domain. Then, through variable substitution, the dynamic model is mapped into the angular-position parameter domain. A phase-triggered excitation mode is designed to concentrate kinetic energy release, and an optimization model with instantaneous pulse characteristics is formulated. The model aims to maximize the vertical excitation force at the critical phase and transforms the hammer-impact excitation optimization problem into a nonlinear optimization with inequality constraints, solved using a sequential quadratic programming (SQP) algorithm. Simulation results show that, compared with the conventional constant-frequency mode, the proposed method achieves more than a 200% increase in excitation energy at 2 Hz, and an average increase of over 20% across the 225 Hz frequency range, significantly enhancing the low-frequency excitation performance of the CASS system. This research introduces, for the first time, a low-frequency excitation optimization strategy for the CASS source, offering a new design concept and optimization pathway for advanced seismic source technologies.

14:30-14:50 **SunC6.4**

基于狐猴多目标优化和最优速度障碍法的无人机三维路径规划

张超, 汤谦, 王敬宇, 方鑫, 张静蕊
(郑州航空工业管理学院)

低空经济作为新兴战略性产业，发展迅速但面临诸多挑战，无人机路径规划是其中的关键问题。本文针对低空经济中无人机路径规划的需求与安全问题，提出基于多目标狐猴优化算法（Multi-Objective Lemurs Optimizer，MOLO）与最优速度障碍法（Optimal Reciprocal Collision Avoidance，ORCA）的无人机三维路径规划方法。首先，构建了包含路径长度、碰撞检测、飞行高度与平滑度的目标函数，并引入帕累托最优解理论扩展狐猴优化算法，形成多目标优化框架。其次，结合 ORCA 算法提升路径规划的动态适应性，通过速度调整策略实时躲避动态障碍物。仿真实验表明，MOLO 算法与 MOPSO、MOGWO 等算法在多张地图中，进行了多目标路径

规划的目标函数比较，MOLO 算法路径规划表现位于前列，且在结合 ORCA 后于动态场景中展现出优异的避障能力，为低空经济发展中的无人机安全飞行提供了高效路径规划方案，有助于推动低空经济的安全、高效发展。

容错控制与可靠控制

时间: 2025/07/27 13:30 **主 席: 许锋 中国石油大学**

地点: 3 楼岷江厅

13:30-13:50 **SunC7.1**

考虑执行器失效的选择性控制系统设计

孔汝成, 张晓萌, 黄佳宇, 许锋
(中国石油大学)

在工业过程中，分散多回路常规 PID 控制被广泛采用。实际系统中，执行器因长期频繁的运行极易发生故障。本文设计了多变量分散常规控制回路的备用控制器，当某控制回路的执行器出现故障时，启用备用控制器操纵其他回路的执行器，形成选择控制系统。首先，基于非方相对能量增益阵进行控制回路配对，为失效回路的被控变量重新匹配操纵变量；其次，根据对角优势下的正奈奎斯特稳定性判据重新整定 PID 控制器参数；最后，将正常控制回路和执行器失效的控制回路组成选择控制系统，实现执行器失效时的容错控制。

13:50-14:10 **SunC7.2**

Reliability Analysis of Nuclear Power Plant Reactor Protection System Based on Bayesian Network

Kaiyue Ma ,tong guan ,Zhiyuan Zhang ,Yinxiao Zhan ,jun liang
(Zhejiang University)

With the continuous development of nuclear power technology, increasing attention has been paid to its operational safety. To mitigate the potential risk of Failure on Demand in critical safety systems of nuclear power plants, this paper proposes a hybrid modeling approach integrating Fault Tree Analysis (FTA) and Bayesian Network (BN). The Reactor Protection System (RPS) of a domestic nuclear power plant is selected as the case study. Based on the actual system architecture and component parameters, an RPS Failure on Demand fault tree was constructed and then converted into a BN model. The Probability of Failure on Demand (PFD) was quantitatively assessed through probabilistic inference and sensitivity analysis. The results show that the overall PFD of the system is quite small, which meets the relevant safety standards and demonstrates the high operational reliability of the studied RPS.

14:10-14:30 **SunC7.3**

基于最优基准区间 -自适应匹配路径的 *Lamb* 波温度补偿方法

邱永健, 吕珊珊, 张劭宇
(齐鲁工业大学)

针对温度变化影响 Lamb 波技术定位精度的问题，本文建立了温度耦合的铝合金结构有限元模型，系统分析了温度参数对结构中 Lamb 波幅值和相位传播特性的影响。基于此，提出了一种基于“最优基准区间 -自适应匹配路径”的 Lamb 波温度补偿方法。首先，根据检测信号与有限基准信号之间的非线性相关系数，确定用于信号补偿的最优基准区间然后基于检测信号在基准区间的位置以及时域弯折方法，自适应调整检测信号与基准信号之间的匹配路径，有效避免了传统方法需要大量基准样本驱动以及过补偿问题。实验结果表明，该方法在基准温度间隔为 20条件下，补偿信号的均方根误差均小于 0.065，补偿信号与基准信号的相关系数均大于 0.96。损伤定位实验进一步证明了所提方法在提高定位准确性方面的有效性，本文研究为基于 Lamb 波的结构健康监测技术在实际工程中的应用提供了新的思路和方法。

工业智能控制与智能制造

时间: 2025/07/27 15:10 **主 席: 陈曦 浙江大学**

地点: 3 楼金江厅

15:10-15:30 **SunD1.1**

基于 *DT-PPO* 算法的机械臂逆运动学求解方法

杨春雨, 李志鑫, 赵悦宏, 顾心仪
(中国矿业大学)

机械臂在现代制造业中具有不可替代的重要作用，其运动学是机械臂控制的核心，精准的逆运动学模型对提升生产效率和保障产品质量至关重要。传统逆运动学求解方法存在诸多不足，通常需进行大量矩阵运算或依赖实体机械臂采集数据进行数值解算，导致计算复杂、成本高昂且适应性较差，难以满足动态多变的应用场景需求。本研究提出了一种融合数字孪生技术与 PPO 算法的机械臂逆运动学求解方法，旨在解决传统方法中矩阵运算量大和实物数据采集的难题。具体而言，首先利用多分支 BP 网络模型结合数字孪生技术，在 Unity 平台上构建机械臂的数字实体；随后，基于 PPO 算法对数字实体进行逆运动学求解。实验结果表明，基于 DT-PPO 算法的逆运动学求解方法在关节运动精度、求解效率及环境适应性等方面均满足实际应用需求。该方法显著提高了机械臂的操作效率，为机械臂智能化升级及数字孪生技术在工业领域的广泛应用奠定了坚实的技术基础。

15:30-15:50 **SunD1.2**

Research on Workpiece Recognition and Robot Grasping Technology Based on Improved YOLOv8 and Binocular Vision

刘宝, 刘天宝, 胡仲硕, 梁福学
(中国石油大学)

Aiming at the low degree of automation and efficiency in the handling and assembly of steel structure welding parts, this paper took the tower foot of the angle steel tower as the research object and proposed a workpiece recognition, positioning and handling system based on machine vision to achieve precise detection and grasping of the workpiece. Firstly, a dataset of tower foot workpieces was constructed, and the data quality was improved through data augmentation and K-fold cross-validation strategies. Secondly, the YOLOv8-BBDG model was proposed, which introduced the BoT module and BiFPN structure to enhance the feature extraction and fusion capabilities, and combined DySample and GhostConv to reduce the computational complexity of the model while maintaining detection accuracy. Further, a robot grasping pose calculation method was designed. Through binocular vision and hand-eye calibration technology, the end grasping coordinate system was constructed to achieve the pose solution of workpieces in any posture. Experiments showed that compared with the original YOLOv8, YOLOv8-BBDG had a 3.3% improvement in Precision on the TJ-seg validation set, a 10% reduction in parameters, and a 1GFLOPs decrease in computational cost. Through high-precision equipment calibration, the system realized the category detection and spatial positioning of tower foot workpieces, with accurate grasping pose calculation and cumulative error less than 2mm, meeting the assembly process requirements and effectively improving production efficiency and operation safety.

15:50-16:10 **SunD1.3**

Design of Adaptive Controller Based on BP Neural Network and Internal Model Control

林忠凯, 张正江, 严俊鹏, 陈冲, 吴龙杰, 朱志亮
(温州大学电气与电子工工程学院 1 号楼 1B-415B)

Against the backdrop of the ongoing intelligentization and systemic efficiency enhancement in modern industry, process control technology, as a critical component of industrial control, has drawn significant attention to the issues of control rapidity and robustness. To address this challenge, this paper proposes an adaptive controller design based on the BP neural network and internal model control. First, this study analyzes the requirements for temperature-controlled objects and other control targets in current engineering applications, collecting problems caused by temperature deviations across various industrial sectors. It systematically analyzes and concludes that the core of control systems lies in system identification and controller design. Building on this conclusion, the research deeply explores the use of BP neural networks for system identification, which reduces parameter errors in identification and improves the convenience of system identification, providing a more robust foundation for controller design. Additionally, this paper summarizes and optimizes the parameter tuning method of IMC-PID (Internal Model Control-Proportional-Integral-Derivative) through simulation experiments, verifying the practicality of the optimized method via numerical validation. Finally, taking a temperature-controlled object as a case study, the paper conducts repeated experiments to further validate the method' s applicability. Results demonstrate that the proposed adaptive control approach effectively balances robustness and rapidity, offering a promising solution for complex industrial control scenarios with high demands on dynamic performance and disturbance rejection.

16:10-16:30 **SunD1.4**

基于联立方程的聚合反应过程模拟软件

林晓文, 焦申华, 陈曦
(浙江大学)

在聚合反应过程的工业化应用中，精确建模与优化的过程模拟是实现产品质量控制和工艺优化的关键。随

着工业化程度的不断提高，聚合反应过程的复杂性逐渐增加，传统的聚合反应模型往往无法满足日益增长的精度和效率要求。因此，为了提升聚合反应过程的模拟与优化效果，开发高效、灵活且易于扩展的聚合过程模拟软件至关重要。本文围绕面向微观结构的聚合反应过程，开发了一套专用的模拟与优化软件平台。该平台具备集成化的系统架构，包含图形化用户界面、灵活的建模与约简模块以及稳健的求解引擎，支持用户通过可视化操作定义反应机理、动力学参数及工艺条件，并由系统自动完成建模与变量标准化流程。平台内嵌双维度离散化与模型转换机制，有效兼顾了模型精度与计算效率。软件支持稳态与动态过程的模拟分析，并提供优化功能，助力工艺设计与运行决策。本文以高密度聚乙烯生产为应用案例，展示了平台在工业聚合反应建模中的有效性与适用性，验证了其对微观结构特征的准确刻画和对操作优化的良好支持。与商业工具的对比进一步证明了本平台的可靠性与实际应用价值。

机器视觉与无人系统

时间: 2025/07/27 15:10 **主 席: 黄玉水 南昌大学**

地点: 2 楼长乐厅

15:10-15:30 **SunD2.1**

Gait Recognition Method Based on Fusion of Gait Silhouette and 2D Skeletal Features

Binghan Zhan ,Xiaogang wang ,Keyu Chen ,Zhiwei Yin ,Renjie Zou
(Sichuan University of Science and Engineering)

Gait recognition plays a significant role in security surveillance by enabling identity authentication through learning pedestrians' walking patterns and appearance characteristics. However, current mainstream silhouette-based gait recognition methods face occlusion issues in walking scenarios with coats, leading to incomplete gait information acquisition and low recognition accuracy. To address this, this paper proposes a gait recognition method based on the fusion of silhouette and 2D skeletal features. First, the design adopts a dual-branch input structure combining silhouette and 2D skeletons. The silhouette branch employs GaitSet as the backbone network, incorporating decoupling and collaboration mechanisms for regional feature self-extraction, while the skeleton branch utilizes the GaitGraph algorithm to extract 2D skeletal features. Subsequently, we introduce a Gait Cross-Modal Feature Fusion module (GCMFM) to achieve dynamic weighted feature fusion between gait silhouette and 2D skeletal features. Experiments conducted on the CASIA-B dataset demonstrate an 11.2% average accuracy improvement in coat-walking scenarios. The proposed method effectively resolves the low recognition accuracy problem in gait identification under coat-wearing walking conditions.

15:30-15:50 **SunD2.2**

基于改进 *YOLOv8n* 的破碎大豆颗粒实例分割算法

杨春雨, 胡子扬
(中国矿业大学)

针对榨油车间中破碎大豆颗粒的检测与分割问题，本文提出了一种基于改进 YOLOv8 的实例分割方法。考虑到实际场景中颗粒密集堆叠、遮挡严重、形状不规则等特点，原 YOLOv8-seg 模型在实例分割过程中易出现边界模糊与目标粘连，造成分割精度下降和漏检率上升的问题。为此，在网络结构上进行了两方面的改进：首先，在 Backbone 中引入了 RFAConv 模块，通过自适应感受野机制增强模型对小目标和纹理特征的建模能力；其次，将 YOLOv8 的 Neck 结构替换为改进的 ASF-YOLO 架构，该架构融合了多尺度上下文建模模块 ScalSeq、边缘增强模块 Add、以及空间 -通道注意力模块 attention_model，以提升模型在密集颗粒环境下的边界分辨力与目标区分能力。通过在破碎大豆样本集上的实验验证，改进后的模型在 mAP50 指标上达到了 95.1%，较原始 YOLOv8 模型提升约 7.2%。其中，在颗粒重叠区域的实例 mask 分割质量、漏检率控制方面均表现出明显优势，证明了所提方法在复杂工业场景下的有效性与实用性。

15:50-16:10 **SunD2.3**

A Non-intrusive Thermal Comfort Prediction Method Integrating RGB Images and Human Pose Keypoints

余运俊, 郑志斌, 向晓争, 陶宏伟, 黄玉水, 胡嘉文
(南昌大学)

Aiming at the problems of inconvenient use and low prediction accuracy of traditional sensor-based invasive and semi-invasive thermal comfort prediction methods, this study proposes a non-intrusive thermal comfort prediction method. The method integrates RGB images and human pose keypoints from surveillance videos and can recognize 12 types of thermal adaptive behaviors in real time. These behavior data are derived from a questionnaire survey conducted by Nanchang University. In the data collection phase, video data of thermal adaptive behaviors were collected from six perspectives (front, front-left, front-right, back, back-left, back-right) of sitting and standing postures, and a thermal comfort prediction model was constructed based on this data. The results show that when considering all the actions, the thermal comfort prediction accuracy of the model can reach 91.42%, effectively verifying the feasibility and efficiency of this method.

16:10-16:30 **SunD2.4**

基于 *Transformer* 的冻干粉缺陷检测模型

张维, 饶水辉, 熊智华, 叶昊
(清华大学)

缺陷检测是冻干粉药剂工业生产过程中的关键环节，基于计算机视觉的冻干粉缺陷检测方法已逐渐运用于工业生产过程中。近年来，Swin Transformer 模型在计算机视觉领域取得重大进展，但它采用局部窗口注意力机制，导致全局建模能力偏弱，难以有效捕捉图像远距离像素之间的依赖关系。为探索可扩展性，本文提出了一种新的 Bwin Transformer 模型，移除了 Swin Transformer 模型中的滑动窗口注意力和掩码模块，而采用通道层面的全局窗口间注意力机制，并设计了基于窗口位置的相对位置编码，从而有效提升了模型对于远距离像素之间依赖关系的捕捉能力，在保持与图像大小具有线性计算复杂度的同时，一定程度上降低了模型参数和计算复杂度。本文进一步以 Bwin Transformer 为骨干网络，融合特征金字塔网络（FPN）模块和 Mask R-CNN 检测器，构成了缺陷检测模型，并在实际工业场景的冻干粉图像数据集上进行了实验，验证了模型在缺陷检测上的有效性。

故障检测、诊断与决策 4

时间: 2025/07/27 15:10 **主 席: 彭鑫 华东理工大学**

地点: 2 楼未央厅

15:10-15:30 **SunD3.1**

A Novel Diffusion Generation Model for Chip Edge Detection

黄嘉庆, 贺建军, 陈致蓬
(中南大学)

Semiconductor laser chips are vital for fiber and solid-state lasers, with broad applications in optical communication, lidar, optical storage, and medical fields, where welding quality critically impacts device performance and reliability. However, detecting the chip’ s bottom edge poses three major challenges: 1) High precision is required, with detection errors constrained to 0.003 mm (3 pixels in 4000000 high-resolution images) to accurately assess the light-emitting area; 2) Edge features are ambiguous due to non-ideal chip geometry (not strictly parallelogram-shaped) and solder creep obscuring the bottom edge, degrading imaging quality and complicating feature identification; 3) Labeled datasets are scarce, as clear-edge images are easily annotated, but annotating unclear-edge images is time-consuming and costly, limiting available data. Traditional edge detection methods struggle with obscured edges, while deep learning approaches are hindered by insufficient labeled data for effective training. This paper proposes a time-frequency dual diffusion model that generates unobstructed ideal bottom-edge images from input images, enabling indirect high-precision edge detection. The model produces a set of images that retain key components of the input while approximating ideal image features. A sample family convergence module integrates global and local edge information, enhancing detection accuracy and robustness. Trained solely on clear-edge images and their labels, the model eliminates the need for unclear-edge annotations. Industrial simulations confirm its superior performance, offering an efficient, innovative solution for laser chip welding quality control.

15:30-15:50 **SunD3.2**

Multi-Source Domain Transfer Learning with Feature Fusion for Fault Diagnosis

Haoze Li ,Jiahao Wang ,Linlin Li ,Xin Peng ,Maiying Zhong
(University of Science and Technology Beijing)

Transfer learning methods have been widely applied in the field of industrial process fault diagnosis, greatly improving the generalization ability of models under different operating conditions. However, current methods used in this field rely on single-source domain adaptation strategies, which do not fully utilize information from multiple source domains, potentially leading to negative transfer. To address this issue, a new multi-source domain transfer method (MFFN) is proposed, aiming to solve industrial process fault diagnosis under multiple operating conditions. A network based on the fusion of common and specific features is designed for domain-invariant feature extraction. This method utilizes multi-source domain adaptation to achieve effective knowledge transfer from multiple source domains, thereby improving prediction accuracy in the target domain. Experimental results on the CWRU dataset validated the effectiveness of MFFN in process fault diagnosis.

15:50-16:10 **SunD3.3**

A Bearing Fault Diagnosis Algorithm Incorporating Time-Frequency Analysis and Sparse Swin Transformer

Zihan Xu ,Jinhao Ge ,Haoqian Wang ,Sheng Gao ,Xin Ma ,Youqing Wang ,Rui Fan
(Beijing University of Chemical Technology)

With the increasing complexity of industrial systems, higher demands are being placed on the accuracy and efficiency of fault identification in fault diagnosis. In recent years, deep learning has shown great promise in pump fault diagnosis due to its powerful feature learning and self-adaptive capabilities. In this study, a novel algorithm named sparse Swin Transformer is proposed based on time-frequency analysis to achieve efficient extraction and accurate identification of potential fault features in vibration signals. The model employs Continuous Wavelet Transform (CWT) to convert one-dimensional vibration signals into two-dimensional time-frequency representations. On top of the Swin Transformer’ s global modeling capabilities, a Top-K sparse attention mechanism is integrated to reduce computational complexity, while a neighborhood enhancement module is incorporated to strengthen the perception of local features. The proposed method improves training efficiency while maintaining high classification accuracy, And the effectiveness of the proposed method has been verified on the bearing dataset of Case Western Reserve University (CWRU) in the United States.

16:10-16:30 **SunD3.4**

Few-shot Learning Photovoltaic Fault Diagnosis Based on PCA-TirTCN

Yanbo Jian ,Aimin An
(Lanzhou University of Technology)

To address the issues of scarce fault samples in photovoltaic arrays and the tendency of traditional

network models to overfit and perform poorly under few-shot learning conditions, a fault diagnosis method based on a triplet siamese network is proposed. By constructing a photovoltaic array simulation model to collect time-series data, the triplet strategy is employed to expand the sample set, thereby increasing the number of samples. PCA dimensionality reduction is applied to reduce computational complexity. A multi-scale temporal convolutional network and a temporal pattern attention mechanism are designed and embedded into the triplet siamese network to effectively extract spatiotemporal features. The Euclidean distance is used to calculate the feature distance between numerical fault samples, enabling accurate diagnosis of photovoltaic array fault types. Experimental results demonstrate that this method exhibits strong generalization capabilities under few-shot learning conditions, with high and stable test accuracy, outperforming traditional network models. It provides an efficient and robust solution for photovoltaic array fault diagnosis.

过程数据分析与建模

时间: 2025/07/27 15:10 **主 席: 马君霞 江南大学**

地点: 2 楼鸿喜厅

15:10-15:30 **SunD4.1**

基于动态图卷积网络的半监督软测量建模方法

杜康萍, 史旭东, 马君霞, 熊伟丽
(江南大学)

复杂工业过程中，高昂的数据采集成本使得输入与输出变量的采样频率存在显著差异，进而导致仅有部分数据有标记。针对这一问题，本文提出一种基于动态图卷积网络的半监督软测量建模方法 (SS-DGCN)，旨在充分挖掘并利用部分标记数据中的信息。为有效表示数据间的拓扑关系，SS-DGCN 设计了基于自注意力机制的图构建方法，用于表征有标记样本与无标记样本之间的拓扑关系，并利用图卷积网络提取图结构数据中的特征用于软测量建模。最后，通过实验验证了 SS-DGCN 有效性和优越性，实验结果表明，与其他半监督软测量建模方法相比，所提方法在预测精度上有了显著提升。

15:30-15:50 **SunD4.2**

有色冶金过程多视角生产知识融合表征方法

邓一凡, 阳春华, 李勇刚, 朱红求, 孙备
(中南大学)

有色冶金过程在长期的生产运行中积累了分别反映状态、质量、操作和效能的工业多视角数据，如何对蕴含其中的丰富工艺规律和经验知识进行深度挖掘、融合沉淀与显性表征，对于提升下游任务的模型性能具有重要意义。为此，本文以锌电解为研究实例，提出了一种有色冶金过程多视角生产知识融合表征方法，通过在下游任务中融入多视角生产知识来提升模型性能。首先，利用锌电解日志记录，在预训练语言基座模型基础上建立了一种锌电解垂域微调基座模型，获取日志记录的释义表征。然后，设计一种跨视角多头注意力融合方法，将日志记录的释义表征与过程参数、工艺指标和生产指标进行融合，形成了锌电解过程多视角生产知识融合表征库，并对其统计分布和相关性结构进行了分析。最后，将锌电解过程多视角生产知识融合表征库用于下游软测量任务进行评估，平均绝对百分比误差下降了 25.95%，验证了所提方法的有效性。

15:50-16:10 **SunD4.3**

Adaptive Causal Inference Spatio-Temporal Graph Convolutional Networks for Correlation Modeling in Disjunction Processes

Chenhao Ren ,Honggui Han ,Fangyu Li ,Zheng Liu
(Beijing University of Technology)

The establishment of predictive models for the Electronic Waste Disjunction Process (EWDP) holds significant importance in optimizing disjunction process parameters and enhancing disjunction reaction efficiency. The external disturbances, such as raw material replacement and equipment aging, cause fluctuations in causal constraints among process variables and make the causal relationships among process parameters unclear. However, existing Spatio-Temporal Graph Neural Network (STGNN) prediction models improve prediction accuracy by modeling the static causal relationships among reaction variables based on prior knowledge. An Adaptive Causal Inference Spatio-Temporal Graph Convolutional Network (ACSTG) is proposed to address the decrease in prediction accuracy caused by fluctuations in causal relationships. First, an adaptive causal inference module based on the multi-head graph attention is constructed to dynamically update the connection weights among variables, effectively extracting the dynamic causal features. Second, a multi-scale spatio-temporal graph convolutional module is designed to extract multi-granularity temporal features under different time patterns, enabling causal inference across time scales. Finally, experimental results on Tennessee Eastman (TE) dataset demonstrate that, compared to existing models, ACSTG effectively captures dynamic causal relationships and achieves improved prediction accuracy.

机器学习算法及应用 4

时间: 2025/07/27 15:10 **主 席: 倪雨青 江南大学**

地点: 2 楼登云厅

15:10-15:30 **SunD5.1**

A Hybrid Model for Few-Shot Attribute Extraction Using Prototypical Networks and k-Nearest Neighbors

Taiyu zhang ,Yuqing NI ,Ziyang Guo
(Jiangnan University)

In the accelerated progress of globalization, Chinese customs play a vital role in safeguarding national sovereignty and public health, especially in the inspection and quarantine of imported goods. However, varying regulatory standards across countries and the emergence of new types of substances pose challenges for customs in detecting and identifying relevant substances. Attribute extraction, a key task in Natural Language Processing (NLP), is crucial for extracting compliance-related information from unstructured text for customs supervision. This paper proposes a few-shot attribute extraction model that combines Prototypical Networks, k-Nearest Neighbors (kNN), and Conditional Random Fields (CRF) decoding. The model uses Bidirectional Encoder Representations from Transformers (BERT) to generate embeddings, constructs attribute prototypes, and enhances the perception of class boundaries with kNN scores. The CRF decoder integrates these components to optimize label sequence prediction. Experiments show that the model achieves higher F1 scores than baseline models such as BERT-CRF and ProtoNet under the 5-way-10-shot setting.

15:30-15:50 **SunD5.2**

An Edge Detection Algorithm of the Improved Canny Operator

bowen zhang ,Shiyong Yang ,Chunlan Luo ,hongping pu
(Sichuan University of Light Industrial Technology)

Abstract—This study proposes an improved Canny edge detection algorithm, which effectively overcomes the limitations of traditional methods in suppressing salt-and-pepper noise and adaptively selecting dual thresholds. The algorithm achieves performance improvement through the following innovations: (1) A K-nearest neighbor median filter is used to replace the Gaussian filter, which maintains image quality while removing salt-and-pepper noise (the signal-to-noise ratio is improved by 4.2 dB); (2) A dynamic threshold adjustment mechanism is constructed based on the improved Otsu algorithm, and the ratio of high and low thresholds is optimized through the analysis of the gray histogram entropy value. To verify the effectiveness of the algorithm, the connected component analysis method is adopted to evaluate the edge continuity index. Experimental results show that for traditional edge detection algorithms (Sobel, Log, Roberts, and Canny), the improved algorithm reduces the C/A index by 12% to 29%, 5% to 32%, 7% to 30%, and 11% to 31%, and reduces the C/B index by 6% to 28%, 3% to 32%, 10% to 33%, and 5% to 27%. This study provides a novel and effective solution for image edge detection.

15:50-16:10 **SunD5.3**

Improving NOX Emission Prediction in SCR Systems via Continual Learning under Dynamic Operating Conditions

Peng Chen ,Xu Baochang ,Wei He ,Hongtao Hu
(China University of Petroleum)

Accurately predicting NOX concentration at the outlet of selective catalytic reduction (SCR) systems is crucial for optimizing process parameters in power plants, enhancing denitration efficiency, and reducing NOX emissions. Existing prediction models often struggle to maintain long-term online prediction accuracy when operating conditions change and new data arrive. Therefore, frequent model updates are required in practical applications. However, new models often exhibit catastrophic forgetting of previously learned operational patterns, leading to a deterioration in NOX concentration prediction accuracy. To address these challenges, a novel continual learning algorithm termed TMIR is proposed. This algorithm is integrated with the iTransformer architecture to establish an online self-updating model, TMIRformer, for predicting NOX emissions in SCR systems. The model utilizes variate tokens to capture cross-feature correlations, effectively addressing prediction inaccuracies caused by multivariate coupling in denitration processes. And it employs the TMIR algorithm for online updates. Actual data from the combustion boiler at the thermal power plant in Xinjiang was used in a case study. Experimental results show that the TMIRformer outperforms existing approaches, achieving reductions in RMSE of 53.4%, 32.3%, and 23.5% compared to the LSTM, PatchTST, and iTransformer models, respectively. Compared to continual learning algorithms, EWC, the model also achieves RMSE reductions of 16.7%.

16:10-16:30 **SunD5.4**

Uncertainty-Aware Soft Sensor with Dual-Branch Modeling Architecture

Yongjing Wang ,Bocun He ,Xinmin Zhang ,Zhihuan Song ,Zhijiang Shao
(Zhejiang University)

Data-driven soft sensors have become essential for estimating key variables in complex industrial processes that are difficult to measure directly. Howev-

er, conventional deterministic models often fail to account for the inherent uncertainties arising from data noise and model limitations. To address this issue, we propose a novel uncertainty-aware soft sensor framework with a dual-branch architecture, which explicitly quantifies both epistemic and aleatoric uncertainty. The proposed method combines a Bayesian LSTM-Transformer backbone for temporal modeling and a dedicated noise estimation branch for aleatoric analysis. While the backbone network is primarily responsible for accurate and robust temporal prediction, the auxiliary noise branch is specifically designed to decouple uncertainty components, enabling more precise estimation of aleatoric uncertainty. A unified loss function is designed to jointly optimize accuracy and probabilistic calibration. During inference, Monte Carlo sampling is applied to obtain credible prediction intervals. Experiments on a blast furnace dataset show that the model improves soft sensing accuracy and provides reliable uncertainty quantification. Further, noise-injection experiments validate the effectiveness of the uncertainty-aware components.

信息物理系统

时间: 2025/07/27 15:10 **主 席: 王焕钢 清华大学**

地点: 2 楼百瑞厅

15:10-15:30 **SunD6.1**

Analysis and Simulation for Multiple Resonant-Point Phenomena in Complicated Power Transfer System

郭樾垚, 熊智华, 王焕钢, 杨耕
(清华大学)

In power transfer systems, the theoretical foundation of maximum power transfer is the conjugate matching between the source impedance and the load impedance, in which the core principle involves system operation at the resonant frequency to eliminate the imaginary part of the impedance, thereby achieving maximum power transfer. However, the multi-solution phenomenon of resonant frequencies, i.e. the multi-resonant-point problem, may occur in third-order and higher-order complex systems, leading to locking onto non-target frequencies and degrading system' s stability and efficiency. This paper focuses on theoretical modeling and frequency-domain analysis of the multi-resonant-point problem. First, a typical second-order RLC series circuit model is constructed, and its transfer function and impedance characteristics are derived, which rigorously validates the uniqueness of the resonant frequency in second-order systems. Furthermore, a typical third-order circuit model is studied and the impedance expression is established, and its real and imaginary components are separated. By integrating constraints for the true resonant point, such as zero imaginary part and target impedance magnitude, analytical conditions for the existence of multiple resonant points are systematically derived. Numerical simulations are further used to validate the parameter ranges of these analytical solutions. Theoretical results demonstrate that the third-order system exhibits multi-solution resonant points, including true resonant points and pseudo resonant points, with the latter' s frequency shifting dynamically with parameter variations. The results not only elucidate the fundamental reasons for the multi-resonant-point problem in theory, but also lay a foundational framework for mechanism analysis and control strategy design in higher-order systems.

15:30-15:50 **SunD6.2**

A High-Precision Reference Source Design With Exponential Curvature Compensation

魏元红, 何平, 罗和平
(四川轻化工大学)

In order to optimize the performance of traditional bandgap reference voltage sources, which typically exhibit poor temperature coefficient and power supply rejection ratio, improvements have been made to the conventional structure. This study, based on the Huazhong Shanghua(CSMC) 0.5um SOI process, designs a bandgap reference voltage source that offers higher precision and stronger load driving capability across a wide input voltage range. Common output errors and temperature drift issues are effectively mitigated in this design. Furthermore, by introducing exponential curvature compensation technology, the bandgap reference voltage source demonstrates superior temperature characteristics over a wide voltage range. The circuit consists of a startup circuit and a core bandgap reference circuit. This design simplifies the circuit structure and is more suitable for system integration. The design is simulated using cadence software, and the simulation results show that, within a temperature range of -55 to 125and an input supply voltage range of 13-20V, the reference output voltage remains stable at 3.71V, with a temperature coefficient of 16.850-6-1 and a power supply rejection ratio of -71.38dB at 100kHz.

15:50-16:10 **SunD6.3**

Recursive State Estimation With Self-Energized Relays: Integrating Parameter Design for Simultaneous Information and Wireless Power Transfer

Jiahao Song ,Zidong Wang ,Xiao He
(Tsinghua University)

This paper is concerned with the networked state estimation problem over communication channels with self-energized relays, which are capable of harvesting energy from wireless signals to support the data forwarding functions. A comprehensive mathematical model is proposed to formulate the workflow of self-energized relays. Subsequently, a recursive state estimator is established, followed by the analysis of the influence of self-energized relays on the data transmission process and the estimation performance. To optimize the estimation performance, the co-design of relay parameters and estimator gains is conducted by grid search. Finally, simulation examples are presented to verify the effectiveness of the proposed approach.

16:10-16:30 **SunD6.4**

Event-triggered Prescribed Performance Model-free Adaptive Sliding-mode Control for Robot Arm with Data Dropouts

Changxiao Ma ,Huarong Zhao ,Dezhi Xu ,Zhengdao Zhang ,Li Peng
(Jiangnan university)

This paper studies an event-triggered prescribed performance model-free adaptive sliding mode control issue for the selective compliance assembly robot arm

system, tackling model uncertainties, communication constraints, and dual-channel packet loss. A model-free adaptive sliding mode control method is designed to ensure robustness without relying on an accurate system model. An event-triggered mechanism is developed to reduce the waste of communication and computational resources by transmitting signals only when the system threshold is reached. Additionally, a dual-channel packet loss compensation mechanism is developed to address data loss issues in both the forward and feedback channels, ensuring system stability. Theoretical analysis confirms error convergence, and simulations validate the method' s effectiveness.

15:10-15:30 **SunD7.1**

Microrobot Actuation Modeling by Angle Constraints and Infinity-Norm Current Optimization

Yanbo Hua ,Haiying Wan ,Xiaoli Luan ,Fei Liu
(Jiangnan University)

This paper presents an accurate actuation modeling method for a modified orthogonal three axis Helmholtz coil electromagnetic actuation (EMA) system, enabling the generation of arbitrary three dimensional forces to drive magnetic microrobots and enhance overall system performance. Due to the number and configuration of the coils, the actuation equations may become inconsistent and can only be solved via least squares; consequently, the currents obtained produce only approximate forces, which impairs the accuracy. Therefore, an angleconstraint strategy based on the desired force is proposed to ensure consistency of the actuation equations and thereby improve actuation accuracy. Further, by exploiting the redundancy arising from consistent actuation equations, the conventional minimum 2- norm solution is replaced with a minimum infinity-norm solution, enhancing magnetic force generation while reducing peak coil currents. The efficiency and superiority of the proposed method are demonstrated through simulation experiments.

15:30-15:50 **SunD7.2**

Dynamic Modeling and Focus Control of a Piezo-Actuated Liquid Tunable Lens

段增鸿
(东北大学)

This study focuses on addressing the complex nonlinear coupling challenges and the pressing need for enhanced control accuracy in the dynamic focal adjustment of piezoelectrically actuated liquid tunable lenses. These lenses exhibit significant dynamic nonlinearities arising from electromechanical coupling, fluid dynamics, membrane-plate vibrations, and hysteresis effects, which pose substantial obstacles to achieving high-precision and fast-response focusing control. Therefore, it is imperative to develop a systematic and interpretable dynamic modeling and control framework.˚To this end, a comprehensive modeling and control approach is proposed in this work, integrating multiphysics coupling mechanisms to establish a unified dynamic model for piezo-actuated liquid lenses. Specifically, the electromechanical behavior of the piezoelectric actuator (PEA) is first described using an equivalent electrical circuit model. Subsequently, a coupled dynamics formulation based on a spring-damper-mass particle chain system is developed to characterize the interactions among the membrane, fluid, and elastic plate within the liquid lens, thereby capturing the dynamic coupling between fluid motion, membrane deformation, and structural vibration. For hysteresis modeling, a discrete Duhem differential model is introduced to effectively capture the hysteretic behavior of the piezoelectric elements under varying voltage amplitudes and frequencies. Building upon this model, a tunable, model-driven PID controller is designed. The controller parameters are analytically tuned using frequency response methods to ensure both rapid response and system stability.˚Experimental validation is conducted using a fully constructed piezo-actuated liquid lens test platform to assess model accuracy and controller performance. Linear subsystem identification is first performed using small-signal excitation, followed by parameter fitting of the hysteresis model under multiple frequencies (5 Hz, 10 Hz, and 20 Hz) and voltage amplitudes (2 V, 3 V, and 4 V). The results demonstrate high fidelity across varying test conditions, with a maximum root-mean-square error (RMSE) of 0.0407 and a peak modeling error of 9.50%. In focusing control experiments, the proposed PID controller achieved stable and rapid focal switching within a diopter range of +0D to +0.58D. The fastest rise time was recorded at 171 ms, with a fall time of 192 ms, and the steady-state RMSE was maintained below 0.0069. Moreover, the controller significantly enhanced PCB image sharpness across different focal settings.˚In summary, this work establishes a dynamic model of piezoelectric liquid lenses that comprehensively accounts for electromechanical coupling, fluid dynamics, structural vibration, and hysteresis nonlinearities. Based on this model, a model-driven precision PID control strategy is developed, substantially improving both focusing accuracy and dynamic response. Extensive experimental results confirm the effectiveness and accuracy of the proposed approach, indicating its strong potential for application in high-speed zoom imaging, active vision systems, and micro-optical manipulation devices. The methodology provides valuable technical support and theoretical reference for future advancements in these related fields.˚

15:50-16:10 **SunD7.3**

基于粘滑原理的介电弹性体驱动机器人眼球

于辰
(东北大学)

本研究解决现有基于柔性驱动器驱动的类人眼球过于侧重仿生设计而导致的运动性能不足与结构复杂化并存等关键问题，目标是开发一种开发一种结构简单、性能媲美人眼球的轻量化眼球驱动器。然而，现有的柔性驱动器驱动的类人眼球，往往在运动速度与运动范围上

与人眼存在较大差距，导致在需要快速反应及大范围跟踪的场景中，如复杂环境下的目标捕捉与跟踪任务，无法及时做出响应。介电弹性体驱动器（Dielectric Elastomer Actuator, DEA）作为一种柔性材料，具有响应速度快及能量密度高的优点，在仿生领域表现出优异的驱动性能。然而，现有的的基于介电弹性体驱动的类人眼球，需要多个 DEA 模块协同操作才能完成眼球的运动，这种多模块的设计不仅增加了系统的机械耦合，还显著增加了装配的复杂度。任何一个模块的故障都可能导致整个系统的运动功能失效，从而严重影响了系统的可靠性和稳定性。°，本研究在深入分析现有类人眼球驱动器的局限性的基础上，提出了了一种新颖的粘滑驱动策略，利用介电弹性体（DE）的独特变形特性与摩擦界面动力学相结合。基于这一原理，开发了一种粘滑式介电弹性体执行器（SSDEA），该驱动器包括一个带有两个扇形电极区域的 DE 模块、一个球形转子和一个 3D 打印框架。该结构设计简化了装配过程，同时确保了运行的稳定性。粘滑机制通过 DE 的循环驱动实现，具体而言，在粘滞阶段，DE 伸展，通过与转子的静摩擦产生位移；在随后的滑动阶段，通过动摩擦实现快速复位。这种设计使 SSDEA 能够在不依赖传统传动机构的情况下实现多自由度的连续旋转位移。°，搭建了驱动器运动性能测量平台，并在不同幅值与不同频率电压输入条件下，开展了 SSDEA 的运动速度及运动精度测试实验。实验结果表明，在 4.6 kV 峰值、10 Hz 的锯齿波电压激励下，SSDEA 的角速度可达 3.2 rad/s，同时保持高达 13.82 mrad 的步进分辨率。同时，根据不同电极区域的选择性激励，该驱动器可实现眼球多个自由度的运动。°，本研究通过深入分析现有类人眼球驱动器的局限性，提出了一种新颖的粘滑驱动策略，并开发了相应的 SSDEA 驱动器。实验结果验证了该驱动器在运动速度和精度方面的优异性能，证明其能够有效解决传统基于 DEA 的类人眼球所面临的运动性能不足与结构复杂化的问题。本研究的成果不仅为类人机器人眼球的高性能驱动提供了一种新的解决方案，而且为未来开发更加智能化、人性化的机器人系统奠定了基础。

张贴论文 (Poster Sessions)

粘贴论文 1 组 **2025 年 7 月 27 日**

会议中心 3 楼连廊 **08:30:00**

主　席: 袁小锋　中南大学

1 *Deep Reinforcement Learning based method for hot rolling mill schedule development*

王鲸量 钢铁研究总院
孙彦广 冶金自动化研究设计院
顾佳晨 冶金自动化研究设计院
陈金香 中国钢研冶金自动化研究设计院

2 *A Hierarchical Intelligent Scheduling Method for Slab Yard Cranes Based on Reinforcement Learning*

冯永兵 冶金自动化研究设计院有限公司
顾佳晨 冶金自动化研究设计院
董晨 冶金自动化研究设计院有限公司

3 *Microgrid Optimal Scheduling Based on the Multi-strategy Improved Crested Porcupine Optimizer*

沈浩 四川轻化工大学
谭飞 四川轻化工大学

4 基于多智能体强化学习的飞机脉动装配线分布式调度方法

陈凌韬 同济大学
乔非 同济大学
王怡琳 国泰海通证券股份有限公司
刘鹃 同济大学电子与信息工程学院
王冬源 同济大学
艾家康 同济大学
马玉敏 同济大学

5 基于 *CNP-NSGA-II* 的飞机脉动装配线分布式重调度方法

黄炘宇 同济大学
乔非 同济大学
王怡琳 国泰海通证券股份有限公司
刘鹃 同济大学电子与信息工程学院
刘佳 同济大学
丁晨 同济大学

6 基于 *LLM* 驱动与近端策略融合的热轧生产调度优化方法

吴阳杰 大连理工大学
王天宇 大连理工大学
赵珺 大连理工大学
王伟 大连理工大学

7 基于聚类算法与强化学习的植保无人机调度研究

范家榕 新疆大学
贾李睿智 新疆大学
孔博 新疆大学
李立行 新疆大学
刘胜全 新疆大学

8 *A Differential Evolution and Heuristic-fused Optimization Algorithm for Online Meal Delivery Problem*

Jingfang Chen Tsinghua University
Ling Wang Tsinghua University

9 *A Reinforcement Learning-based Optimization algorithm with Decoupling Strategy for On-Demand Food Delivery Problem*

Jingfang Chen Tsinghua University
Ling Wang Tsinghua University

10 *Multi-parameter optimization and performance Analysis of Injector Structure Based on TRIZ Theory*

Hao Xing Qilu University of Technology
Ruiyang Zhao Shandong High-speed Information Group Co., Ltd.
Hailun Zhang Shandong University
Wenxu Sun Shandong University
Shanshan Lv Qilu University of Technology
Lei Jia Shandong University

11 *Optimization Design of Vertical-Tube Multi-Effect Distillation Water Machine Based on TRIZ Theory*

Yiqian Cheng Qilu University of Technology
Wenxu Sun Shandong University
Xuejun Yan SHANDONG ZHENGZHONG INFORMATION TECHNOLOGY CO.,LTD.
Shanshan Lv Qilu University of Technology
Lei Jia Shandong University

12 *Finite-Time Control for Nonlinear Systems: Theory, Design, and Applications*

Yuelin Yang Zhejiang University
Chunjie Yang Zhejiang University
Yunkai Li North China Electric Power University
Yang Cao Zhejiang University
Siwei Lou Zhejiang university
Weibin Wang Zhejiang University

13 水平运输车区间二型模糊 *PID* 控制研究

周艳丽 华东交通大学
毛磊 华东交通大学
杨辉 华东交通大学

14 考虑结焦的乙烯裂解炉多目标操作优化

叶吴辰	华东理工大学
赵亮	华东理工大学
郑锦泉	无锡雪浪数制科技有限公司

15 *Distributed Coordinated Optimal Scheduling of Integrated Energy Systems With CHP Units and Wind Power Storage*

Lingyue Zhang	East China University of Science and Technology
Jiawen Mao	East China University of Science and Technology
Junbo Shao	East China University of Science and Technology
Yuxiang Niu	East China University of Science and Technology
Minxue Kong	East China University of Science and Technology
Xin Peng	East china university of science and technology

16 *Operation optimization of LNG receiving terminal based on first principle model*

HanXiao Luo	ZheJiang University
Chenguang Liu	Zhejiang University
Guanghui Yang	Zhejiang University
Duo Zhang	Zhejiang University
XIONGFENG FENG	HuZhou Institute of Industrial Control Technology
Zhijiang Shao	Zhejiang University
Lingyu Zhu	Zhejiang University of Technology

17 *Multicriteria Optimization for an FGD System Using Ensemble Learning-Assisted Dragonfly Algorithm*

Chunbo Wang	Beijing University of Technology
Xiaoli Li	Beijing University of technology
Kang Wang	Beijing University of Technology

18 *Integrating Intrinsic Motivation and Fuzzy Rewards in Reinforcement Learning for Robust Control of CDQ System*

Han Zhang	Dalian University of Technology
Yang Liu	School of Control Science and Engineering
Jin Jie	Dalian University of Technology
Jun Zhao	Dalian University of Technology
Wei Wang	Dalian University of Technology

19 基于 *Q-Learning* 的青霉素流加发酵过程优化控制

罗梦真	江南大学
王志国	江南大学自动化研究所
刘飞	江南大学

20 面向典型流程工业的数据驱动强化学习控制综述

田昊	北京工业大学
汤健	北京工业大学
杨春生	北京高安屯垃圾焚烧有限公司

21 *Formation Obstacle Avoidance Control for Quadrotor UAVs Based on Leader-Follower Approach and Improved Artificial Potential Field Method*

陈韦	四川轻化工大学
严月浩	中国民用航空飞行学院
韩强	四川轻化工大学
徐芊芊	四川轻化工大学
杨梦	四川轻化工大学
叶浩东	四川轻化工大学

22 基于固定时间分层控制的多欧拉 -拉格朗日系统时变编队跟踪

潘娇	东北大学
卢绍文	东北大学
丁进良	东北大学

23 *Binary Consistency of Linear Multi Agent Systems Based on Distributed Event Triggered Control*

李杰泰	四川轻化工大学
陈昌忠	四川轻化工大学
张奎	四川轻化工大学
勾鹏飞	四川轻化工大学

24 *Adaptive Vehicle Parallel Control Strategy Based on Multi Agent Reinforcement Learning*

万仟	华东理工大学
王振雷	华东理工大学
王昕	上海交通大学电工与电子技术中心

25 *Research on PV-Integrated Grid Frequency Control Strategy Based on Enhanced MADDPG*

杨鑫	中南大学
赵宣茗	中南大学
张佳诚	中南大学
贺彬宾	中南大学
裘智峰	中南大学

26 *Distributed Self-triggering Consensus Control of Multi-agent Systems Based On Observers*

勾鹏飞	四川轻化工大学
陈昌忠	四川轻化工大学
李杰泰	四川轻化工大学

27 基于数据融合的旋翼模式抗干扰飞行控制

郭天豪	中国空气动力研究与发展中心
杨小川	中国空气动力研究与发展中心
黄楷	中国空气动力研究与发展中心
杨旭	中国空气动力研究与发展中心
贺文涛	中国空气动力研究与发展中心
蒲建鑫	中国空气动力研究与发展中心

28 *Intelligent Control and Simulation of Power-assisted Exoskeleton Based on Image Signal Tracking Method*

FENG ZHOU	Sichuan Institute of Arts and Science
quanjun zhao	Sichuan University of Arts and Science

29 基于改进强化学习的作物施肥决策优化研究

杨星光	新疆大学
张小利	新疆大学
刘卜文	新疆大学
孔博	新疆大学
贾李睿智	新疆大学
刘胜全	新疆大学

30 基于李群框架下的智能车 *GNSS/INS* 组合导航算法及优化

蓝天	兰州交通大学
司涌波	兰州交通大学
陈光武	-兰州交通大学

31 基于改进多目标鲸鱼优化算法的高速列车姿态感知研究

杨辉	华东交通大学
李丹婷	华东交通大学
董帅强	华东交通大学
谢春华	华东交通大学

32 *Optimal Energy Storage Capacity for Wind-Solar-Storage Power Systems Based on Improved Grey Wolf Optimization Algorithm*

Chenyi Zhang	Chongqing University of Posts and Telecommunications

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薛安克	杭州电子科技大学
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主　席: 袁小锋　中南大学

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四川轻化工大学

四川轻化工大学是四川省人民政府与国家国防科技工业局共建高校，四川省一流学科建设高校、国家“中西部高校基础能力建设工程”高校、国家知识产权试点高校、教育部数据中国“百校工程”建设院校、教育部首批高等学校科技成果转化和技术转移基地。学校位于四川省自贡市和宜宾市，有李白河、汇东、宜宾、黄岭 4 个校区，占地总面积近 5500 亩，建筑面积 175 万余平方米，在校学生 4 万余人。在长期办学实践中，学校形成了“厚德达理 励志勤工”校训和“胸怀天下之家国情怀、舍我其谁之使命担当、自强不息之开拓奋进”的“652”大学精神。

学校现有教职工 3100 余人，其中专任教师 2400 余人，高级职称教师近 800 人，博士学位教师 1100 余人。有国家杰出青年科学基金获得者、四川省学术和技术带头人、四川省突出贡献优秀专家等省部级及以上人才近 50 人次，入选全球前 2%顶尖科学家榜单 8 人次；聘请特聘教授、兼职教授、客座教授 100 余人。

学校推进学科专业一体化发展，学科涵盖工学、理学、管理学等 12 学科门类；现有 3 个四川省高等学校“双一流”建设贡嘎计划建设学科，3 个省级重点学科，27 个硕士学位授权点，

化学、工程学、材料科学 3 个学科进入 ESI 全球学科排名前 1%。学校有 76 个本科招生专业，其中国家级一流专业 9 个，国家级特色专业 4 个，国家级“卓越工程师教育培养计划”试点专业 5 个；省级一流专业 17 个，省级“卓越工程师教育培养计划”试点专业 14 个，省级应用型示范专业 4 个，省级“课程思政”示范专业 2 个，通过教育部专业认证专业 6 个。

学校有国家级工程实践教育中心 4 个、省级校外实践教育基地 6 个、省级实验教学示范中心 4 个、省级虚拟仿真实验教学中心 4 个，省级现代化产业学院 2 个。立项教育部产学合作协同育人项目 149 项、教育部“新文科”“新农科”“新工科”研究与改革实践项目 2 项、四川省“新文科”“新农科”“新工科”研究与改革实践项目 4 项。学校是国家卓越工程师教育培养计划试点高校、国家级大学生创新创业训练计划高校、四川省深化创新创业教育改革示范高校。近三年，学生在“互联网+”“挑战杯”“创青春”等各类创新创业大赛中获得省部级及以上奖励 2500 余项；一大批毕业生升学进入浙江大学、上海交通大学、中国人民大学、南京大学、四川大学、悉尼大学等国内外一流高校。

学校累计培养了中国工程院院士、行业专家、知名企业家、杰出管理者为代表的各类人才 24 万余名。学校被誉为“中国白酒行业人才培养的摇篮”“彩灯行业的黄埔军校”。

学校现有国家晨光高性能氟材料创新中心、国家大学科技园 2 个国家级平台；酿酒科学与技术四川省重点实验室、智能感知与控制四川省重点实验室、材料腐蚀与防护四川省重点实验室、四川省酿酒专用粮工程技术研究中心、四川省高盐废水处置及资源化工程技术研究中心、四川省白酒智能酿造工程技术研究中心、有机氟材料四川省重点实验室、软物质材料制造重庆

市重点实验室、长江上游地区白酒数智化管理与生态决策优化重点实验室、国盐文化研究中心、川酒发展研究中心 11 个省部级平台；全国循环经济工程实验室、中国轻工业酿酒生物技术及智能制造重点实验室等 4 个行业协会平台；过程装备与控制工程四川省高校重点实验室、绿色催化四川省高校重点实验室、基层司法能力研究中心、川酒文化国际传播研究中心等 24 个市厅级平台；国家语言文字推广基地、四川省知识产权教育培训基地等 10 个科研基地。

学校始终坚持“研学结合、产教融合、特色发展”战略，在耐腐蚀、耐高温等特种关键材料研制领域解决了一大批行业“卡脖子”难题，研究成果获得国家科技进步奖；构建了“从一粒粮食到一滴美酒”的全链条服务体系，有力支撑全省白酒产业发展；组建了一批服务电子信息、装备制造、能源化工、医药健康产业的专家团队。先后与中国酒业协会、宜宾五粮液集团有限公司共建“中国白酒学院”，与中昊晨光研究院等单位共建“氟材料产业学院”，与中国工艺美术学会等单位共建中国彩灯学院，连续两次获批“四川省产教融合示范项目”。学校是四川省职务科技成果权属改革示范先进单位，完成科技成果转移转化近 400 项，创造经济效益达百亿元。

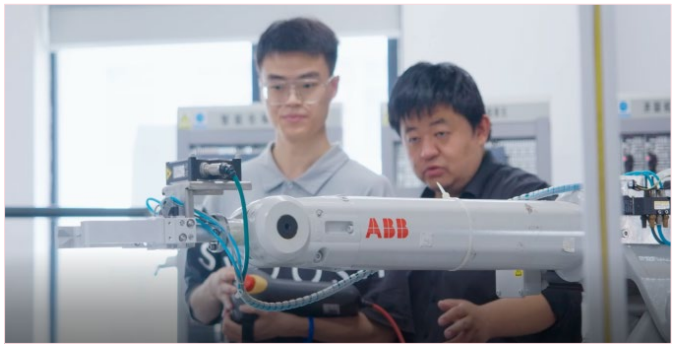
悠悠六秩风华，漫漫征程如歌。四川轻化工大学始终坚持以习近平新时代中国特色社会主义思想为指导，全面贯彻党的教育方针，坚持社会主义办学方向，坚持立德树人根本任务，扎根巴蜀大地办大学，赓续“三线建设”红色基因，以服务国家战略和地方经济社会发展需求为导向，加快落实第二次党代会确定的“1257”发展思路，奋力推进学校内涵式高质量发展，全面开启建设特色鲜明、优势突出的高水平综合性大学的新征程。

四川轻化工大学自动化与信息工程学院

学院是首批四川省高等学校电子与信息类本科人才培养基地，是首批教育部入选共建“AI+智慧学习”人工智能学院项目试点单位。设有自动化、电气工程及其自动化、通信工程、生物医学工程、智能科学与技术、智能无人系统技术等六个本科专业，其中自动化是国家特色专业和国家首批卓越工程师培养计划专业，四川省应用型示范专业和四川省一流专业，电气工程及其自动化专业为四川省卓越工程师培养计划专业和四川省一流专业，通信工程为国家一流专业，生物医学工程为校级一流专业。具有控制科学与工程一级学科和人工智能交叉学科硕士学位授予权，以及电子信息类和能源动力专业硕士学位授予权。控制科学与工程是省级一流学科，模式识别与智能系统是省级重点学科。

学院现有教职工 100 余人，其中国家千人 1 人，四川省千人计划 2 人，省学术与技术带头人 3 人、后备人选 2 人，教授 10 人，副教授 31 人，硕博士 80 余人，包含 2 个省级青年科技创新研究团队和 2 个省级优秀教学团队。

学院建有智能感知与控制四川省重点实验室和智能无人系统研究院，实验面积达 7000 平方米，拥有价值 4000 余万元的实验仪器设备。近年来，承担国家级、省部级等各类项目 100 余项，发表论文 1000 余篇，出版学术著作和教材 40 余部，授权专利 30 余项，完成的课题中获省部级奖 10 余项，其他科研奖 20 余项，同时科研成果转让及应用 20 余项。



学院高度重视学生实践能力和创新精神的培养，积极鼓励和组织学生参加各级各类课外科技和创新创业活动。近年来，学生在各类科技竞赛中获国家级奖项 300 余人次，省级奖项 400

余人次，其中包括全国大学生智能汽车竞赛一等奖、“挑战杯”全国大学生课外学术科技作品竞赛国家三等奖、全国大学生电子设计竞赛一等奖、全国软件和信息技术专业人才大赛一等奖等。学生就业质量高，毕业生深受用人单位和社会好评。

自动化与信息工程学院 2025-2026 学年人才引进计划表

学科（一级学科）	研究方向	人数	联系人
控制科学与工程、航空宇航科学与技术、兵器科学与技术、计算机科学与技术、信息与通信工程、生物医学工程、电气工程、电子科学与技术、仪器科学与技术、核科学与技术、数学、电子信息、能源动力、集成电路科学与工程、智能科学与技术等学科专业。	控制理论与控制工程、电力系统与智能控制、检测技术与自动化装置、模式识别与智能系统、人工智能、集成电路、通信工程，及其他前述一级学科涉及的研究领域和方向。	25	院长：曹立佳 联系电话：13990001062 邮箱：caolj@suse.edu.cn 工作人员：刘老师 联系方式:13890028629