HPMA
2023

2023人因建模与增强国际会议
暨第二届人因工程与混合智能创新大会

The International Conference of Human Performance Modelling and Augmentation 2023 （HPMA 2023）

The 2nd Human Factors Engineering and Hybrid Intelligence Conference

会议手册

2023年8月26-27日
中国，北京

大会机构

大会主席

毕路拯 北京理工大学　　吴昌旭　清华大学

主办单位

北京理工大学
清华大学
中国人因工效学学会人因建模与增强分会（筹备）

协办单位

中国人工智能学会脑机融合与生物机器智能专业委员会
中国计算机学会智能汽车分会
脑机接口产业联盟

承办单位

北京理工大学　机械与车辆学院
清华大学　　工业工程系

联合承办单位

博睿康科技（常州）股份有限公司
北京七鑫易维科技有限公司
北京泰和利康医疗技术开发有限公司
北京津发科技股份有限公司
北京理工大学出版社

大会学术委员会

清华大学	王凌
西安交通大学	陈霸东
北京航空航天大学	李阳
中国兵器工业集团	赵小川
中科院自动化所	左年明
电子科技大学	徐鹏
军事科学院创新研究院	印二威
北京师范大学	斯白露
浙江大学	祁玉
北京理工大学	闫天翼
北京理工大学	陈斌凌
西北工业大学	谢松云
首都医科大学附属北京康复医院	刘爱贤
中国人民解放军总医院	赵明
四川大学华西医院	李康
中国民航大学	汪磊

大会组织委员会

北京理工大学	薛庆
北京理工大学	刘莹
北京理工大学	罗龙溪
北京理工大学	Abraham Genetu Feleke
北京理工大学	费炜杰
清华大学	李翀
清华大学	龙新佳妮
中国信息通信研究院	李文宇
首都医科大学附属北京康复医院	莫林宏
燕山大学	谢平
华为技术有限公司	田坤
中国航天科工集团	范新安
中国电子科技集团	滕腾
军事医学科学院	连金岭

大会秘书处

罗龙溪 费炜杰 王佳蓉 史健廷 朱鹏飞

会议日程

8 月 26 日-上午：开幕式/大会主旨报告

时间	报告人	单位	报告题目	主持人
开幕式				
9:00-9:10	北京理工大学机械与车辆学院院长兼党委书记 席军强 大会共同主席 清华大学工业工程系 吴昌旭			毕路拯
大会主旨报告				
9:10-9:50	Bin He	美国卡内基梅隆大学	Bidirectional Brain-Computer Interface	毕路拯
9:50-10:30	王凌	清华大学	Data-Driven Intelligent Optimization Scheduling	
10:30-10:50	茶歇			
10:50-11:30	侯增广	中科院自动化所	Enhancement of Engagement Based on BCI for Rehabilitation Robotics	左年明
11:30-12:10	李阳	北京航空航天大学	脑机智能融合关键技术与应用	
12:10-13:30	午餐及墙报展示			

8 月 26 日-下午：主题报告

时间	报告人	单位	报告题目	主持人
主题报告				
13:30-14:00	吴昌旭	清华大学	人的认知和行为的统一建模	汪磊
14:00-14:15	程子健	上海交通大学	生物数学模型预测的警觉度显著影响精神警觉度任务绩效：一项更新的基于跨国飞行的漂移扩散模型	
14:15-14:30	魏子凯	石河子大学	有人/无人机协同作战战机智能座舱人机交互建模研究	
14:30-14:45	柴晨	同济大学	Effects of Targeted Psychological Inoculation on Unplanned Takeover Performance Improvement in Conditional Autonomous Vehicles: An Experimental Study	
14:45-15:00	栾昊	中国民航大学	基于 QN-MHP 的空速不可靠场景人机交互建模研究	
15:00-15:15	李欣璘	清华大学	人的信息加工排队网络模型 （QN-MHP）在智能座舱设计中的应用	
15:15-15:30	罗龙溪	北京理工大学	基于多种视觉识别任务的威胁行为自主识别方法	
15:30-15:45	茶歇			
15:45-16:10	毕路拯	北京理工大学	自然场景下的脑机接口与脑机协同控制技术	范新安
16:10-16:35	左年明	中科院自动化所	无线可穿戴脑认知检测调控闭环技术	
16:35-16:50	史健廷	北京理工大学	Brain-Computer Fusion for Sound Target Detection	

16:50-17:05	贾天宇	清华大学	Tailoring rTMS therapy based on personalized neural reorganization: towards individualized treatment for stroke patients	
17:05-17:20	李梦凡	河北工业大学	基于多感知融合的共享控制脑控移动机器人系统	
17:20-17:35	刘泉影	南方科技大学	Multi-objective optimization via evolutionary algorithm (MOVEA) for high-definition transcranial electrical stimulation of the human brain	
17:35-17:50	刘国洋	香港大学	Human Attention-Guided Explainable Artificial Intelligence for Computer Vision Models	
17:50-18:05	罗靖	西安理工大学	A Shallow Mirror Transformer for Subject-Independent Motor Imagery BCI	

8月26日晚上18:30-21:30 大会工作坊Workshop

18:30-21:30	大会Workshop 吴昌旭 清华大学 人的认知和行为建模文章写作要领和经验分享 人的认知和行为建模方法总述 魏子凯 石河子大学 人的认知和行为建模实践 注：请参会人员自备笔记本电脑进行现场教学	吴昌旭 魏子凯

8 月 27 日-上午：大会特邀报告

时间	报告人	单位	报告题目	主持人
大会特邀报告				
9:00-9:25	Shan Bao	美国密歇根大学	Driving Style Classification and ADAS Effectiveness: Differences between Teen and Adult Drivers	吴昌旭
9:25-9:50	许敏鹏	天津大学	消费级脑机接口发展与挑战	
9:50-10:15	闫天翼	北京理工大学	基于影像导航的无创神经调控技术与应用	
10:15-10:35	茶歇			
10:35-11:00	李国齐	中科院自动化所	类脑计算与类脑智能	闫天翼
11:00-11:25	解芳	北方车辆研究所	乘员认知绩效实时评估技术研究	
11:25-11:50	孙鹏	百度	自动驾驶技术、开源开放及商业化实践	
午餐 11:50-13:00				

8 月 27 日-下午：大会主旨报告/主题报告

时间	报告人	单位	报告题目	主持人
主题报告				
13:00-13:15	范新安	航天科工 206 所	Using Amplitude and Latency of ERP to Predict Performance of Rapid-Serial-Visual-Presentation BCI	

13:15-13:30	李广利	湖南工业大学	面向无创脑-机接口:柔性凝胶半干脑电电极最新研究进展	费炜杰
13:30-13:45	许萌	北京工业大学	基于 RSVP-BCI 范式的图像识别关键技术研究	
13:45-14:00	唐揽月	同济大学	An Interactive Vehicle Trajectory Prediction Method Considering Emotion Based on SOR Cognitive Theory	
14:00-14:15	李萌	中国医学科学院	A High-Frequency SSVEP-BCI System Based on Simultaneous Modulation of Luminance and Motion Using Intermodulation Frequencies	
14:15-14:30	崔玉洁	西北工业大学	Dynamic Probability Integration for EEG based RSVP Performance Enhancement: Application in Nighttime Vehicle Detection	
14:30-14:45	刘祥惠	西北工业大学	基于多模态生理信息的人机融合智能增强导航方法	
14:45-15:00	蔡雨	天津大学	基于 BLE 射频映射的多设备数据同步方法研究	
15:00-15:15	郑春厚	天津大学	基于烧结 Ag/AgCl 拉普拉斯电极的 SSVEP 脑电信号采集研究	
15:15-15:35	茶歇			
大会主旨报告				
15:35-16:05	潘纲	浙江大学	从人工智能到脑机智能	毕路拯
主题报告				
16:05-16:20	董一群	复旦大学	飞行员空战行为特征建模与分析	魏子凯 罗龙溪
16:20-16:35	丰上	哈尔滨工业大学	基于超图的驾驶认知状态识别方法研究	
16:35-16:50	张栋	燕山大学	基于强化学习的功能性电刺激闭环调控策略研究	
16:50-17:05	邵谢宁	燕山大学	基于虚拟现实和听视觉反馈的增强康复训练方法研究	
17:05-17:20	张宇锋	北京邮电大学	基于脑机接口的无人机航拍目标检测	
17:20-17:35	张若晴	中国医学科学院	A calibration-free 32-target hybrid BCI speller system based on high-frequency SSVEP and sEMG	
17:35-17:50	安亚宁	北京交通大学	基于脑电功能连接网络的驾驶员风格识别	

注：请每位报告人预留 3-5 分钟自由提问时间

墙报展示：8 月 26 日 12:30-13:30

墙报展示			
编号	**展示负责人**	**单位**	**展示题目**
1	谢壮	天津大学	基于时频注意力机制的现实生活场景下低延迟脑电听觉注意力检测
2	刘宇城	天津大学	基于脑机接口检测技术的驾驶员警觉度检测
3	梁莹	同济大学	Confounding Impact in Takeover Performance: Using Causal Analysis to Uncover the Influencing Mechanism in Level-3 Autonomous Driving
4	郑大路	西北工业大学	增强现实环境下基于 SSVEP 的任务级脑机控制方法
5	王祥铭	西北工业大学	TIFRUnet: A Residual Unet Using Time-frequency Information for EEG Artifact Removal and Reconstruction
6	刘睿	北京交通大学	基于复杂网络特征的分心驾驶脑功能网络分析

7	于纪翔	北京交通大学	基于脑电数据和模糊卷积神经网络的自动驾驶关键脱离场景识别
8	陈玉风	南京理工大学	How information within the perceptual span guides visual search and aids perception
9	刘潇	南京理工大学	机载显控界面复杂度对飞行员认知绩效影响
10	张绚绚	北控水务（中国）投资有限公司	“感知-交互-决策”：一种基于工业大数据与人工经验量化耦合的混合智能研究方法
11	李文婧	天津工业大学	Study on the effect of repeated transcranial electrical stimulation on mental rotation
12	柳朝阳	西藏民族大学	一种结合身份认证的轻量级混沌脑电信号加密方案
13	靳丹阳	西藏民族大学	Latin-square based encryption method for medical images

致辞嘉宾

席军强 | 北京理工大学

席军强，男，教授，博士生导师，入选国家“万人计划” 科技领军人才、科技部“创新人才推进计划中青年科技创新领军人才”、“百千万人才工程”国家级人选并被授予“有突出贡献中青年专家”荣誉称号。2001 年博士毕业后留校工作至今，现任北京理工大学机械与车辆学院院长兼党委书记。

主要从事车辆智能化操纵与控制方向教学与科研工作，作为项目主持人承担十余项国家/国防项目，曾任某型号项目副总设计师。针对国家国防重大需求，在考虑驾驶员操纵特性与意图的车辆智能化操控方向进行了长期基础理论方法和关键技术用研究，车辆操纵与控制技术相关研究成果已批量应用于多型车辆，2019 年牵头完成的“车辆自动机械变速操控系统”获国家科技进步二等奖。以第一或通讯作者发表 SCI/EI 检索论文 81 篇；获国家及国际发明专利 32 项；获得过国家科技进步二等奖 2 项以及部级科技奖励 7 项；2018 年作为导师指导的博士论文“基于个性化驾驶员模型的车辆辅助驾驶系统自适应技术研究”获得中国汽车工程学会优秀博士学位论文。

现任中国机械工业教育协会车辆工程专业教学委员会副主任委员、北京汽车工程学会副理事长，担任 International journal of electric and hybrid vehicles 等期刊编委职务。

大会主席

毕路拯 | 北京理工大学

毕路拯，北京理工大学机械与车辆学院教授、博导、机电系统与装备研究所所长。长期致力于自然场景下的脑机接口、脑机融合智能感知与脑机协同控制的理论与应用研究。在人体运动参数的鲁棒脑电解码和脑机融合智能协同控制方面做出系统性创新贡献。担任 IEEE 资深会员、中国脑机接口产业联盟专家委员会资深专家、数据与基础软件工作组副主席、中国计算机学会智能汽车分会专委会常务委员、中国人工智能学会脑机融 合与生物机器智能专委会委员、世界机器人大赛专家组成员。主持国家自然基金项目、JKW 前沿科技创新项目、GF 基础科研、华为技术有限公司项目等。第一著者出版学术专著和教材两部。第一或通讯作者在 IEEE TCYB, TBME, TITS, TSMCS, THMS, TNSRE 等发表论文 100 余篇。获授权国家发明专利 30 项。获教育部自然科学二等奖和中国电子学会科技进步二等奖。指导学生获 2022 年世界机器人大会-BCI 脑控机器人大赛青年优秀论文一等奖，获首届“京彩大创”北京大学生创新创业总决赛季军、北京市一等奖和第八届中国国际“互联网+”大学生创新创业大赛全国铜奖，2023 年“挑战杯”北京市特等奖。

报告题目：自然场景下的脑机接口与脑机协同控制技术

报告简介：非侵入式脑机接口在运动功能康复和感知、认知能力增强等方面有重要应用价值。为了推动非侵入式脑机接口走向真实应用场景，本团队一直致力于自然场景下的脑机接口和脑机协同控制的理论、方法和应用研究。本报告将汇报本团队近年来在自然场景下的人体运动参数的鲁棒脑电解码、低信噪比下声音目标的脑机融合检测和面向动态系统的脑机协同控制方面的研究进展。

大会主席

吴昌旭｜清华大学

吴昌旭博士 2007 年毕业于美国密歇根大学安阿伯分校工业与运筹工程学系。博士毕业后在美国纽约州立大学、美国亚利桑那大学历任助理教授、副教授、和终身正教授， 并于 2020 年入选国家高层次人才全职回国成为清华大学长聘正教授。吴博士致力于建立人类认知和行为统一计算模型，并在典型人机系统设计中应用该模型，提高人机系统安全和效率。吴博士已经在人因工程领域发表了 133 篇论文，被引用数量近 4000 次。吴博士回国后正在主持国家基金委重大项目等多个关键项目。吴博士培养的学生任职于美国宾夕法尼亚州州立大学、北京大学、和中国科学院等著名高等学府和研究机构, 以及美国通用汽车, 美国通用电气, 中国联想等主要企业。

报告题目：人的认知和行为的统一建模

报告简介：基于尖端科学走向统一建模的趋势，本报告介绍了一种人类认知和行为统一计算模型：人的认知排队网络模型。该模型基于可解释人工智能技术（清晰算法和数学建模）和离散事件仿真技术，统一并整合大量人因工程、人机交互和心理学实验研究成果，落地于心行者科技的人的认知和行为仿真软件，预测人在人机系统中任务完成时间、错误率、工作负荷等，服务人-机-环系统设计和快速评估。

专家及其报告介绍

Bin He | 美国卡内基梅隆大学

Bin He is a Trustee Professor of Biomedical Engineering, Professor of Neuroscience Institute, and Professor by Courtesy of Electrical and Computer Engineering at Carnegie Mellon University. Dr. He has made significant research contributions to the field of neuroengineering and biomedical imaging, including brain-computer interface, electrophysiological source imaging, and focused ultrasound neuromodulation. He has been recognized by several prestigious awards including the IEEE Biomedical Engineering Award, the IEEE EMBS William J. Morlock Award, and the IEEE EMBS Academic Career Achievements Award. Dr. He served as a Past President of IEEE Engineering in Medicine and Biology Society, Past Chair of the International Academy of Medical and Biological Engineering, Editor-in-Chief of IEEE Transactions on Biomedical Engineering, and a Member of NIH BRAIN Initiative Multi-Council Working Group. He is an elected Fellow of National Academy of Inventors, International Academy of Medical and Biological Engineering, IEEE, American Institute of Medical and Biological Engineering, and Biomedical Engineering Society. Dr. He is the editor of the textbook “Neural Engineering” first published in 2005, with its 3rd edition published in 2020 by Springer, and is the current Editor-in-Chief of IEEE Reviews in Biomedical Engineering.

报告题目：Bidirectional Brain-Computer Interface

报告简介：Brain-computer interface (BCI) measures and decodes brain activity and converts it into artificial output that replaces, restores, enhances, supplements, or improves natural output. It can also influence brain activity and behavioral performance by injecting physical energy into the brain to modulate the ongoing interactions between the brain and its external or internal environment. Noninvasive sensing and mapping neural electrical activity can provide a window to watch the brain at work at the systems level, decode human “intention” to control a machine, and guide neuromodulation for non-pharmacological treatment of neurological disorders. In this presentation, we will discuss noninvasive brain-computer interfacing, through sensing and decoding sensorimotor rhythm signals accompanying motor imagery, to allow human subjects

to control a virtual or physical device using only their “thoughts”. We show that humans can fly a drone and control a robotic arm to continuously move and grasp an object all based on noninvasive EEG signals. We will also discuss our effort to establish a noninvasive neuromodulation technology to enable precise stimulation of neural circuits using transcranial focused ultrasound. Our results show that focused ultrasound is able to provide cell-type specificity and deep brain penetration, and can reduce pain sensitivity.

王凌｜清华大学

Ling Wang received the B.Sc. and Ph.D. degrees from Tsinghua University, Beijing, China, in 1995 and 1999, respectively, and now is a tenured Full Professor in Tsinghua Univ. His research interests mainly include intelligent optimization, scheduling and applications. He has authored 5 academic books and more than 350 SCI-indexed papers and his publications have attracted over 30K Google Scholar Citations. He is the Editor-in-Chief of International J of Automation and Control, Complex System Modeling and Simulation, and the Associate Editor of IEEE Trans on Evolutionary Computation, Expert Systems with Applications, Swarm and Evolutionary Computation, etc. Prof. Wang received National Natural Science Award of China (2nd Prize 2014), Natural Science Award of the Ministry of Education (MOE) of China (1st Prize 2003, 2nd Prize 2007 and 2022), Technology Innovation Award (1st Prize 2019) and Natural Science Award (1st Prize 2021 and 2022) of China Simulation Federation, etc. He also received the Best Paper Awards of Acta Automatica Sinica (2014), Control Theory & Applications (2016), Control and Decision (2017), Journal of System Simulation (2021-2011) and several International Conferences. He was the recipient of National Natural Science Fund for Distinguished Young Scholars of China (2015), Young Talent of Science and Technology of Beijing City, New Century Excellent Talent in University by the MOE of China, Academic Young Talent of Tsinghua University, Young Scientist Award of CAA, Chinese Most Cited Researcher and IEEE TEVC Outstanding Associate Editor (2019~2022).

报告题目：Data-Driven Intelligent Optimization Scheduling

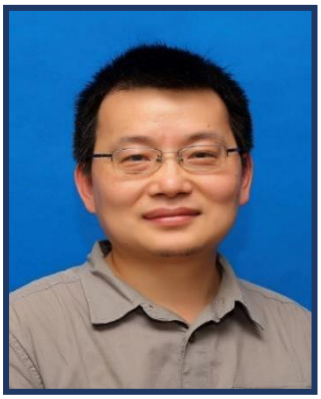
报告简介： Optimization and scheduling problems are the significant issues faced by the manufacturing industry. This talk first shows the complexities of the engineering optimization and scheduling problems (EOSPs); and then introduces a unified framework for the population-base intelligent optimization techniques from a systematic perspective as well as an integrated intelligent optimization framework; finally presents some typical research work in terms of theoretical analysis, constrained optimization and intelligent scheduling algorithms. The primary aim of this talk is to show that intelligent algorithms are powerful and general solution tools for solving the EOSPs, while it is more important to incorporate the problem-specific knowledge into the algorithms for solving specific problems.

侯增广｜中科院自动化所

Zeng-Guang Hou is a Professor and Deputy Director of the State Key Laboratory of Management and Control for Complex Systems, Institute of Automation, Chinese Academy of Sciences (CAS). He is a VP of Chinese Association of Automation (CAA), VP of the Asia Pacific Neural Network Society (APNNS), and BOG member of International Neural Network Society (INNS). Dr. Hou is a CAA/ IEEE Fellow. He also serves as an AE of IEEE Transactions on Cybernetics, and an Editorial Board Member of Neural Networks. Dr. Hou was a recipient of IEEE Transactions on Neural Networks Outstanding Paper Award in 2013, and the National Natural Science Award of China and the Outstanding Achievement Award of Asia Pacific Neural Network Society (APNNS) in 2017.

报告题目：Enhancement of Engagement Based on BCI for Rehabilitation

报告简介： Rehabilitation training is a continuous while tedious process which causes slackness of patients. Engagement or active training of stroke patients helps to increase the neural activities of the cerebral cortex, and thus promotes neuroplasticity. In this talk, we discuss the challenges and possible solutions to enhance the engagement of patients using brain computer interface techniques in the process of rehabilitation training.



潘纲 | 浙江大学

潘纲，浙江大学计算机学院教授，脑机智能全国重点实验室常务副主任，获国家杰出青年科学基金资助，中国人工智能学会会士、常务理事、脑机融合专委会主任委员， 中国自动化学会机器人智能专委会副主任委员，中国神经科学学会类脑智能分会副主任等。研究方向为脑机接口、类脑计算、人工智能等。担任 IEEE Trans. NNLS、IEEE Trans. CDS 等期刊编委。

报告题目：从人工智能到脑机智能

报告简介： 人工智能、计算神经科学、微电子、神经生理学等领域的最新进展，显示出计算机和生命体之间的融合成为可能并日趋明显。以脑机接口为代表的神经技术的突破使得脑与计算机之间的结合越来越紧密，脑机融合及其一体化已成为人工智能发展的一个重要趋势。如何让生物脑与机器脑深度融合并协同工作，是当前人工智能与脑认知科学交叉领域面临的重要课题。本报告将从脑机接口出发，介绍新型人工智能形态——脑机智能，以及课题组的部分研究进展。

李阳 | 北京航空航天大学

李阳，北京航空航天大学自动化科学与电气工程学院教授、博士生导师，副院长，教育部青年长江学者。2011 年毕业于英国谢菲尔德大学自动控制与系统工程系，获哲学博士学位。2012 年 12 月入选北京航空航天大学“卓越百人”海外人才计划。2013 年 2 月起在北京航空航天大学模式识别与智能系统实验室工作。主要从事医学影像数据分析与处理、脑机接口与神经康复工程等方面的相关研究工作。主要研究手段包括脑电图(EEG)，结构及功能性磁共振成像(DTI/fMRI)，以及深度学习等计算分析方法。研究成果以第一/通讯作者在国际学术刊物上发表 SCI 论文 40 多篇，包括 IEEE Transactions on Medical Image、IEEE Transactions on Cybernetics、Annual of Neurology 及自然语言处理领域 ACL、医学影像领域重要国际会议 MICCAI 等。近五年承担国家级、省部级等科研项目 10 余项，其中包括国家自然科学基金重点、北京市自然科学基金专题重点项目等。曾获英国谢菲尔德大学“哈里沃辛顿”学术奖、英国“优秀自费留学生奖”，研究成果获吴文俊人工智能自然奖、中国体视学“青年科技奖”等。担任国际期 international Journal of Biomedical Engineering and Science 编委等。

报告题目：脑机智能融合关键技术与应用

报告简介：本报告以多模态脑信息深度融合学习方法为基础，采用多模态个体化脑信息与小样本深度学习融合研究方法，探讨基于电生理数据、文本及语音、多模态结构/功能影像数据等数据驱动模型假设，如何用于揭示脑活动机制，解决临床难以有效检测大脑异常活动机制的问题。基于理论创新成果，研发了脑机智能交互及神经调控闭环治疗系统，在中国康复研究中心及宣武医院等多家医院临床应用，为探索神经慢性脑疾病的个体化脑功能网络异常连接机理提供了理论基础和技术支持。

左年明 | 中科院自动化所

左年明，博士、研究员，中国科学院自动化研究所脑网络组研究中心副主任，脑网络组北京市重点实验室副主任，北京脑网络组与类脑智能学会秘书长。主要研究方向为智能诊-疗技术及脑科学，基于电子技术和人工智能算法，实现脑信号的检测、认知功能识别以及个体化闭环神经调控干预。目前自主研发的无线无创可穿戴式脑认知功能检测与调控闭环技术已经在多家临床医院及某特殊场景批量试用。以主要作者发表 SCI 学术论文 30 余篇，杂志包括 Cerebral Cortex 等；以主要发明人技术专利授权 20 余项，包括 2 项美国技术专利授权。以项目负责人身份承担的项目包括国家自然科学基金委面上项目及某委重大项目（首席科学家；项目成果被某委纳入官方重点成果推荐清单）；担任中国科学院自动化研究所“2035 创新任务”负责人；入选中国科学院特聘研究岗骨干岗位、中国科学院关键技术人才。

报告题目：无线可穿戴脑认知检测调控闭环技术

报告简介：未来脑机接口的发展方向将是以“脑控-控脑”双向信息交互为主要特点。但是目前在该领域以可穿戴“即戴即用”方式实现闭环的“脑控-控脑”尚缺乏有效技术和装备。为了解决该问题，我们团队过去五年集中攻关，研发了无线无创可穿戴脑电检测与经颅电刺激闭环技术和装备。该设备采用盐水电极设计（接触阻抗 5KΩ 左右）， 结合可主动适配不同头型的记忆塑料工艺设计爪形结构（头发长短基本不会有影响），实现即戴即用的效果，大大减少传统脑电检测和经颅电刺激的实验准备时间。该技术与设备已经通过第三方医疗检验机构的电气性能和安全性检验，且已经实现小批量生产， 在多家三甲和二甲临床医院、多种特殊训练场景开展应用测试。

该设备为 16 通道配置，所有通道均可以通过终端（手机或电脑）实现脑电检测或电流调控，并且可以实现多环路多靶区聚焦性调控（High-Definition），而且从硬件和算法上实现了调控情形下脑电噪声的去除和信号恢复。单独的脑电检测或电流调控主要参数性能可以分别媲美甚至超过美国 Emotiv 以及美国 Soterix 公司产品。目前已经搭建了完整的应用平台，包括数据采集硬件软件系统、远程数据库结构化存储、临床实验范式、信号识别算法等（项目网站 http://www. SignBrain. cn），已有超过 20 项国内外专利授

权，多项论文发表，并已经构建了本领域国际最大的抑郁症检测调控数据库。2022 年 9 月中国科学院重大任务局组织的全院重大项目评估中，本项技术排名信息领域第一；该技术的特殊应用已于 2023 年 5 月被某部门纳入官方成果推荐清单。

Shan Bao | 美国密歇根大学

Dr. Bao is a human factors researcher with positions as an associate professor in the Department of Industrial and Manufacturing Systems Engineering (IMSE) at the University of Michigan-Dearborn and an associate research professor at the University of Michigan Transportation Research Institute (UMTRI). Commencing in September 2023, she will assume the role of IMSE department chair. She earned her Ph.D. in mechanical and industrial engineering from the University of Iowa in 2009. Dr. Bao's research focuses on modeling and analyzing human behavior and its impacts on safety and system designs. To date, Dr. Bao has served as PI or co-PI on 63 research projects, and she is currently an author of 110 technical publications. She has given multiple keynote speeches and served on expert panels at different conferences or meetings. Dr. Bao is currently the vice chair of the human factors committee of the Transportation Research Board (TRB).

报告题目：Driving Style Classification and ADAS Effectiveness: Differences between Teen and Adult Drivers

报告简介： The concerningly increasing trend of vulnerable road user (VRU) crash fatalities has continued in recent years. According to the latest national crash data of the U.S., pedestrian fatalities in 2021 sustained a 12.5% increase from 2020 and a disturbing 65.8% increase from 2011. The advancement in automated driving technologies brings the opportunity for novel solutions to address this challenge; meanwhile, a thorough evaluation of the designed automated system is essential to ensure the flawless function of the solution. To assist the evaluation of this effort, this work presents a framework to identify real-world corner-case scenarios of VRUs through a data-driven approach. Multiple resources, such as crash data and naturalistic driving and cycling data, were utilized to identify relevant factors of VRU-related corner-case scenarios. By applying the 6-Layer Model and the model of human information processing, we selected six determining factors of corner-case scenarios: weather, lighting, road surface condition, driver vision obstruction, driver misbehavior, and VRU misbehavior. The six factors were then used to extract VRU-related corner-case scenarios from the national crash data and naturalistic data. For identified corner-case scenarios, a description of the scenario context as well as a diagram depicting the vehicle-VRU interaction, were provided. We expect the framework and the library of corner-case scenarios to benefit the design and testing of

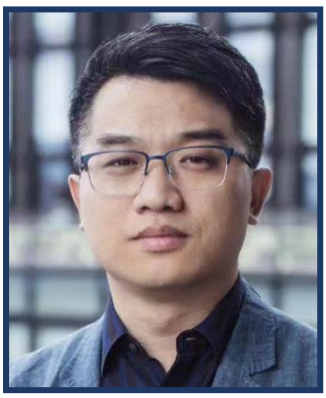
automated vehicles in real-world situations by incorporating a diverse range of contexts with greater fidelity and efficiency.

许敏鹏 | 天津大学

许敏鹏，男，1988 年生，英才教授，天津大学医工院副院长，长江学者，国家优青科学基金获得者，“强国青年科学家”称号获得者，IEEE senior member，主要研究方向为脑-机接口，研究成果入选国家“十三五”科技创新成就展。目前担任中国脑-机接口产业联盟资深专家委员、总体工作组副主席、数据与基础软件工作组主席，中国电子学会智能人机交互专委会副秘书长，中国生物医学工程学会医学神经工程分会委员，中国康复辅助器具协会康复工程专业委员会委员，中国人工智能学会脑机融合与生物机器智能专业委员会委员，中国医师学会神经修复学专业委员会委员，中国自动化学会青年工作委员会委员等；入选 2018-2020 年度中国科协“青年人才托举工程”项目，主持国家级、省部级、航天、华为等项目 10 余项；2022 年度《麻省理工科技评论》“35 岁以下科技创新 35 人”中国入选者，入选 2022 科学 Talk 生命新力量年度人物榜单，获 2020 中国生物医学工程学会“首届青年学者奖”，2019 世界机器人大赛 BCI 脑控机器人大赛技术赛一等奖，2017 黄家驷生物医学工程奖，2016 天津市技术发明奖一等奖等。以第一作者或通讯作者在 Science Advances、Engineering、NeuroImage、IEEE TBME、JNE 等国内外脑-机接口与神经工程领域重要学术期刊或会议集发表论文 50 余篇，获中国、美国等授权发明专利 30 余项。学术论文获 IOP China Top-Cited Paper Award，入选 ESI 高被引论文，IEEE TBME 封面论文、JNE 高亮论文，被 Science 专刊报道。作为技术负责人开发脑-机接口综合性开源软件 MetaBCI，作为骨干参与研制“天宫二号”在轨脑- 机接口系统、人工神经康复机器人系统、“脑语者”芯片等。

报告题目：消费级脑机接口发展与挑战

报告简介：脑机接口通过在大脑与外界设备之间建立直接的信息通路，能够实现所谓的“意念控制”。脑机接口被誉为未来元宇宙空间的终极入口，有望改变人机交互模式，颠覆人类生产生活方式。但是，现有脑机接口技术尚不足以支撑体验良好的脑机交互应用，亟需解决交互范式不自然、硬件平台不友好两大挑战。本次报告将围绕消费级脑机接口技术展开，讨论未来非侵入式脑机接口的发展。



闫天翼 | 北京理工大学

闫天翼，北京理工大学教授、博士生导师，生命学院副院长、生物医学工程系主任、生物医学工程学科责任教授，国家高层次青年人才、北京市科技新星计划获得者。主要从事脑机智能与神经系统疾病诊治领域的理论和仪器设备开发、及无创神经调控机理与技术研究。承担国家重点研发计划项目、国家自然科学基金重点项目、北京市重大科技专项等 15 项。以第一完成人获教育部技术发明奖二等奖（2022 年）、中国发明协会发明创新创业奖一等奖（2021 年）、北京市高等教育教学成果二等奖（2022 年）。作为主笔人撰写专家共识一项。研究成果发表学术论文 150 余篇，其中在 Nature Communications、Radiology、MIA、Stroke、IEEE TNNLS 等会刊发表 SCI 论文 100 余篇。申请/授权国家/国际发明专利 59 项。

报告题目：基于影像导航的无创神经调控技术与应用

报告简介：当前，神经精神类疾病是我国乃至全球范围内造成残疾的主要原因，而老龄化进一步加剧了脑疾病带来的严重的社会负担。面向临床诊疗需求，围绕研究背景、技术突破、应用案例三方面，重点介绍双向脑机接口技术及其应用，首先分析临床、国防、行业等方面的技术需求，介绍脑机接口技术的发展进程，引出双向脑机接口技术内涵。其次，介绍在个体功能定位、类脑计算导航、精准神经调控等方面的技术难点及突破， 包括新机制、新算法、新系统研究。最后，介绍该技术在视听触觉功能替代、临床诊断调控等方面的应用。

李国齐 | 中科院自动化所

李国齐，中国科学院自动化所研究员，博士生导师。2011 年毕业于新加坡南洋理工大学，获博士学位。2011 年-2014 年就职于新加坡科技局，任科学家。2014 年-2022 年任教于清华大学，历任助理教授、副教授、博士生导师。李国齐在 Nature、Nature/Science 子刊、Proceedings of the IEEE、IEEE TPAMI 等期刊和 ICLR、NeurIPS、AAAI 等会议上发表论文 190 余篇；出版类脑方向学术专著 1 部；论文在 Google 学术上被引用 8000 余次；申请专利 40 余项；主持国家自然科学基金重点项目、国家自然科学基金联合重点项目、科技部重点研发项目、 JKW 基础加强项目、北京市科委项目等 20 余项；担任多个国际会议的 Tutorial Chair，Symposium Chair，Track Chair，Publicity Chair 和组委会成员；担任多个国内期刊和国际 SCI 期刊的编委、副主编、特邀编辑；曾获得中国指挥与控制学会科学技术一等奖，教育部技术发明二等奖，2017 年入选北京自然基金优秀青年人才，2019 年入选北京智源学者，2021 年获得北京市杰出青年基金资助，2022 年入选中国科学院百人计划，2023 年入选 DeepTech 中国智能计算科技创新人物。其参与的类脑芯片理论、架构和工具链的工作曾入选 2019 年中国科学十大进展和 2020 年世界人工智能十大进展。

报告题目：类脑脉冲神经网络模型算法及应用

报告简介：类脑计算是受人脑信息处理方式启发，基于神经元和神经环路的结构和功能，以更通用人工智能为目标构建计算系统的技术总称。近年来类脑脉冲神经网络在一些场景体现了类似大脑处理复杂智能问题的能力和效率，被寄予厚望，展现出引领未来智能 技术的潜力。本报告介绍类脑计算和类脑智能基本概念和范畴，结合报告人的工作，介 绍以脉冲神经网络为代表的类脑理论模型、算法及其硬件部署，并展望类脑计算和类脑 智能的发展趋势。

解芳 | 北方车辆研究所

解芳，中国北方车辆研究所研究员、研究所人因工程学科首席技术专家，中国系统工程学会人-机-环境系统工程专业委员会委员，中国人类工效学会复杂系统人因与工效学专业委员会委员。从事车辆人机环系统工程、车辆舱室噪声仿真与控制技术、车辆人机界面设计与评价等领域的研究。主持了特种车辆人机环境实验室建设、多项车辆研制人机环专项负责人；主持参加了国家级项目研究工作和多项“十二五”，“ 十三五”及“十四五”重点预研项目；曾获得多项国家发明专利授权，在国内外学术刊物上发表论文 30 余篇。

报告题目：乘员认知绩效实时评估技术研究

报告简介：新一代乘员座舱的智能化操控对于乘员脑力负荷水平不断提升，而乘员的认知绩效会直接影响操作效能。针对这一问题，本报告提出了一种基于多信息融合的乘员认知绩效实时评估方法和认知绩效模型，通过研究乘员认知绩效的分析、评估与实时检测一体化技术和适应乘员特性的认知辅助预警方法，实现了对乘员认知绩效的实时评估和干预调控，从而提升了乘员的操作效能。

孙鹏｜百度

孙鹏，博士，现就职于百度自动驾驶技术部，中国计算机学会高级会员、智能汽车分会执行委员，中国科学院大学首届创新创业 MBA。于 2011 年在中国科学院计算技术研究所获得计算机系统结构博士学位，2009-2010 年在美国北德州大学（UNT）做高级访问学者，2011-2013 年在中国科学院软件研究所国家级重点实验室天基综合信息系统重点实验室任助理研究员。主要研究兴趣包括：计算机系统结构，科学史，自动驾驶系统，空间数据挖掘等。本人参与科技冬奥、科技部科技创新 2030 等重大项目 5 项，发表论文 14 篇，出版译著 1 部，拥有发明专利 4 项，参与标准制定 7 项。

报告题目：自动驾驶技术、开源开放及商业化实践

报告简介：本报告将从自动驾驶技术体系、Apollo 开源开放能力以及商业化实践三个方面进行介绍。自动驾驶技术体系方面，我将介绍如何打造安全、智能、高效的自动驾驶技术体系；在开源开放方面，我将从源码、服务、硬件接口等方面介绍我们的开放能力； 商业化实践方面，将介绍最新的在北京、武汉、重庆等地的商业化成果。

北京理工大學 BEIJING INSTITUTE OF TECHNOLOGY

SPJ | AAAS

OPEN ACCESS

APC FREE

Cyborg and Bionic Systems

(类生命系统)

Cyborg and Bionic Systems 是北京理工大学（BIT）与美国科学促进会（AAAS）/Science共同打造的高水平国际英文科技期刊，也是AAAS旗下“Science Partner Journal”项目里首个面向机器人与生命系统交叉领域的学术期刊。国际刊号ISSN：2692-7632，国内刊号 CN：10-1778/TP。

Cyborg and Bionic Systems 编委团队成员均为类生命系统领域的权威专家和学者，大部分都是本领域的高被引科学家，编委国际比例超60%。

主编

福田敏男 Toshio Fukuda

- 中国科学院外籍院士
- 日本工程院院士
- IEEE 2020总主席
- 北京理工大学教授

CBS官微二维码

CBS官网二维码

执 行 主 编

黄 强
北京理工大学教授

Abderrahmane Kheddar
法国科学院院士

Alois Knoll
慕尼黑大学教授

Nigel Lovell
新南威尔士大学教授

我们的特色：

- **高效传播：** 所有收录文章，将在Science官方网站上为读者提供免费下载服务，Science期刊的营销和推广将为您的研究成果提供更为广泛和有效的宣传。
- **开放获取：** 所有读者将更为便利地获取您的学术思想以便助力读者的科学研究,读者无需承担任何费用。
- **快速发表：** 国内外同行评议专家审稿迅速，平均不到25天便可获得首轮审稿意见。
- **免费发表：** 作者在2023年12月之前发表无需承担发表费用,文章处理费用由期刊主办方承担。

Cyborg and Bionic Systems 将发表原创研究类文章（Research Article）、综述类文章（Review Article）、亮点前瞻展望（Perspective）和特邀评论/社论（Editorial）等类型的学术作品。期刊聚焦领域（包括但不限于）：

- **机器人**
  - 仿生机器人
  - 可穿戴机器人
  - 生命系统-机器人系统共生
  - 面向生命科学监测与探索的机器人系统解决方案
- **神经工程学**
  - 具有生理活性的生物机器人
  - 终身生物机器接口与共存
- **BME**
  - 生物材料、生物传感器、生物执行器和生物反应器
  - 器官芯片和生物自组装/组织工程
- **以及围绕CBS相关技术的伦理，法律和社会影响**

***Cyborg and Bionic Systems* 已入选中国科技期刊卓越行动计划高起点新刊项目，期刊文章已于2021年1月正式上线，2021年4月期刊被 DOAJ 数据库收录，2021年5月期刊被 CNKI 数据库收录，2022年5月被 Inspec 数据库收录，2022年6月被 PubMed 数据库收录，2023年3月被Scopus 数据库收录，2023年4月被EI和ESCI数据库收录。**

专刊征稿中：

1. Bio-inspired, Biomimetic, and Biohybrid Systems
2. Emerging Micro/Nano Tools for Cyborg and Bionic Systems
3. Advanced Biofabrication and Biomaterials for Regenerative Medicine
4. Visual Perception for Natural Human-Robot Interaction
5. Advanced Technologies for Implantable Brain-Computer Interface
6. Advances in Intelligent Biomedical Microfluidics
7. Cross-Subject Affective Computing

Cyborg and Bionic Systems 投稿网址：https://www.editorialmanager.com/cbsystems

编辑部联系方式：Email：editorialoffice@cbsystems.org.cn

北京理工大学出版社
BEIJING INSTITUTE OF TECHNOLOGY PRESS

报告摘要集

生物数学模型预测的警觉度显著影响精神警觉度任务绩效：一项更新的基于跨国飞行的漂移扩散模型

报 告 人： 程子健
报告单位： 上海交通大学

报告摘要：

个体的警觉度通过多种认知行为因素（如认知加工速度、肌肉运动速度等）影响反应速度，不同的因素对不同类型的工作任务影响也各有不同，而目前主流的警觉度计算模型（如 Three Process Model（TPM）模型，unified 模型等）对警觉度的预测结果单一，无法提供更多维的清醒-疲劳预警信息。我们使用精神警觉度任务（Psychomotor Vigilance Task, PVT）获取了 79 名飞行员的反应时数据，应用漂移扩散模型（Drift-Diffusion model, DDM）进行拟合并得到 4 种与反应时相关的认知行为潜变量，分别是漂移率、漂移率变异性、非反应时间、非反应时间变异性。结合 TPM 警觉度预测模型与漂移扩散模型进行联合建模，我们得到了个体的警觉度与这 4 种变量之间的关系。结果发现警觉度可以通过提高漂移率、降低非反应时间、降低变异性来加快个体反应速度。其中警觉度对漂移速度与变异性的影响较大，对非反应时间影响较小，这说明清醒程度对认知加工的速度和稳定性影响较大，而对肌肉运动速度的影响较小。通过这一研究，我们有望发展出基于 PVT 任务的警觉度检测方法，并能够在多个维度上对个体的认知状态进行评估，可以为更精细的工作任务安排提供参考。进一步的研究有可能将个体的疲劳易感性区分为不同亚型，并能够为飞行员等航空从业人员的选拔与训练提供针对性的建议。

有人/无人机协同作战战机智能座舱人机交互建模研究

报 告 人： 魏子凯
报告单位： 石河子大学

报告摘要：

有人 / 无人机协同作战作为向全无人化空中作战的过渡方式，是未来作战样式的重要发展方向。这种新型空战环境下，飞行员要同时完成有人机驾驶、无人机指挥决策、与无人机、人工智能协同作战等任务，驾驶员须同时面对越来越多的仪表，并对复杂的信息做出反应。同时，完成战斗任务期间，战机的飞行高度、速度、飞机姿态急剧变化， 飞行员经常处于过载飞行状态。为了研究有人/无人协同作战场景多任务条件下飞行员工作负荷和工作绩效，基于战机座舱的多功能显示器，展开不同智能座舱显示界面设计， 根据上述任务的信息特征和人的信息处理方式，使用人的信息加工排队网络模型 （QN- MHP）对飞行员与智能座舱 AI 系统交互进行建模，对比不同显示界面设计方案对飞行员第二任务操作绩效的影响，结果表明：基于 QN-MHP 模型的飞行员工作负荷和工作绩效预测，第二种设计方案，更适用于战机飞行员多任务场景。该方法避免了实验依赖性和主观误差，并能够大量节省实验时间和风险，可用于战机座舱显示界面人机交互的工作绩效预测与优化设计。

Effects of Targeted Psychological Inoculation on Unplanned Takeover Performance Improvement in Conditional Autonomous Vehicles: An Experimental Study

报 告 人： **柴 晨**
报告单位： **同济大学**

报告摘要：
Objective: To explore a more efficient targeted intervention program improving drivers' unplanned takeover performance and assess its effectiveness.

Background: In recent years, automated driving technology has become an important development trend to improve the quality of travel and reduce road traffic accidents. The takeover is a major challenge in conditional autonomous driving vehicles. When encountering an unknown urgent incident that the system cannot handle, drivers need to passively take over in unplanned situations, but not all drivers react to certain situations promptly and appropriately. Existing training programs are mostly enhancing performance through spoon-feeding education and repetitive driving exercises, which still have limitations such as low efficiency and poorly targeted.

Method: This study conducted two rounds of driving simulation experiments to collect the driver's behavioral, psychological, and physiological data during unplanned takeovers. Based on the performance of forty drivers in the first experiment, we proposed a psychological inoculation training program targeted at adverse takeover behaviors. Specifically, drivers were first immersed in the takeover environment by watching the video. Then incorrect cognition was proposed by the experimenter from automated driving system limitation, takeover request, and poor takeover behavior progressively, which motivated the drivers to take the initiative to refute the wrong cognition and prevent forming adverse behaviors. In the second experiment, eighteen of the drivers with poor takeover behaviors were selected and randomized into two groups, receiving targeted psychological inoculation and education intervention (spoon-feeding) separately. Intervention effects were assessed by pre and post-test comparisons.
Results: The results revealed that turning the steering wheel without braking in time for risk evasion was a prominent adverse takeover behavior. Compared with education intervention, targeted psychological inoculation had more significant intervention effects in improving urgent takeover behavior and relieving tension. Within-group standard deviations for steering reaction time and maximum steering wheel angle after targeted psychological inoculation were 1.30s and 1.09° lower than the education intervention, respectively. Besides, twice as many people receive stress relief from targeted psychological inoculation as from education intervention. The targeted psychological inoculation was generally effective, and less influenced by individual characteristics such as driving experience and the trust of the automated system, etc.

Conclusions: The findings suggest adverse behaviors during urgent takeovers and demonstrate the general effectiveness of the targeted psychological inoculation. This method calibrates

drivers' perceptions of human-machine cooperation to correct the behavior, which improves takeover performance more efficiently and reduces individual differences.

Application: This study for the first time attempts to propose a PI training program targeted at adverse takeover behaviors. The results provide a driver testing method and a basis for the selection of drivers to be intervened. It also enriches the method of improving takeover safety, guiding the improvement of autonomous vehicle user manuals and performance enhancement programs.

基于 QN-MHP 的空速不可靠场景人机交互建模研究

报 告 人： **栾昊**
报告单位： **中国民航大学**

报告摘要：

飞机驾驶舱是飞行员执行飞行任务的主要活动场所，随着驾驶舱向智能化方向发展，人机关系也随之发生变化，为探索民机驾驶舱人机交互中人为错误的频发场景及错误发 生的认知层面原因，对 1990-2020 年全球民航发生的不安全事件与事故进行检索，以在人机交互过程中主要由人为错误导致的事故为依据，共检索出相关事故 93 起，对事故类型进行分类，将人为错误的发生划分于感知，认知，动作三阶段。选取空速不可靠场景运用人因可靠性方法和 QN-MHP 模型对场景下的飞行员错误概率与认知行为进行仿真，共确定 6 个易发生人为错误的实体，对其在特定服务器错误发生概率进行计算与建模。结果表明，空客 A320 机型空速不可靠处置任务中，飞行员在空速不可靠事故决策；自动驾驶脱开后控制飞行及检查襟翼，减速板，起落架状态三个关键步骤中易发生人为错误，仿真飞行过程中飞行员眼部平均利用率达到 94.77%，过高的眼部负荷可能是导致人为错误发生的原因之一。该结论可验证 QN-MHP 模型在民机驾驶舱人机交互研究中的可行性并为飞行员项目训练以及未来智能化驾驶舱设计与应用提供依据与帮助。

人的信息加工排队网络模型（QN-MHP）在智能座舱设计中的应用

报 告 人： **李欣璘**
报告单位： **清华大学**

报告摘要：

驾驶智能座舱的设计多种多样，选取驾驶人地址输入任务，使用人的信息加工排队网络模型（QN-MHP）对驾驶人与智能座舱的语音交互以及触控屏交互进行建模。结果表明，该驾驶人计算模型可以快速评估智能座舱中的语音交互和触控屏交互设计。该模型能够根据输入的设计参数预测人的绩效以及驾驶安全情况，帮助设计人员更快更好地设计智能座舱。

基于多种视觉识别任务的威胁行为自主识别方法

报 告 人： 罗龙溪
报告单位： 北京理工大学

报告摘要：

基于多种视觉识别任务的威胁行为自主识别方法随着社会对公共安全需求的不断增长，威胁行为自主识别技术成为研究的焦点。本研究在基于目标检测的威胁行为识别 方法基础上，进一步拓展了分析维度。传统方法主要关注威胁行为的存在，然而忽略了 人与威胁工具之间复杂的互动关系，从而降低了识别准确度。为了应对这一问题，我们 综合运用了多种计算机视觉技术，将威胁行为识别分为多种视觉识别任务，不仅进行了 目标检测，还深入分析了图像中的人体动作和威胁工具类型。通过综合运用目标检测、人体姿态估计和动作分析技术，构建了基于多种视觉识别任务的威胁行为自主识别方法。在该方法中，我们将人、动作和威胁工具三元组的识别、理解和融合，充分利用先验知 识实现更精准的威胁行为识别。实验结果验证了该系统在自建数据集上具有很好的表现， 实现了智能无人系统对威胁行为的细粒度理解。

Brain-Computer Fusion for Sound Target Detection

报 告 人： 史健廷
报告单位： 北京理工大学

报告摘要：

In this study, a novel sound target detection method based on auditory brain-computer interface is proposed. Aiming at the low SNR sound environment, which is difficult to cope with by the current mainstream automatic sound detection system, it is proposed to add human perception and reasoning ability of environmental information into the detection system. This study first designed an experimental paradigm according to the actual application scenario, collected the EEG signals of the subjects before and after the sound target perception, and then conducted a comprehensive analysis of the neural representations caused by the sound target perception from the perspective of event-related potential, event-related spectrum disturbance and source analysis. According to the observed neural representation, a brain-computer interface based sound target detection and decoding model was established to complete the classification of EEG signals perceived by sound targets, and its decoding performance was tested under off-line conditions. Finally, aiming at the false alarm rate of BCI in practical applications, this study proposed a human-machine fusion target detection system based on confidence mechanism, which effectively combined the stability of automatic sound target detection method against known situations with the generalization performance of BCI detection method for new sound targets, and realized the performance reinforcement of a single method. The results of online experiments show that the proposed method can achieve reliable sound target detection under the condition of low SNR, and has good generalization performance for new targets that do not appear in the training set.

Tailoring rTMS therapy based on personalized neural reorganization: towards individualized treatment for stroke patients

报 告 人： 贾天宇
报告单位： 清华大学

报告摘要：

Repetitive transcranial magnetic stimulation (rTMS) has been proven a promisingly potential therapeutic intervention for stroke patients' neural rehabilitation. However, in the face of patients' various individual differences, the clinical effects of neural modulation therapy vary greatly among patients, and it is confusing to further improve its efficiency. This study aimed to explore the hypothesis that tailoring individualized neural modulation therapy according to different types of neural reorganization patterns promisingly contributes to stroke patients' motor rehabilitation.

We randomly applied three kinds of rTMS treatments on nineteen subacute stroke patients and observed their cortical activation changes after the 2-week neural modulation therapy. rTMS treatments consisted of ipsilesional activation, contralesional suppression and ipsilesional suppression. Motor imagery tests with EEG recording and Fugl-Meyer assessment were conducted on the day before and after the 2-week rTMS therapy. Event-related desynchronization (ERD) analysis was used for motor-related cortical activation analysis. In the comparative analysis before and after the intervention, patients were grouped by intervention or lesion side respectively.

Neural reorganization patterns showed the characteristics of individual differences. Patients with motor cortex lesion mostly showed contralesional recruitment and patients without motor cortex lesion mostly presented ipsilesional focusing. Neural modulation treatments also showed individual effects on brain activation pattern changes. rTMS can effectively enhance the motor-related cortical activation but is hard to reverse the neural reorganization tendency.

Stroke patients with different neural reorganization patterns responded differently to rTMS therapy. Tailoring personalized rTMS therapy by recognizing neural reorganization patterns and lesion location is promising for the improvement of rTMS effectiveness in clinical use. This study provides a novel perspective in personalized trajectory to precision rehabilitation medicine.

基于多感知融合的共享控制脑控移动机器人系统

报 告 人：　　李梦凡
报告单位：河北工业大学

报告摘要：

在脑控移动机器人（brain-controlled mobile robot, BCMR）的研究过程中，脑机接口（brain computer interface, BCI）很难清晰地表达人类对外部环境的感知。在本研究中，提出了一种具有多感知融合（multi-perception fusion, MPF）的共享控制 BCMR 系统，通过栅格代价地图将人类感知和机器人感知相结合，在少量脑机接口命令的情况下准确描述人类感知。MPF-SC 利用计算机视觉在视觉刺激界面和环境之间建立映射关系，并以栅格代价地图的形式呈现人类感知。8 名受试者被要求参与在线 BCMR 的导航避障控制，并将所提出的方法与其他两种方法进行了比较。结果表明，MPF-SC 模式在轨迹平滑性、重复实验稳定性、持续时间更短、命令数量和碰撞更少等方面取得了更好的性能。人机感知融合充分发挥了人类对复杂环境的个性化认知和机器人对环境的精细感知能力。在人工智能的帮助下，将有效提高 BCMR 的控制智能性和交互友好性。

Multi-objective optimization via evolutionary algorithm (MOVEA) for high-definition transcranial electrical stimulation of the human brain

报 告 人：　　刘泉影
报告单位：南方科技大学

报告摘要：

Transcranial electrical stimulation (tES) is a promising non-invasive neuromodulation technique with the potential for diverse clinical applications, including stroke treatment, motor function improvement, memory consolidation, and brain disease treatment. However, a significant challenge in harnessing the full potential of tES lies in the inter-subject variability of response to stimulation, necessitating personalized approaches. To address this issue, we present a novel framework, Multi-Objective Optimization via Evolutionary Algorithm (MOVEA), designed to optimize multiple objectives simultaneously through Pareto optimization.

Our MOVEA framework takes individual structural MRI, tES sensor montage, and target areas as inputs, initiating with pre-processing steps to segment the brain volume into tissues with distinct conductivities, co-register the individual's structural MRI with HD-tES sensors, and define target areas based on the Brodmann atlas. Subsequently, an accurate finite element method (FEM) head model is constructed, and the leadfield matrix for the region of interest is computed. This matrix represents the relationship between applied tES montages and the resulting electric field distribution within the brain.

MOVEA then efficiently explores the parameter space to generate a Pareto front of optimal montages. It simultaneously optimizes objectives, including maximizing the electric field intensity, achieving high focality, controlling stimulation depth, and minimizing unwanted

stimulation in specific regions (avoidance zone). The Pareto front contains optimal solutions that exhibit diverse trade-offs between conflicting objectives, without the need for manual weight adjustments.

The versatility of MOVEA allows it to accommodate various tES modalities, such as transcranial alternating current stimulation (tACS) based on both large sponge electrodes and high-definition (HD) electrodes, and transcranial temporal interference stimulation (tTIS) based on HD and two-pair systems. Furthermore, MOVEA considers user-defined constraints, making it possible to customize stimulation protocols to individual needs.

We evaluated and compared the performance of different tES modalities using MOVEA. Our analysis revealed that, for electrical fields without a predefined orientation, both HD-tACS and HD-tTIS can achieve higher stimulation intensities. Additionally, HD-tTIS stood out for its superior focality, making it particularly effective in precisely targeting specific brain regions.

The effectiveness and versatility of MOVEA make it a valuable tool for advancing tES-based neuromodulation, enabling personalized strategies that account for inter-subject variability. It offers potential applications in understanding brain-cognition relationships and developing tailored treatments for neurological disorders. To facilitate its implementation, we have provided the code for MOVEA at https://github.com/ncclabsustech/MOVEA, empowering researchers to design effective and personalized tES protocols.

In conclusion, our novel MOVEA framework offers a promising solution to the challenges posed by inter-subject variability in tES-based neuromodulation. By optimizing multiple objectives through Pareto optimization, MOVEA enables personalized strategies that can achieve higher stimulation intensities and superior focality, thus advancing the understanding and clinical applications of tES.

Human Attention-Guided Explainable Artificial Intelligence for Computer Vision Models

报 告 人： 刘国洋
报告单位： 香港大学

报告摘要：

Introduction

- Deep learning models suffer from the black-box issue affecting user trust.
- It is essential to develop effective XAI methods for object detection models to make them more useful and accessible to users.
- Current XAI methods, including gradient-based and perturbation-based methods, are unsuitable for object detection.
- Human attention may offer interpretive, diagnostic features enhancing both faithfulness and plausibility of XAI methods.

Materials

- AI Model: Yolo-v5s (Faster-RCNN).
- Image Database: BDD-100K driving image database.
- Training Set: The Yolo-v5s was trained on 69,400 images of BDD-100K.
- Testing Set: Two independent image subsets, each of 160 images.
- Human Task: Vehicle detection task (record human attention data with an eye-tracking device).
- Paradigm: Drift checks → 0.5s fixation cross → Present a driving scene image → Participants searched for and remembered vehicle locations → Click detected target locations by a mouse on a blank screen.
- Participants: 49 participants for dataset A and 27 participants for dataset B.

Study1: XAI Methods for Object Detection

Methods

The FullGrad-CAM method was derived from Grad-CAM, where no average pooling operation is applied to gradients. The FullGrad-CAM is defined as:

$$S_F = \sum_{m=1}^{N_{obj}} \mu \left(ReLU \left(\sum_{k=1}^{N_{ch}} \frac{\partial y^m}{\partial A^k} \odot A^k \right) \right)$$

When we apply the ReLU function to the gradient term following Grad-CAM++, our FullGrad-CAM++ is defined as:

$$S_F^* = \sum_{m=1}^{N_{obj}} \mu \left(ReLU \left(\sum_{k=1}^{N_{ch}} ReLU \left(\frac{\partial y^m}{\partial A^k} \right) \odot A^k \right) \right)$$

The XAI performance is measured by plausibility and faithfulness.

- Plausibility: The similarity between human attention and AI saliency.
- Faithfulness: How faithfully saliency information in the map reflects feature importance to AI's output, which can be measured by how deletion/insertion of features according to saliency values affects AI's output.

Results

- FullGrad-CAM-based methods showed superior plausibility (measured by PCC and RMSE) over Grad-CAM-based methods.
- FullGrad-CAM++ outperforms FullGrad-CAM.
- The faithfulness of human attention maps is surprisingly higher than that of current XAI methods (Fig. 1).
- Strong motivation to use human attention as guidance to improve XAI methods.

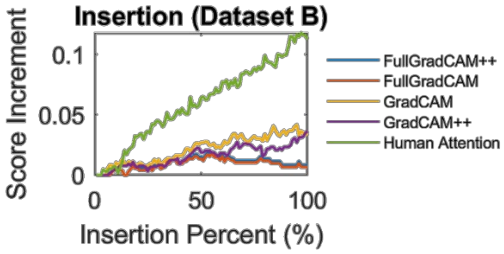


Fig. 1 The faithfulness of human attention and other XAI methods.

Study2: Human Attention-Guided XAI

Methods

Our HAG-XAI saliency generation method is

$$S_{HI} = G^{v_\gamma}_{A_\gamma} * \sum_{m=1}^{N_{obj}} \mu \left| ReLU\left(\sum_{k=1}^{N_{ch}} \left| G^{v_\alpha}_{A_\alpha} * \varphi^{\alpha^+}_{\alpha^-} \left| \frac{\partial y^m}{\partial A^k} \right| \right| \odot \varphi^{+}_{\beta^-}\left(A_k\right) \right| \right|$$

φ^{α^+} φ^{β^+}

- α^- and β^- are the learnable activations for the gradient and activation map.
- $G^{v_\gamma}_{A_\gamma}$ and $G^{v_\alpha}_{A_\alpha}$ are learnable Gaussian smooth kernels for the activation map and the gradient map
- μ is a normalization function, * is the convolution operator.
- The loss function is set to the (dis)similarity between human attention map and AI saliency map, based on PCC and RMSE.

Results

- The trained HAG-XAI models were evaluated on dataset A's validation set and dataset B's testing set.
- The saliency maps generated from HAI-XAI and human attention maps had high similarity (above 0.7 in PCC; Fig. 2).

Fig. 2 Example HAG-XAI saliency maps vs. human attention maps.

- HAG-XAI reached the highest plausibility among tested XAI methods (Fig. 3).

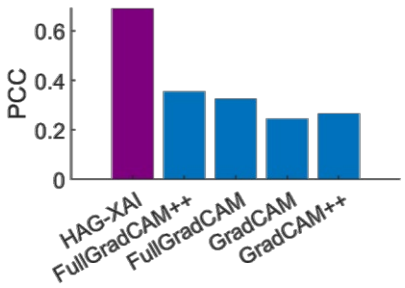


Fig. 3 The similarity between XAI saliency and human attention maps

- HAG-XAI outperformed other XAI methods in faithfulness (Fig. 4).

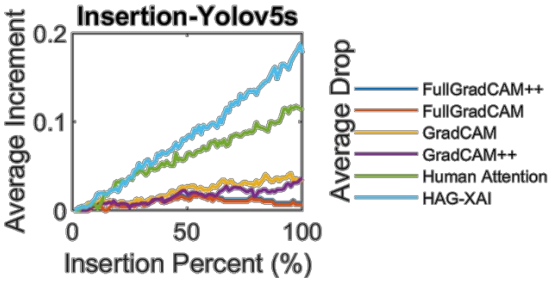


Fig. 4 The faithfulness performance comparison

- MS-COCO database images (5000 images) were used to probe the transferability of learned functions from HAG-XAI, with results showing that the HAG-XAI achieves the highest faithfulness among the tested XAI methods.

Conclusions

- We proposed two novel XAI methods that can generate explanations for object detection models and showed the potential of human attention maps in enhancing the faithfulness of XAI methods.
- Using human attention maps as guidance, we designed a HAG-XAI method, achieving higher faithfulness and plausibility for object detection models than the existing methods.
- In future work, we will explore the potential of the HAG-XAI to be used as a human attention imitator for object detection tasks.

A Shallow Mirror Transformer for Subject-Independent Motor Imagery BCI

报 告 人：　　罗靖
报告单位：　西安理工大学

报告摘要：

Objective: In the human-machine hybrid intelligent system, the intelligent human-computer interface, including a well-designed human-machine interface or BCI, can realize the manipulation of the intelligent system to achieve the deep integration of human-machine hybrid intelligence. The motor imagery BCI has the advantages of endogenous, non-stimulating, and subject-friendly, and is a classic paradigm of brain-computer interface. However, the position and duration of the discriminative segment in an EEG trial vary from subject to subject and even trial to trial, and this leads to poor performance of subject-independent motor imagery classification. Thus, determining how to detect and utilize the discriminative signal segments is crucial for improving the performance of subject-independent motor imagery BCI.

Approach: In this paper, we propose a novel Shallow Mirror Transformer (SMT) model that can take advantage of the global receptive field of the self-attention module to detect and utilize the discriminative EEG segment from the entire EEG trial in MI recognition, resulting in outstanding performance in subject-independent MI-BCI. Specifically, a multihead self-attention layer with a global receptive field is employed to detect and utilize the discriminative segment from the entire input EEG trial. Furthermore, the mirror EEG signal and the mirror network structure are constructed to improve the classification precision based on ensemble learning. Finally, the subject-independent setup was used to evaluate the shallow mirror transformer on motor imagery EEG signals from subjects existing in the training set and new subjects.

Main results: The proposed method was verified on a subject-independent setup including EEGs from new subjects and existing subjects in the training set based on the OpenBMI dataset and BCI Competition IV Datasets 2a and 2b, and the SMT model showed excellent performance compared with the state-of-the-art algorithms in the subject-independent MI-BCI. The shallow mirror transformer obtained average accuracies of 74.48% and 76.1% for new subjects and existing subjects, respectively, which were highest among the compared state-of-the-art methods. In addition, visualization of the attention score showed the ability of discriminative EEG segment detection. This paper demonstrated that multihead self-attention is effective in capturing global EEG signal information in motor imagery classification.

Significance: This study provides an effective model based on a multihead self-attention layer for subject-independent motor imagery-based BCIs. To the best of our knowledge, this is the shallowest transformer model available, in which a small number of parameters promotes the performance in motor imagery EEG classification for such a small sample problem.

Using Amplitude and Latency of ERP to Predict Performance of Rapid-Serial-Visual-Presentation BCI

报 告 人： 范新安
报告单位：航天科工 206 所

报告摘要：

本文提出了一种利用事件相关电位（ERP）的幅度和潜伏期来预测快速序列视觉呈现脑机接口（RSVP-BCI）性能的模型。文章首先构建了面向行人检测的 RSVP-BCI 系统，利用主成分分析法进行特征提取并线性分类，分析了事件相关电位的潜伏期和幅度与 RSVP-BCI 性能之间的关系；来自 15 名被试者的实验结果表明，RSVP-BCI 性能与顶叶和颞叶脑区的 ERP 的幅值以及顶叶脑区的 ERP 的潜伏期相关，其中，准确率与幅值和潜伏期正相关，而虚警率与幅值负相关；然后文章基于 ERP 信号的幅值和潜伏期指标构建了 RSVP-BCI 性能预测模型，并对其进行了评估分析表明，该模型可有效的预测 RSVP-BCI 的性能，支撑了 RSVP-BCI 适宜人群的选拔。

面向无创脑-机接口:柔性凝胶半干脑电电极最新研究进展

报 告 人： 李广利
报告单位： 湖南工业大学

报告摘要：

脑电电极是脑-机接口（BCI）的关键硬件，它直接影响 BCI 系统信号输入质量。近年来，日常生活场景的 BCI 应用蓬勃发展，对脑电电极的可靠性、方便性、舒适度提出了更高要求。湿电极是 EEG 记录的“金标准”，具有电极-皮肤阻抗低、信噪比高等优势。然而，湿电极需要皮肤预处理和注入导电胶，使用不方便、不舒适，严重限制了其在日常生活场景 BCI 的应用推广。干电极无需使用任何外加电解质，佩戴使用更为方便舒适， 但电极-皮肤阻抗过高，EEG 信号质量较差。半干电极通过释放微量的电解质溶液代替导电胶，兼具干、湿电极的优点，是最具发展前景的脑电电极之一。课题组通过凝胶界面材料设计，构建了超大孔水凝胶半干电极和双网络水凝胶半干电极，实现了电解质溶液的“快充慢放”和柔性接触，显著提升半干电极的使用方便性。同时通过原位负载 Ag/AgCl 纳米粒子，创新构建“电子导体与离子导体一体化”半干电极，有效解决了电子导体与离子导体接触不良风险、细菌滋生等共性问题。10 Hz 下凝胶半干电极的电极-皮肤阻抗约为 15 ~ 25 kΩ，相邻位点的半干/湿电极的平均时域互相关系数在 0.90 以上。而且，凝胶半干电极能有效捕获睁闭眼、P300、N200、SSVEP 等 BCI 范式的 EEG 信号，分类准确率与 “金标准”湿电极无显著性差异。

基于 RSVP-BCI 范式的图像识别关键技术研究

报 告 人： 许萌
报告单位： 北京工业大学

报告摘要：

快速序列呈现（rapid serial visual presentation, RSVP）是利用人看到“新奇”事物诱发出诸如 P300 等事件相关电位属性的特异性质，通过解析电位信号可在海量图片流中检索出目标图像。RSVP 图像识别有助于实现比机器视觉分类更高效的目标检测，在军事、监测等领域有着广泛的前景。然而，RSVP 解码仍面临一些挑战，如信号冗余、目标与非目标信号类别不平衡、跨被试差异大等问题的制约。本研究专注于这些问题在 RSVP 解码方面带来的困扰，提出通道选择、数据增强、零训练样本等新方法。首先，针对 RSVP 通道特征维度高和跨被试泛化分类表现弱的问题，首次提出一种基于大规模稀疏多目标优化的 RSVP 通道选择模型，仅使用不足一半的通道数就获得了更优的分类效果。其次， 提出生成对抗网络 BWGAN-GP 数据增强方法，降低 RSVP 样本目标与非目标不平衡的问题，有效改善分类准确性，此网络亦可在实用中实现 RSVP 人工样本的生成。最后， 利用元学习思想，尝试缓解 RSVP 跨被试和跨模态的困扰，提出混合注意力机制的原型网络 RSVP 零校准方法，在模型中融合多尺度卷积和注意力机制，显著提升了 RSVP 在零训练数据和跨模态解码方面的性能。综上所述，本文针对 RSVP 范式分类问题中的多个关键问题进行探究，对进一步推动 RSVP-BCI 系统的发展提供了有力技术支持。

An Interactive Vehicle Trajectory Prediction Method Considering Emotion Based on SOR Cognitive Theory

报 告 人： **唐揽月**
报告单位： **同济大学**

报告摘要：

Accurately predicting vehicle’s trajectory is an important technology for vehicle active safety systems, especially in a scenario with strong interactions. Most of the current trajectory prediction algorithms are based on the assumption that the drivers are always in a normal state, without considering the influence of emotion. Furthermore, the structure of these models often does not correspond to human cognitive processes. It leads to a low prediction accuracy of trajectory, resulting in false alarms from vehicle active safety systems. To address the problem, this study models the impact of emotion on driving behavior based on the Stimulus-Organism-Response (SOR) cognitive theory. Considering both physical and cognitive features, a trajectory prediction method called CPSOR-GCN is proposed. At the cognitive level, the SOR theory provides insights into the influence mechanism of emotion on driving behavior. Dynamic Bayesian inference is adopted to calibrate the SOR framework, which is embedded into the cognitive GCN module. At the physical level, motion interaction information between vehicles is embedded into the physical GCN module. The proposed model was calibrated on a CARLA-SUMO co-simulation platform, and 26 volunteers were recruited for the driving simulation experiment. Novelty, driving scenarios were reproduced in simulation to naturally induce emotions of anger and fright. The results show that the proposed model has a significant reduction in prediction error compared to the baseline methods. The findings can be applied to vehicle active safety design, enabling better adaptation to driver emotion and effectively reducing false alarms.

A High-Frequency SSVEP-BCI System Based on Simultaneous Modulation of Luminance and Motion Using Intermodulation Frequencies

报 告 人：　　李萌
报告单位：中国医学科学院

报告摘要：
Objective: The low-frequency steady-state visual evoked potential (SSVEP)-based brain-computer interfaces (BCIs) tend to induce visual fatigue in the subjects. In addition, the number of visual stimulus targets encoded is limited by the frequency range. However, the information transfer rate (ITR), which is affected by the number of targets encoded, is one of the most important standards for evaluating the performance of the system. According to previous studies, the use of intermodulation frequency components has the potential to increase the number of visual targets. In order to enhance the comfort level and improve the performance of SSVEP-BCIs, a novel SSVEP-BCI encoding method based on simultaneous modulation of luminance and motion is proposed.

Methods: In this work, sixteen stimulus targets are simultaneously flickered and radially zoomed using a sampled sinusoidal stimulation method. The flicker frequency is set to a 30 Hz for all the targets, while assigning different radial zoom frequencies (ranging from 0.4 Hz to 3.4 Hz, with an interval of 0.2 Hz) are assigned to each target separately. Accordingly, an extended vision of the filter bank canonical correlation analysis (eFBCCA) is proposed to detect the intermodulation (IM) frequencies and classify the targets. In addition, we adopt the comfort level scale to evaluate the subjective comfort experience. The offline and online experiments were built to analysis original EEG data and verify the feasibility of the proposed system.
Results: In addition to fundamental frequency and second harmonic, the corresponding obvious intermodulation (IM) frequency components appear in the Fourier spectra of all visual stimulus targets. Specifically, the topographies of the F+f IM component SSVEP signals elicited by the 16 different zoom frequencies are similar, and the strong SSVEPs are mainly obtained in the parieto-occipital area, especially at the Oz electrode channel. The average recognition accuracy of the offline experiments reaches 92.74 ± 1.53% by optimizing the combination of IM frequencies for the classification algorithm. Subsequently, we optimized the data length based on information transfer rate (ITR) results obtained from offline experimental data calculations. The average recognition accuracy of twelve subjects is 93.33 ± 0.01% in the online experiments, which is considered to meet the standard of practicality. Most importantly, the average comfort scores are above 5.

Conclusion: These results demonstrate the feasibility and comfort of the proposed system using IM frequencies, which provides new ideas for the further development of highly comfortable SSVEP-BCIs. In summary, the proposed novel stimulus encoding method provides an alternative solution for conventional SSVEP-BCIs and expands the horizon for the further development of exceptionally comfortable SSVEP-BCIs.

Dynamic Probability Integration for EEG based RSVP Performance Enhancement: Application in Nighttime Vehicle Detection

报 告 人：　崔玉洁
报告单位：西北工业大学

报告摘要：

Background: Rapid serial visual presentation (RSVP) has become a popular target detection method by decoding electroencephalography (EEG) signals, owing to its sensitivity and effectiveness. Most current research of EEG based RSVP task focused on feature extraction algorithms developing to deal with non-stationarity and low signal-to-noise ratio (SNR) of EEG signals. However, these algorithms cannot handle the problem of no ERP component or miniature ERP components caused by the attention lapses of human vision. The fusion of human–computer vision can obtain complementary information, making it a promising way to become an efficient and general way to detect objects, especially in attention lapses.

Methods: Dynamic probability integration (DPI) was proposed in this study to fuse human vision and computer vision. A novel probability assignment method was included, which can fully consider the classification capabilities of different heterogeneous information sources for targets and non-targets, and constructs the detection performance model for the weight generation based on classification capabilities. Furthermore, a spatial-temporal hybrid common spatial pattern-principal component analysis (STHCP) algorithm was designed to decode EEG signals in RSVP task. It is a simple and effective method to distinguish target and non-target by using spatial-temporal feature.

Results: A nighttime vehicle detection-based RSVP task was performed to evaluate the performance of DPI and STHCP, which is one of the conditions of attention lapses because of its decrease in visual information. The average AUC of DPI was 0.912±0.041 and increased 11.5%, 5.2%, 3.4% and 1.7% compared with human vision, computer vision, naive Bayesian fusion and dynamic belief fusion, respectively. A higher average balanced accuracy of 0.845± 0.052 was also achieved using DPI, which representing that DPI have balanced detection capacity of target and non-target. Moreover, STHCP obtained the highest AUC of 0.818±0.06 compared with other two baseline methods and increased by 15.4% and 23.4%.

基于多模态生理信息的人机融合智能增强导航方法

报 告 人：　　刘祥惠
报告单位：西北工业大学

报告摘要：

智能导航在物流、救援、自动驾驶等多个领域应用广泛。然而目前基于人工智能的 导航方法受到传感器、样本数据以及极端环境等多种因素的限制，在面对复杂动态环境 时仍存在不可避免的安全隐患。为了提高智能体导航任务的安全性和灵活性，考虑人类 具有强大的快速认知和决策能力，本文提出了一种基于生理信息和人工智能的人机融合 导航新方法。该方法通过采集脑电和眼动两种生理信息实现人对环境的快速认知与决策。其中，脑电特征提取采用时空混合 CSP-PCA（STHCP）方法，眼动信息则记录注视点的位置信息。随后基于动态窗口法将其与雷达传感器检测信息融合，实现局部路径规划完 成导航。具体的，基于人脑对环境认知结果对智能体速度进行约束，构建人机融合速度 空间采样多条运动轨迹，并基于眼动注视点位置构建人机融合评价函数选择最优的导航 轨迹。在线实验结果表明，该方法能够在不造成大脑负担的同时实现高效精准导航，可 以成功识别并躲避导航任务中突然出现的无法被激光雷达检测到的异常障碍物，5 名被试的平均成功率达到了 88.7%，为实现智能增强提供了一种新途径。

基于 BLE 射频映射的多设备数据同步方法研究

报 告 人：　　蔡 雨
报告单位：　天津大学

报告摘要：

脑电采集设备穿戴化是脑-机接口走向消费级的重要途径，分布式低功耗蓝牙(Bluetooth Low Energy, BLE)一主多从架构是实现多节点穿戴式脑电采集设备主流方式， 如何保证多采集设备的高精度数据同步是分布式 BLE 采集系统亟待解决的关键技术问题。本文提出一种基于 BLE 连接事件射频映射的多设备数据同步方法，通过对 BLE 设备进行射频映射并基于射频映射进行计时，控制多设备在第一设备的连接事件前 1ms 同步开启数据采集，并在下一连接事件前 1ms 进行同步传输，实现多设备数据同步，显著降低数据传输时延，并通过设计基于脉冲方波信号的多设备采集范式验证数据同步精度。结果表明，在采样率为 1KHz 时，各个采集设备的数据同步误差≤1ms。研究进一步发现， 该方法的数据同步误差与采样率存在显著相关关系，且其数据同步误差小于等于采样周 期。该方法为多节点穿戴式脑电设备提供了高精度数据同步方法，可以应用于个体的多 生理数据采集或多人群脑实验，以确保多节点数据采集的同步性与实时传输的可靠性、鲁棒性。

基于烧结 Ag/AgCl 拉普拉斯电极的 SSVEP 脑电信号采集研究

报 告 人： 郑春厚
报告单位： 天津大学

报告摘要：

脑电图（Electroencephalography，EEG）是一种用于测量人脑电生理活动的技术，因具有非侵入性、高时间分辨率和方便易得的优势被广泛应用于脑机接口（brain-computer interface，BCI）。然而，EEG 空间分辨率相对较低，现有研究未能充分发掘 EEG 的应用潜力，提高 EEG 的空间分辨率成为一个重要的研究挑战。拉普拉斯（Laplacian）算子已被证明可提高体表电位的空间分辨率，与传统的圆盘电极相比，双极同心环电极（Bipolar concentric ring electrodes, BCRE）已被证明可以实现表面拉普拉斯估计，从而提高 EEG 的空间分辨率。本研究提出了一种基于烧结 Ag/AgCl 的 BCRE，研究了电极的性能，探究了 Laplacian 电极在检测稳态视觉诱发电位（Steady-state visual evoked potentials, SSVEP）方面的有效性。长期稳定性测试和噪声分析显示，在 10 小时内，烧结 Ag/AgCl BCRE 的漂移比传统金 BCRE 低 64%，噪声比金 BCRE 低约 29%，证明了 Ag/AgCl BCRE 具有更小的电压漂移和噪声，同时，Ag/AgCl 电极也表现出更低的阻抗。此外，本研究在人体 SSVEP 实验中使用了 Ag/AgCl BCRE，识别出 5 个 SSVEP 信号频率：14Hz、18 Hz、22 Hz 和 26 Hz。这为提高 EEG 的空间分辨率、推动 Laplacian 电极的应用以及探索新的 EEG 特征提供了研究基础。

飞行员空战行为特征建模与分析

报 告 人： 董一群
报告单位： 复旦大学

报告摘要：

飞行员空战行为特征建模与分析在有人无人协同等智能空战任务场景中具备广阔的应用前景，对未来航空军事装备的发展至关重要。针对视距内空战和超视距空战，建立了 1v1 场景下的飞行员行为数据库，并研究了飞行员空战行为特征。针对采用基本空战战术（BFM）的视距内空战，分析了飞行器运动方程，提出了重点分析在视距内空战中的飞行员滚转角决策指令。进而，通过聚类算法将视距内空战中的飞行员滚转角决策指令分为 6 类，确定了视距内空战中的飞行员飞行机动决策时间窗，并采用能量谱分析方法确定了在视距内空战中的飞行员飞行机动决策频率。针对超视距空战以中远距空空导弹为主要武器的特点，分析了超视距空战中空空导弹发射模式对飞行员发射行为的影响。此外，针对空空导弹的初制导、中制导、末制导三阶段制导的特征，本研究进一步分析了超视距空战中空空导弹进入末制导阶段前的飞行员制导行为，并提出了超视距空战中的飞行员行为特征分析方法。

基于超图的驾驶认知状态识别方法研究

报 告 人：　　丰上
报告单位：哈尔滨工业大学

报告摘要：

驾驶员的认知状态检测是人机交互的关键技术之一，是交通安全和运输效率的基础保障。基于单一生理信号的驾驶员认知状态检测方法难以覆盖认知活动的全部环节。根据具身认知理论及近年研究成果，基于脑电和躯体的多模态生理信号检测分析可以更全面精准地判别驾驶认知状态，但多模态信号的融合建模及认知状态识别与量化分析一直是阻碍认知状态精准分析的瓶颈。

本研究拟使用生理信号嵌入表示和超图学习分析进行驾驶认知状态的全面判别。首先利用多模态生理信号嵌入表示方法，建立非均匀采样生理信号的嵌入表示；其次，针对具身认知理论在驾驶认知分析中的应用，以生理信号嵌入表示为基础，提出基于超图学习的驾驶认知状态识别方法，发掘多种生理信号在认知任务中的连接关系以进行认证状态的识别。

本文方法可以突破生理信号融合表示和具身认知中身体-大脑关系发掘方法的瓶颈，全面且精准分析驾驶员综合认知状态，对认知科学和神经科学等基础研究走向应用有一定的引领作用。

基于强化学习的功能性电刺激闭环调控策略研究

报 告 人：　　张 栋
报告单位：　燕山大学

报告摘要：

背景及目的：功能性电刺激作为一种新兴的运动康复治疗手段，被应用于肢体运动功能损伤的临床治疗，取得了显著的康复效果，但目前临床应用上的开环控制方式存在不足。因此，针对功能性电刺激的闭环调控策略研究具有一定研究意义。

方法：本研究提出一种新的基于强化学习算法的功能性电刺激闭环调控策略，该策略基于对康复动作完成度、稳定度、肌肉疲劳度多种指标量化评估的基础上，充分考虑个体差异以及刺激效应，结合行为克隆算法和深度强化学习模型完成功能性电刺激的闭环调控。进一步采用 14 天的运动实验范式（上肢移动，手部抓握，腕部屈伸），对采集的肌电惯性信号进行分析，验证了该策略有效性。

结果：结果表明本文提出的调控策略在保证康复动作完成度的基础上，有效提升了康复动作的稳定度，减缓了电刺激康复过程中的肌肉疲劳，增强使用者舒适度的同时减小了个体差异性对康复系统造成的影响。

结论：本文提出的闭环调控策略在完成康复治疗的同时，能够有效解决功能性电刺激普适性差、刺激效应评估模糊、刺激参数优化标准不明确的问题。本研究为功能性电刺激在临床治疗康复中的闭环调控策略提供了一种新方案。

基于虚拟现实和听视觉反馈的增强康复训练方法研究

报 告 人： 邵谢宁
报告单位： 燕山大学

报告摘要：

背景及目的：基于虚拟现实技术的康复疗法作为一种新兴的智能康复方法，已经在因脑卒中而造成的运动、认知功能障碍的康复治疗中开始应用，康复效果显著，但目前基于虚拟现实技术的康复方法在感官刺激方面存在不足。因此，基于虚拟现实和听视觉反馈的增强康复训练方法研究具有一定研究意义。

方法：本研究提出一种基于虚拟现实和听视觉反馈的增强康复训练方法，该训练方法利用虚拟现实技术，搭建基于虚拟现实的多感官生物反馈(VR-MSBF, Virtual Reality-Multisensory Biofeedback)的交互训练环境，在提供良好的沉浸感的基础上，避免在单一感官生物刺激下在一定程度上会引起患者的行为异常，在为患者提供沉浸感的前提下，给予患者多感官生物反馈，充分刺激患者的感知，促进情绪调整，最大程度上获取患者的运动意图，根据运动意图的强弱动态调整虚拟现实场景的人机交互参数（实验范式难度、物体移动速度、物体相对位置等），使得患者在更为自然的环境下进行康复训练，加速康复进程。进一步采用 32 天融合脑机接口的实验范式，对采集的脑电信号进行功能连通性分析和脑网络特性分析，进而验证该增强康复训练方法的有效性。

结果：结果表明本文提出的融合虚拟现实技术、听视觉生物反馈和脑机接口的增强康复训练方法有效提升了患者的主动性和积极性，避免患者单一感官生物刺激下出现的行为动作的异常，与标准康复环境相比，能更有效地促进运动、认知功能和神经的恢复， 增强神经可塑性。

结论：本文提出的康复训练方法在完成患者运动、认知功能恢复的同时，有效解决患者康复积极性差、康复过程枯燥无趣、单一感官生物刺激下行为动作异常的问题。本研究为基于虚拟现实的智能康复训练方法在临床康复治疗提供了一种新思路。

基于脑机接口的无人机航拍目标检测

报 告 人： 张宇锋
报告单位： 北京邮电大学

报告摘要：

无人机航拍目标检测在搜救、预警、防火等领域具有重要的应用价值。然而，通常基于机器学习的方法在训练样本不足的情况下难以满足应用要求，同时也缺乏目标切换的系统灵活性。为了解决这一问题，我们将脑机接口（BCI）的方法应用于无人机图像检测。在这项研究中，提出了基于快速序列视觉呈现（RSVP）范式对航拍图像检测。由于捕获的图像存在空间相关性，对目标进行联合决策可以增强广域目标检测的能力。其次，为了抑制脑电干扰成分，提出的增强事件相关电位（ERP）算法可以提高检测效率。决策方法和去干扰算法都是基于严格的统计理论。脑机任务由 12 名受试者完成。结果表明，所提出的方法显著降低了干扰分量和噪声相关性，在虚警率小于 5%的情况下目标检测率为 86.6%。我们在野外进行了真实的目标检测，采用稳态视觉诱发电位（SSVEP） 模式控制无人机巡航拍摄路径。图像流实时传输，并呈现给检测人员，最终在虚警率小

于 1%情况下成功探测到目标。目前，大多数的脑机接口系统仅部署于实验室中，我们的研究为脑机接口实际应用提供了一个范例。所提出的目标检测系统实现了人类智能与人工智能的互补，利用人类的感知、认知能力极大优化了信息决策。

Acalibration-free 32-target hybrid BCI speller system based on high-frequency SSVEP and sEMG

报 告 人：　　张若晴
报告单位：中国医学科学院

报告摘要：
Background: Brain-computer interfaces (BCIs) have the potential to reduce disability by establishing a direct channel between the brain and the external world. Spelling is one of the most common applications of BCIs. Hybrid BCI systems that combine steady-state visual evoked potential (SSVEP) and surface electromyography (sEMG) signals have attracted attention of researchers due to the advantage of exhibiting significantly improved system performance. However, almost all existing studies adopt low-frequency SSVEP to build hybrid BCI. Although low-frequency SSVEP has a very strong response and is more easily detected, it produces much more visual fatigue than high-frequency SSVEP. On the other hand, high-frequency stimuli can decrease visual fatigue caused by flickering. Therefore, the current study attempts to build a hybrid BCI based on high-frequency SSVEP and sEMG.

Methods: This study designed and realized a 32-target hybrid BCI speller system by combining high-frequency SSVEP and sEMG. Thirty-two targets were divided into two groups, each of which encoded 16 targets using 16 different high-frequency visual stimuli (i.e., 31-34.75 Hz with an interval of 0.25 Hz). Users can complete a single spelling task by simply gazing at the flashing target while synchronizing the gesture of pointing to the target area. sEMG was utilized to choose the group and SSVEP was adopted to determine the target stimulus within the group. The filter bank canonical correlation analysis (FBCCA) and the root mean square value (RMS) method were used to detect SSVEP and sEMG, respectively. Therefore, the proposed system allowed users to operate it without system calibration. The experiment was divided into two parts: offline experiment and online experiment, and the system parameters were optimized through the offline experiment results, and then the feasibility of the system was verified through online experiment.

Results: Offline results from 10 healthy subjects showed that the entire system achieved the highest information transfer rate at 1.8 s of data length. Thus, the task time of the online experiment was confirmed to be 1.8 s. The online results obtained from 12 healthy subjects showed that the proposed system achieved an average accuracy of 93.52 ± 5.26% and an average information transfer rate (ITR) of 93.50 ± 9.80 bits/min. Furthermore, all subjects successfully completed the free-spelling tasks using the proposed hybrid BCI speller system.

Conclusions: These results of the offline and online experiments indicated feasibility and practicality of the proposed hybrid BCI speller system. Furthermore, these results will provide the basis for hybrid BCIs combining sEMG and SSVEP.

基于脑电功能连接网络的驾驶员风格识别

报 告 人：　安亚宁
报告单位：北京交通大学

报告摘要：

驾驶风格可用于表征驾驶员的行为特性，风格识别可为发展自动驾驶技术、制定个性化的驾驶策略提供基础。相较于问卷调查，通过客观驾驶数据和脑电信号对驾驶风格进行分类能够解决风格识别过程中的主观性问题。目前基于脑电信号的驾驶风格分类研究大多只提取了脑电时频特征，然而驾驶是一种涉及多个脑区活动，需要各区域协调配合的复杂行为。研究不同驾驶风格下大脑网络特征变化，揭示大脑区域之间功能连接模式具有重要意义。因此，本文提出一种基于脑功能连接网络的驾驶风格分类方法，采用锁相位值构建大脑功能连接网络，以驾驶数据聚类结果为标签，使用图卷积神经网络(GCN)训练驾驶风格分类模型，所用图卷积在综合提取脑电信号时频特征以及功能连接性的同时提高了模型的表达能力，最终三类驾驶风格识别准确率达到 86.5%。结果表明，采用功能连接性作为驾驶风格表征指标具备有效性，大脑功能连接特征与驾驶风格之间存在相关关系，可为不同驾驶风格下脑电活动差异的研究提供依据。

墙报摘要集

基于时频注意力机制的现实生活场景下低延迟脑电听觉注意力检测

报 告 人： 谢 壮
报告单位： 天津大学

报告摘要：

In the cocktail party scenario, human auditory attention can focus on a specific sound source for a long time. Previous studies on auditory attention detection (AAD) have mainly focused on electroencephalogram (EEG) data collected in laboratory settings. In this study, we propose a nonlinear decoder for real-time AAD based on time-frequency attention mechanism, and verify the excellent performance of the proposed model on EEG data collected in real-life scenarios. EEG data were collected from 20 subjects with normal hearing. Each participant performed six trials, in three of which participants were asked to walk along a defined route and were given no further instruction regarding speed or walking stability. During the remaining three trials, the subjects sat on a chair in front of a white wall. 24-channel EEG data were collected using a wireless electrode cap at a sampling rate of 250 Hz. Our proposed model can directly detect the direction of auditory attention from EEG signals without the need for original stimuli to participate in the calculation, which is more realistic. The core part of our model is the frequency-band attention module as well as the temporal attention module. The frequency band attention module can dynamically assign weights to different sub-bands according to the input EEG signal, and strengthen the representation of frequency band information that is beneficial to auditory attention. The temporal attention module can explore the temporal features of EEG signals. An effective time-frequency attention mechanism can better extract the features of EEG signals, thereby achieving low-latency AAD, and solving the problem of large differences in EEG signals between subjects. Experimental results show that the AAD accuracy of the time-frequency attention mechanism method is between 94. 8% and 98.1% under different decision windows (0.1s-10s), achieving low-latency AAD and outperforming state-of-the-art linear and nonlinear baseline models. The frequency band analysis results show that the most important frequency for decoding the subjects' auditory attention is the EEG signal in the 12-30 Hz frequency band, no matter the subjects are walking or sitting. In addition, we analyze the AAD accuracy of the subjects in different states (walking or sitting) when using different decoding methods. The results show that the non-linear method is more effective for AAD when the subjects are in the walking state, reflecting the advantages of deep learning. The advantage also shows that the EEG signal in the human walking state is more complex and closer to nonlinearity. These results provide a more realistic approach to AAD that could bring the application of neural-guided hearing devices closer to reality.

Confounding Impact in Takeover Performance: Using Causal Analysis to Uncover the Influencing Mechanism in Level-3 Autonomous Driving

报 告 人： 梁 莹
报告单位： 同济大学

报告摘要：

Background: The investigation of the response mechanism of drivers to an emergency takeover request in Level 3 autonomous vehicles is helpful to explore the key factors affecting emergency takeover performance which is a crucial area of focus in traffic safety research. Many studies have identified the factors that influence takeover performance using statistical analysis. However, statistical analysis can only show the same or opposite trend of increase or decrease between variables. There remains a lack of knowledge about the underlying takeover response mechanism of drivers.

Objective: To address this gap, the study employs causal analysis based on the Linear non-Gaussian acyclic model (LiNGAM) to explore drivers' response to an emergency takeover request.

Methods: Causal analysis is a powerful tool that can overcome the limitations of statistical analysis and effectively identify variable relationships. And LiNGAM, one of causal analysis methods, is capable of discovering causal networks and estimating causal effects solely based on observational data, without requiring any prior knowledge of the system's underlying structure. Besides, the emergency takeover process can be divided into two phases: the signal response phase and the post-takeover phase. The two-phase causal model is applied to investigate the different mechanisms in these two phases.

Data: In a driving simulation experiment with an emergency cut-in event as the emergency event, the participants (N = 40) experimented with three different emergency takeover experiments with time headway of 0.4s, 0.6s, and 0.8s while driving behavior, eye movements, brain activity based on functional near-infrared spectroscopy (fNIRS) were recorded.

Results: Results show that causal analysis is better than correlation analysis in discovering variable relationships. Causal analysis can provide the influencing relationship between variables and identify the correct variable relationship even if the data do not show a significant correlation. For example, the contribution of physiological indicators to takeover performance, which is consistent with previous research on these factors, was verified by causal analysis, even when the data does not indicate a significant correlation. Besides, results indicate that both traffic situation and drivers' reaction time are the main causal factors of takeover performance. In the signal response phase, the cognitive load has been found to passively affect drivers' reaction time, while in the post-takeover phase, drivers' reaction time affects the cognitive load. Moreover, the study also finds how these factors interact with each other, such as the primary function of drivers' situational awareness is to impact their takeover response time.

Application: The findings of this study are useful in identifying the critical influencing factors of takeover performance and improving the safety and effectiveness of L3 autonomous vehicles in emergency situations.

增强现实环境下基于 SSVEP 的任务级脑机控制方法

报 告 人： 郑大路
报告单位： 西北工业大学

报告摘要：

基于视觉诱发的脑机接口（Brain-Computer Interface，BCI）由于高鲁棒性、训练量小、信息传输率高等优点，得到广泛应用，将其与增强现实（Augmented Reality，AR）相结合能够提供沉浸、自然的人机交互体验。已有的 AR-BCI 是基于关节级控制和动作级控制实现的，存在控制过程离散的问题。本文设计了一种增强现实环境下的任务级的脑机控制方法，并实现了用该方法控制机械臂进行木块抓取、放置。该方法利用频率-相位调制的稳态视觉刺激编码任务信息，通过分类用户的 SSVEP 解析出控制任务，并通过有限状态机方法将任务分解为机器指令，以实现脑机协同控制。10 名被试离线结果表明，平均分类正确率为 86.5%，信息传输速率为 45.856bits/min，证明了该方法的有效性。本文还进行了在线实验，利用任务级脑机控制方法控制机械臂完成移动方块的任务，并与典型的关节级控制方法和动作级控制方法进行比较，结果证明了与关节级、动作级控制方法相比，任务级的脑机控制方法能够实现对机械臂的连续控制，并有效减少了控制步骤数量和控制时间。同时通过调查问卷提供用户主观参考，结果表明与其他两种控制方式相比，任务级脑机控制方法引发的疲劳感最低、使用最方便。

基于脑机接口检测技术的驾驶员警觉度检测

报 告 人： 刘宇城
报告单位： 天津大学

报告摘要：

近年来，由于疲劳驾驶所导致的交通事故频频发生，通过对驾驶员的警觉度进行检测从而避免不必要的损失已经成为了一项十分重要的课题。现有的检测方法包括基于面部表情、生理信号等方法。相比之下，生理信号中的脑电信号 （Electroencephalography, EEG）能够直接反映驾驶员的精神状态，并且相较于其他方法更加稳定，减少了对检测结果的影响。

本文的研究目标是通过基于从脑电信号中提取的时域、空域、频域三个维度的特征，设计了一种多模态特征融合的深度神经网络对驾驶员的警觉度进行检测。首先使用传统的特征提取方法对不同特征域包括时域、空域、频域进行特征提取，之后分别通过卷积神经网络（Convolutional Neural Networks, CNN），长短时记忆网络（Long short-term memory, LSTM）等深度神经网络结构在已经提取的传统特征的基础上进一步提取用于分类的深层特征，之后将不同维度的深层特征进行融合，最终通过一个全连接层作为最终的决策层，对驾驶员的警觉度水平进行检测。

为了证明方法的有效性，在公开的 SEED-VIG 数据上进行了分类实验，在清醒、疲劳、嗜睡三个类别的分类准确率分别达到了 97.0%，95.3%，97.8%。分析了单一维度

特征分类模型，设置了消融实验证明了每个特征融合的有效性，并且与本领域之前提出的一些模型效果进行了对比，验证了所提出模型的有效性。

TIFRUnet: A Residual Unet Using Time-frequency Information for EEG Artifact Removal and Reconstruction

报 告 人：　王祥铭
报告单位：西北工业大学

报告摘要：

Objective Recorded electroencephalography(EEG) signals are often contaminated by artifacts, which hinders the application of brain-computer interface. Deep learning methods have recently been regarded as a promising approach for artifact removal. However, current deep learning algorithms have limited effectiveness in extracting artifact features and reconstructing EEG signals. Method A deep learning approach based on the UNet architecture, namely Time-Frequency Residual Unet(TIFRUnet), is proposed for artifact removal and EEG signal reconstruction, providing achieve high-quality, end-to-end, and fast EEG artifact removal. The model extracts both temporal and spectral features from raw EEG to discriminate between clean EEG and artifacts. Additionally, residual blocks are employed to learn the differences between raw EEG and clean EEG, which can accelerate the model training process. The model is trained by clean EEG and contaminated EEG obtained from the public datasets EEGdenoiseNet and PhysioNet. Contaminated EEG is contaminated by electrooculogram(EOG), Electromyogram(EMG), or movement artifacts(MA). Results We compare our approach with FCNN, Simple CNN, Complex CNN, and RNN methods on the EEGdenoiseNet and PhysioNet datasets. The five models are also tested on the BCICIV 2a dataset, which was not used for model training, to compare the transfer learning capabilities. Evaluation metrics, including the correlation coefficient(CC) and relative mean squared error(RMSE) between clean and denoised EEG, demonstrate that our model achieves superior performance across all datasets. Significance Our TIFRUnet offers a strong artifact removal performance while preserving more useful information. Minimal fine-tuning on a new dataset can achieve satisfactory results. This algorithm provides a promising solution for EEG artifact removal and paves the way for practical applications of brain-computer interfaces.

基于复杂网络特征的分心驾驶脑功能网络分析

报 告 人：　　刘睿
报告单位：　北京交通大学

报告摘要：

驾驶人面对干扰因素众多，分心是引发驾驶失误的重要原因。本研究旨在探究分心驾驶与正常驾驶之间脑网络的差异，并寻找不同连接方式下的脑功能网络的相似性。设计并进行了由多个驾驶任务组成的驾驶模拟实验，共有 50 名驾驶员参与。将采集到的脑电信号利用相位锁相值、同步似然和相干性等方法构建了脑功能网络，并计算其图论属性，了解不同驾驶状态下的脑功能网络的特征与变化。结果表明，分心驾驶与正常驾驶之间存在显著差异，特别是对于 θ 和 β 频段。相比于正常驾驶，分心驾驶导致了脑功能网络的失衡和不稳定性的增加，表现为网络中特征路径长度和全局的效率降低，以及局部效率的增高。此外，比较发现三种方式构建的脑功能网络在图论属性上存在一定的相似性，这表明了不同网络连接方式能够捕捉到相似的脑功能特征，为理解脑网络的组织和功能提供了更全面的视角。这些发现对于理解驾驶过程中的认知负荷和脑网络机制具有重要的意义，为驾驶训练和安全管理提供了依据。

基于复杂网络特征的分心驾驶脑功能网络分析

报 告 人：　　于纪翔
报告单位：　北京交通大学

报告摘要：

随着自动驾驶技术的不断发展，关键脱离场景的识别成为实现安全、高效自动驾驶的一个重要挑战。目前的研究大多以驾驶数据和传统神经网络作驾驶场景识别，而很少研究脑电信息这一生理指标；主要专注于对单一类别场景进行识别，而很少专注多个类别场景。因此，本研究提出了一种基于脑电特征的模糊卷积神经网络（FCNN）方法，旨在实现对自动驾驶关键脱离的四种不同场景准确识别。FCNN 模型的特征是将提取不同脑电特征和对应的场景标签输入到该模型模型中，通过模糊逻辑的运算，对输入的脑电特征进行模糊化处理，映射为模糊隶属度函数。使用模糊逻辑的模糊集合进行卷积操作作进一步处理。该模型结合卷积神经网络的优势和模糊逻辑的表达能力，并在脑电特征上训练该模型，使其能够学习和识别不同的关键脱离场景，最终四种类型的驾驶场景识别准确率达到 84.9%。结果表明，与传统的神经网络相比，该模型有着模拟人类判断和决策能力以及人脑模糊逻辑思维的优势。能够有效地识别关键脱离场景，有着较高的准确率和稳定性。

How information within the perceptual span guides visual search and aids perception

报 告 人： 陈玉风
报告单位： 南京理工大学

报告摘要：

We explore the guiding effect of task-related information appearing within the perceptual span on visual search based on elements such as the range of effective information attention within the perceptual span and the orientation of task-related objects. In the first experiment, we recorded reaction time and eye movement data of 48 subjects performing a visual search task for target information in the navigation interface and divided them into four experimental groups according to the perceptual span (within or outside the range) and orientation (left or right) of the task-related information. The experimental results showed that: (a) task-related information appearing within the perceptual span had a guiding effect on target search; and (b) the right side closer to the target in task search have better performance in guiding. In the second experiment, eye-movement experiments of the navigation interface based on the eye-movement processing theoretical model of linguistics showed that: (a) within the perceptual span, the shifting of attention causing eye movements (saccade) and brings gaze into the area of interest, and (b) the perceptual span moves with attention shifts. This study provides evidence for cognitive processing of information responses within the perceptual span and dynamic adjustment of perceptual span location and provides a reliable method for effective information presentation and visual layout in navigation interfaces, with a view to providing reference and learning for related studies.

机载显控界面复杂度对飞行员认知绩效影响

报 告 人： 刘潇
报告单位： 南京理工大学

报告摘要：

机载显控界面复杂度会影响飞行员的认知绩效，针对机载界面，建立界面复杂度的测量方法并探究其对认知绩效的影响。首先，构建界面复杂度的测量指标及评价方法，结合机载显控界面元素特征，将界面信息元素数量与显控界面显示面积作为评价指标，定量计算出界面信息密度，作为评价界面复杂度的度量方法；其次，对机载显控界面进行模拟，选取作战阶段的机载显控界面作为评价客体，通过计算发现信息元素在界面中的分布并不均衡，界面局部复杂度并不一致；随后开展视觉搜索实验，采用 4(信息密度等级)×4(实验任务)的重复测量组内设计，通过行为反应指标中的反应时和正确率，探究不同界面信息密度等级对认知绩效的影响。实验结果表明：（1）行为绩效受界面信息密度的影响，过低或过高的信息密度都会使反应时延长、正确率下降，并且反应时比正确率对信息密度的变化更敏感；（2）目前的机载显控界面的局部信息密度超过了认知绩效的最优范围，将会对飞行员的认知绩效带来不利影响。该结论能在未来机载显控界面的设计优化中起到一定参考作用。

“感知-交互-决策”：一种基于工业大数据与人工经验量化耦合的混合智能研究方法

报 告 人： 张绚绚
报告单位： 北控水务（中国）投资有限公司

报告摘要：

人工智能与人因工程的应用正在改进传统行业的工作效率和工作方法。先进技术在智慧水务领域的应用使得传统水务行业实现了人效的提升，推动了无人、少人化的生产方式。然而在复杂的污水处理过程中，部分生产工艺仍旧依靠着人工经验来进行诊断决策。如何量化和消除人的不稳定因素，并且将专家经验进行量化和快速复制到更多实际应用场景当中，是水务行业走向标准化、数字化、智能化进程中，面临的全新课题与机遇。本文提出了一种将人因技术与工业大数据相结合的研究方法，针对污水处理生物反应池曝气这一生产环节，提出用眼动追踪技术来捕获污水处理专家的注意力焦点，并将其与机器视觉（CV）模型深度学习算法相结合，对曝气状况智能识别分析进行深度优化。凭借摄像头和工业传感器设备代替人眼感知，用人因数据结合工业数据搭建机器视觉模型来优化交互过程，依靠深度学习算法完成生产控制过程中的调控决策，最终实现智慧化的“感知-交互-决策”生产过程。

一种结合身份认证的轻量级混沌脑电信号加密方案

报 告 人： 柳朝阳
报告单位： 西藏民族大学

报告摘要：

随着脑机接口的快速发展，其隐私保护越来越受到研究者的关注。脑电图信号包含关于个人思想、情绪和健康状况等敏感信息，在开放网络上传输时存在泄漏或篡改的安全风险。为了保证其完整性和安全性，提出了一种与身份认证相结合的轻量级混沌脑电图信号加密方案。首先，分别通过 SHA-256 从身份 id 和 EEG 信号本身中生成部分密钥。然后，利用该密钥作为一维分数阶三角函数（1DFTF）混沌映射的初始值，生成混沌序列。最后，利用生成的伪随机序列对脑电图信号进行混淆和扩散操作，实现数据加密。本方案对不同的脑电图数据库中对该算法进行了测试，实验结果表明，该算法具有抗统计攻击、明文攻击和微分攻击等特点。另外，从时间效率和鲁棒性对方案进行了分析，通过与其他方案的比较，验证了方案的实用价值和创新性。

Study on the effect of repeated transcranial electrical stimulation on mental rotation

报 告 人： 李文婧
报告单位： 天津工业大学

报告摘要：

Background: Motor imagery training can improve the motion and functionality of the upper extremities in chronic stroke and orthopedic patients. Mental rotation of hand images, a well-established paradigm, involves subjects participation in motor imagery processing. Transcranial alternating current electrical stimulation (tACS) has been repeatedly shown to regulate endogenous brain oscillations in a frequency-specific manner and, therefore, it is a promising tool to improve patient motor imagery. Although studies confirm that single tACS or tDCS and repeated tDCS can improve mental rotation performance, the current studies have focused on behavioral analysis, with little analysis of electrophysiological data and did not measure the actual brain activity. And it is unclear whether repeated tACS can have a cumulative effect to improve motor imagery.

Objective: This topic deeply explores the influence of repeated tACS stimulation on the ability of motor imagination task and the mechanism of action, in order to provide new methods for improving the effect of motor imagination therapy method.

Methods: Fifteen subjects, successively serving as a tACS stimulation group versus a sham stimulation group, participated in a task that combined tACS with the mental rotation of the hand. The 64-channel EEG data before and after single and repeated tACS were recorded during the experiment. The error rate, the event-related potentials (ERPs), the negative wave RRN and the event-related desynchronization (ERD) were analyzed.

Results: Consistent with previous studies, the P300 amplitude decreases as the angle increases, and the rotation-related negativity (RRN) occurs in the central and parietal region and decreases as the rotation difficulty increases. By comparing the results before and after electrical stimulation, we found that the error rate at 180°decreased significantly after repeated tACS. Regarding electrophysiology, the RRN in the repeated tACS group was significantly higher than the RRN before stimulation during the mental rotation phase, with no significant difference before and after the sham stimulation group. Furthermore, only the tACS group exhibited a trend towards increased ERD after stimulation compared to pre-stimulation. The results indicate that repeated tACS seems to provide better improved mental rotation performance than single tACS.

Conclusions: The reduced error rate, the positive elevation of negative wave RRN and the enhanced ERD illustrate the improved mental rotational ability, and the fact that repeated tACS can improve motor imagery.

Significance: The event-related-potentials and the event-related desynchronization were able to show the difference in the mental rotation phase between the tACS and sham group. The results of this study provide some reference for the application of tACS in motor imagery rehabilitation.

Latin-square based encryption method for medical images

报 告 人：　　靳丹阳
报告单位： 西藏民族大学

报告摘要：

Telemedicine diagnosis via the Internet has been widely used recently. The transmission of patients' private data over the network is subject to threats such as tampering, forgery, and theft, and the unauthorized theft and modification of other people's data can be a great nuisance to both patients and doctors. Often, multiple medical images of the same patient are put together for transmission, and once one image is stolen, other medical images carrying patient information will no longer be secure. In order to protect the security of medical images, this paper proposes a new medical image encryption method based on fourth-order Latin square. In the diffusion process in order to be able to medical grayscale images into color images for visual interference must be dynamically generated fourth-order Latin square, the method also needs to be first through the bit plane decomposition of the pixel value of the high and low bits to be upset for preprocessing, in order to achieve the encryption of the image is both related to the original image and will not be easily cracked, the encryption of the use of half the bit plane. In the disarrangement process, the encrypted values are rearranged using weighted summation and then product. This encryption scheme considers encrypting two grayscale medical images of the same patient to generate color images with rich color information with visual interference effect. Its security is tested in terms of information entropy, correlation coefficient, key sensitivity, and noise attack. The results show that the method has a high level of encryption effect on color images and can achieve lossless decryption.

会务安排

- 8 月 25 日 15:00 开始报道，报道及会议地点为北京市海淀区学院路 39 号唯实国际文化交流中心四层唯实厅
- 报道期间请您仔细核对所发资料袋内物品，内含物品如下：会议手册、餐券、代表证、会议注册费用发票、笔和记事本、产品宣传资料。
- 请与会代表遵守作息时间，服从会议安排。
- 请与会代表提前十分钟入场，开会期间请将手机调整到无声或振动状态。

会议举办城市天气情况

8/26	星期六	多云	22℃-32℃	南风 1 级
8/27	星期日	晴	22℃-32℃	南风 1 级

交通指引

会议地址：北京唯实大厦

交通位置：海淀区学院路 39 号（近知春路）

距离北京首都国际机场 29 公里

方案 1：北京首都国际机场→唯实大厦（打车约 73 元，耗时 48 分钟）

方案 2：北京首都国际机场（步行 139 米）→首都机场 T3 航站楼公交站（机场大巴北京南站线）→三元桥公交站（步行 184 米）→三元桥南公交站（671 路）→学知桥西公交站（步行 378 米）→唯实大厦

距离北京大兴国际机场 59 公里

方案 1：北京大兴国际机场→唯实大厦（打车约 140 元，耗时 73 分钟）

方案 2：北京大兴国际机场（步行 462 米）→大兴机场地铁站（北京大兴国际机场线）→草桥地铁站（站外换乘 19 号线）→牡丹园地铁站（站内换乘 288 米）→西土城地铁站（步行 543 米）→唯实大厦

距离北京西站 14 公里

方案 1：北京西站→唯实大厦（打车约 34 元，耗时 29 分钟）

方案 2：北京西站（步行 54 米）→北京西站地铁站（9 号线）→国家图书馆地铁站（4 号线大兴线）→海淀黄庄地铁站（10 号线内环）→西土城地铁站（步行 543 米）→唯实大厦

距离北京丰台站 25 公里

方案 1：北京丰台站→唯实大厦（打车约 50 元，耗时 33 分钟）

方案 2：北京丰台站（步行 633 米）→丰台站地铁站（10 号线内环）→西土城地铁站（步行 543 米）→唯实大厦