

ICUSAI 2019

2019 International Conference on Unmanned Systems and Artificial Intelligence

November 15–17, 2019

Shaanxi, China

CONFERENCE DIGEST



Organizers



Northwestern Polytechnical
University



Unmanned System Research Institute



China Agricultural University

Sponsors:



IEEE Systems, Man and
Cybernetics Society



IFAC Technical Committee on Economic, Business,
and Financial Systems (TC 9.1)

Conference Digest

2019 International Conference on Unmanned Systems and Artificial Intelligence

IEEE ICUSAI 2019

Nov. 15-17, 2019

Shaanxi, China.

Organized by

Northwestern Polytechnical University, Shaanxi, China

Unmanned System Research Institute, Shaanxi, China

China Agricultural University, Beijing, China

Technically cosponsored by

IEEE Systems, Man and Cybernetics Society

IEEE SMCA Technical Committee on Computational Psychophysiology

IFAC Technical Committee on Economic, Business, and Financial Systems (TC 9.1)

Foreword

On behalf of the Organizing Committee, we sincerely welcome you to join us at the 2019 International Conference on Unmanned Systems and Artificial Intelligence (ICUSAI2019) being held in Shaanxi, China, during November 15-17, 2019. ICUSAI2019 aims to provide an international forum that brings together those actively involved in unmanned systems. It also provides a premier interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of unmanned systems.

ICUSAI2019 attracted a total of 160 submissions involving the most advanced development and research coverage with reliability of unmanned systems, path planning and navigation, regulations, interoperability, airspace control, airspace management, airworthiness, biologically inspired unmanned systems, energy efficient unmanned systems, environmental issues, information security and anti-counterfeit, digital watermarking, multidimensional code, cryptography, network penetration, internet protocol, big data processing and application, big data storage and management, cloud computing, artificial intelligence and cybernetics, robotics & control systems, etc. According to the strict peer review of planning committee members and reviewers, 72 papers (acceptance rate 45%) were selected and included in the conference proceedings.

Many organizations and volunteers made great contributions toward the success of this conference. We would like to express our sincere gratitude to IEEE Systems, Man and Cybernetics Society, and IFAC Technical Committee on Economic, Business, and Financial Systems (TC 9.1) for their sponsorship, Northwestern Polytechnical University, Unmanned System Research Institute and China Agricultural University for their Organization. We would also like to sincerely thank all the committee members for their great efforts in organizing the conference. Special thanks to all technical committee members and reviewers for their professional review to ensure the high quality of the meeting process. Finally, we would like to thank all speakers, authors, and participants for their great contribution and support to make ICUSAI2019 a success. We sincerely hope that all participants can gain academic achievements, enhance mutual communication, broaden their horizons and gain friendship in this conference!

General Chair	General Co-Chairs	Program Chair	Program Co-Chairs
Prof. C. L. Philip Chen	Prof. Junqiang Bai Prof. Panfeng Huang Prof. Guang Pan	Prof. Zhaoyong Mao	Prof. Junwei Han Prof. Rongxin Cui Prof. Wenxing Fu

Location: Xigongda Chuangxin Building, Laodong South Road, BeiLin District, Xi'an, China.

Welcome Message

Welcome to the 2019 International Conference on Unmanned Systems and Artificial Intelligence (ICUSAI 2019)!

ICUSAI 2019 provides an international forum that brings together those actively involved in unmanned systems. It also provides a premier interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of unmanned systems.

We would like to take this opportunity to thank the Technical Program Committee comprising of many Area Chairs and Reviewers from all over the world, who have worked diligently to ensure that high quality papers will be presented and published in the proceedings. We also acknowledge the support of and express our sincere appreciation to the members of the local organizing committee. We are also grateful to the advice and guidance of the Executive Committee of the Northwestern Polytechnical University, China and the IEEE SMC Society (SMCS). Lastly and most importantly, we thank all of you, the authors and delegates, for participating in ICUSAI 2019, sharing your knowledge and experience and contributing to the advancement of science and technology for the improvement of the quality of our lives.

We wish each and every one a most pleasant experience at ICUSAI 2019 in Shaanxi.



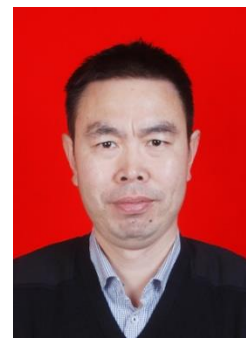
C. L. Philip Chen
General Chair
ICUSAI 2019



Junqiang Bai
General Co-Chair
ICUSAI 2019



Zhaoyong Mao
Program Chair
ICUSAI 2019



Wenxing Fu
Program Co-Chair
ICUSAI 2019

IEEE ICCSS 2019 Conference Digest

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Technical Sessions

Regular Sessions	25
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Committees

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Secretaries	Xueyan Kang, South China University of Technology, China Hanyun Ye, South China University of Technology, China

General Information

AO XIANG International Conference Center (西安翱翔国际会议中心)) is located at Xigongda Chuangxin Building, Laodong South Road, BeiLin District, Xi'an. The hotel has a variety of professional services including special luxury rooms, executive lounge, first-class restaurants, coffee bar, international conference center, hot spring spa, fitness center, business center and so on.

Transportation Information

Route 1: (about 1 hour and 30 minutes)

Xi'an Xianyang International Airport(西安咸阳国际机场) ———— 机场大巴高新区丽柏酒店线 ————> Ziction Liberal Hotel Station

Come out from Exit 1 and walk about 1500 meters.



Route 2:(about 1 hour and 6 minutes)

Xi'anbei Railway Station(西安北站) ———— Line 2 ————> Yongning Gate Station(永宁门站) ———— Walk about 460m ————>
Weiqunan direction

Nanmenwai Station(南门外站) ———— 184 Road ————> Xigongdaximen Station(西工大西门站)

Come out from Exit 1 and walk about 140 meters.



Surrounding Hotels

Le Garden Hotel (西安骊苑大酒店)

The Le Garden Hotel (Liyuan Jiudian) is located in central Xi'an, approximately 47 km (29 mi) from Xianyang International Airport. Xi'an Railway Station is about 8 km (5 mi) away. Diners can enjoy Chinese and Western dishes at the on-site restaurants. A lobby bar and cafe serve drinks. Business travelers are invited to make the most of the business center and meeting rooms. In their leisure time, guests can head to the gym for a workout or enjoy a game of pool in the billiards hall. This Xi'an hotel provides free parking and free Wi-Fi in public areas.

Hanbang Boutique Hotel (西安汉邦精致酒店)

The Hanbang Boutique Hotel (Hanbang Jingzhi Jiudian) is located within easy reach of the airport shuttle bus Gaoxin stop. Xianyang International Airport is approximately 35 km (22 mi) away. Diners can enjoy local food at the hotel restaurant. Business travelers are invited to make the most of the meeting rooms. This Xi'an hotel offers parking on site.

Surrounding Information

Xi'an, also known as Sian, is the capital of Shaanxi Province. A sub-provincial city on the Guanzhong Plain in northwest China, it is one of the oldest cities in China, and the oldest of the Four Great Ancient Capitals, having held the position under several of the most important dynasties in Chinese history, including Western Zhou, Qin, Western Han, Sui, and Tang. Xi'an is the starting point of the Silk Road and home to the Terracotta Army of Emperor Qin Shi Huang.



Here are some places worth visiting in Xi'an:

1. Giant Wild Goose Pagoda (大雁塔)

Giant Wild Goose Pagoda or Big Wild Goose Pagoda is a Buddhist pagoda located in southern Xi'an, Shaanxi, China. It was built in 652 during the Tang dynasty and originally had five stories. The structure was rebuilt in 704 during the reign of Empress Wu Zetian and its exterior brick facade was renovated during the Ming dynasty.

One of the pagoda's many functions was to hold sutras and figurines of Gautama Buddha that were brought to China from India by the seventh-century Buddhist monk, scholar, traveller, and translator Xuanzang. Today, the interior walls of the pagoda feature engraved statues of Buddha by the renowned artist Yan Liben.



2. Bell Tower, Drum Tower of Xi'an(西安钟楼、鼓楼)

The Bell Tower of Xi'an, built in 1384 during the early Ming Dynasty, is a symbol of the city of Xi'an and one of the grandest of its kind in China. The Bell Tower also contains several large bronze-cast bells from the Tang Dynasty. The tower base is square and it covers an area of $1,377m^2$. The tower is a brick and timber structure and close to 40m high. It is located in the center of Xi'an, at the intersection of the four streets of the east, west, south and north. It is the largest and most preserved one amongst the many bell towers left over from ancient China.

The Drum Tower of Xi'an, located in the heart of Xi'an in Shaanxi province of China, along with the Bell Tower is a symbol of the city. Erected in 1380 during the early Ming Dynasty, it stands towering above the city center and offers incredible view of Xi'an. The Drum Tower got its name from the huge drum located within the building. In contrast to the Bell Tower, where bell was stricken at dawn, drum was beat at sunset to indicate the end of the day. On the Drum Tower's first floor, lies a hall which hangs many large drums. Each was decorated with intrinsic and beautiful Chinese writing, which symbolizes good fortune. The impressive arrays of drums are only on show and visitors are not allowed to touch any of them. But there is an extra drum near the front entrance where visitors can pose for pictures for a small fee. Inside the Drum Tower there is also a drum museum, where a variety of drums are on display, some of which can be dated back thousands of years. There is a drum show performed here every day. The top of the tower commands a panoramic view of the city.



3. Terracotta Army(兵马俑)

The Terracotta Army is a collection of terracotta sculptures depicting the armies of Qin Shi Huang, the first Emperor of China. It is a form of funerary art buried with the emperor in 210–209 BCE with the purpose of protecting the emperor in his afterlife.

The figures, dating from approximately the late third century BCE, were discovered in 1974 by local farmers in Lintong County, outside Xi'an, Shaanxi, China. The figures vary in height according to their roles, with the tallest being the generals. The figures include warriors, chariots and horses. Estimates from 2007 were that the three pits containing the Terracotta Army held more than 8,000 soldiers, 130 chariots with 520 horses, and 150 cavalry horses, the majority of which remained buried in the pits near Qin Shi Huang's mausoleum. Other terracotta non-military figures were found in other pits, including officials, acrobats, strongmen, and musicians.



Conference Registration

A conference registration desk will be set up and opened at the AO XIANG International Conference Center, (西安翱翔国际会议中心), Shaanxi from Nov. 15 (13:00) as followings.

Nov. 15, 2019: 13:00 ~ 20:00

Nov. 16, 2019: 8:30 ~ 20:00

Nov. 17, 2019: 8:30 ~ 12:40

Registration Area: 1 floor, AO XIANG International Conference Center, Shaanxi, China.

Map of Conference Rooms



IEEE ICUSAI 2019

Program at a Glance

Nov. 15-17, 2019

Shaanxi, China

November 15 (Friday)	
13:00-20:00	On-site Registration
18:00-20:00	Dinner
November 16 (Saturday)	
08:30-08:50	Opening Ceremony
08:50-11:50	Keynote 1 by Bin Jiang: 飞行应用的自适应故障调整 Keynote 2 by Jinhu Lv: 群体智能赋能协同感知与控制 Keynote 3 by Hong Qiao: 类脑智能机器人 Keynote 4 by Jingdong Chen: 人机语音交互:从声信号感知到声场感知
12:00-13:00	Lunch
13:00-17:10	Invited Talks 1 by Chenguang Yang: 人机技能传递与仿人机器人控制设计 Invited Talks 2 by Wenwu Yu: 网络系统协同抗干扰控制 Invited Talks 3 by Shiji Song: 深海可控式可视化采样器及其强化学智能运动控制方法 Invited Talks 4 by Xi Peng: 可解释的深层神经网络 Invited Talks 5 by Mou Chen: 多无人机协同任务规划 Invited Talks 6 by Xiwang Dong: 分布式编队合围控制技术及其在无人机集群中的应用 Invited Talks 7 by Zhengguang Wu: 分布式连续非线性系统的异步 Lebesgue 近似模型 Invited Talks 8 by Wei He: 柔性机械臂建模与控制 Invited Talks 9 by Jian Sun: 网络控制系统的稳定性分析、控制器设计和安全性 Invited Talks 10 by Xiaojie Su: 时滞随机扰动模糊控制系统的分析与综合 Invited Talks 11 by Huayan Pu: 海洋无人艇环境智能感知与应用
13:30-18:10	Oral Session I
18:10-20:00	Dinner

20:00-20:30	Awards Ceremony
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November 17 (Sunday)	
08:30-12:40	Parallel Oral Session II
08:30-12:40	Parallel Oral Session III
12:40-14:00	Lunch

*10 minutes are scheduled for oral presentation including discussions for each paper.

ICUSAI 2019 Program at a Glance

November 15, 2019		
13:00-20:00	On-site Registration	AO XIANG International Conference Center(西 安翱翔国际会议中心)
18:00-20:00	Dinner	2F
November 16, 2019		
8:30-8:50	Opening Ceremony	Aoxiang Banquet Hall (翱翔厅)
8:50-11:50	Keynote Speech	
12:00-13:00	Lunch	2F
13:00-17:10	Invited Talks	Juya Banquet Hall (聚雅厅)
13:00-18:10	Oral Session I	Xianyun Banquet Hall (贤云厅)
18:00-20:00	Dinner	2F
20:00-20:30	Awards Ceremony	2F
November 17, 2019		
8:30-12:40	Parallel Oral Session II	Juya Banquet Hall (聚雅厅)
8:30-12:40	Parallel Oral Session III	Xianyun Banquet Hall (贤云厅)
12:00-14:00	Lunch	2F

Technical Program Schedule

Oral Session I:

November 16, 13:30-18:10; Xianyun Banquet Hall (贤云厅)

Chair: Hanqiao Huang

Time	Title	Author
13:30 — 15:30	[#03] Cooperative Collision Avoidance Method for MultiUAV Based on Kalman Filter and Model Predictive Control	Hanqiao Huang and Huan Zhou
	[#08] A Point Cloud Density Enhancement Method Based on Super-resolution Convolutional Neural Network	Hao Meng and Yu Han
	[#26] Current Research Status of Omnidirectional Mobile Robots with Four Mecanum Wheels Tracking based on Sliding Mode Control	Hao Xu and DengXiu Yu
	[#51] Research on Autonomous Navigation Algorithm of Aircraft	MinZhou Dong and HaoDi Zhang
	[#52] Optimal Coverage Path Planning Algorithm of the Tractor-formation Based on Probabilistic Roadmaps	Yi Cao and Yu Han
	[#54] Fuzzy path planning of unmanned underwater vehicle based on adaptive fireworks algorithm optimization	Y. Ma and Z.Y.Mao
	[#56] Position Tracking for Continuum Robots with Joint Limit Constraints	Dengliang Lin, Xin Dong, Chenguang Yang
	[#02] Self-Compensation Method of Constant Drift Error of Gyroscope	Jianqiang Zheng and QinghuaMa
	[#06] Research on autonomous obstacle avoidance module of walking-swimming submersible	Weidong Liu and Wei Sun
	[#29] Neural Network Control Using Composite Learning for USVs with Output Error Constraints	Puyong Xu, Chenguang Yang*, Shi-Lu Dai and Zhaoyong Mao
	[#18] Single Image Super-Resolution Based on Self-Attention	Lujie Zong and Lianna Chen
	[#19] A PID based approximation-free controller with prescribed performance function for model helicopter attitude control	Bin Zhu and Ruisheng Sun
15:30 — 15:50	Coffee break	

15:50 — 18:10	[#64] Optimal Path Planning Based On Hybrid GeneticCuckoo Search Algorithm	Junrui Wang,Xiang Shang,Ten Guo,Jinchao Zhou,Sining Jia and Chuang Wang
	[#67] Reliability Allocation Method for Unmanned Underwater System Based on Intuitionistic Fuzzy	Xiangyao Meng
	[#68] Infrared target detecting in severe jamming using detector based on Deep Learning	Yangguang Hu, Mingqing Xiao and Zhaozheng Liu, Jiaojiao Meng, Mingjian Kuang
	[#69] Time Registration Algorithm Based on MultiMissiles Cooperative Target Detection	Xinliang Wang , Kai Chen, Mingang Wang and Qiqi Xue,
	[#70] A Summary of the Development of Cooperative and Intelligent Technology for Multi-UA V Systems	Huan Zhou and Jingguang Yang, Qian Su, Wenxing Fu and Meiyun Zheng, Cheng Xu
	[#37] Vision-based UA V Obstacle Avoidance Algorithm on the Embedded Platform	Xupeizhang, Zhong Ma, Zhanzhuang He and Zhuping Wang
	[#48] Effects of Uneven Asymmetric Ice Accretion on Aircraft Flight	Yupeng Feng , Shiyu Liu, Yandong Cai, Ning Liu, Xiang Huang and Pei Hu
	[#27] An Integral Evasion and Pursuit Guidance Strategy for an Unpowered Air-to-Ground V ehicle in Descending Phase	Hang Guo, Wenxing Fu, Kang Chen and Jie Yan,
	[#71] Distributed Coordination of Heterogeneous Multi-Agent Systems with Output feedback Control	Shixun Xiong, Qingxian Wu and Yuhui Wang
	[#72] A Study on The Modified Proportional Guidance of LOS Angle Acceleration	Xingan Li, Wenxing Fu, Meiyun Zheng and Xiaofei Chang, Cheng Xu, Di Zhang
	[#73] Hybrid guidance for Common Aero Vehicle equilibrium glide reentry with multi-constraints	Yang Ren , Jingguang Yang and Wei Xiong
	[#10] Application of Shielding Coils in Efficiency Optimization for Underwater Wireless Power Transmission Systems	Yushan Wang , Zhaoyong Mao and Kehan Zhang
	[#24] Design and Analysis of Permanent Magnet Generator for unmanned V ehicles	Yan'an Zhang, Zhe Xin , Mingxi Shao, Houfu Yang and Qiubo Jiang
	[#38] Pipeline Image Dehazing Algorithm Based on Atmospheric Scattering Model and Multi-Scale Retinex Strategy	Tan He, Ce Li, Ruili Liu, Xiao Wang and Longshuai Sheng

Parallel Oral Session II:**November 17, 8:30-12:40; Xianyun Banquet Hall (贤云厅)****Chair: Yi Cao**

Time	Title	Author
8:30 – 10:00	[#7] A Tractor Formation Coverage Path Planning Method Based on Rotating Calipers and Probabilistic Roadmaps Algorithm	Yi Cao, Yu Han, Jian Chen*, Xuzan Liu, Zichao Zhang, Kai Zhang
	[#9] A Coverage Path Planning Method Based on Multiple Solar Powered Unmanned Aerial Vehicles	Nannan Du, Zichao Zhang, Jian Chen*, Xuzan Liu, Kai Zhang, Ben Ma,
	[#12] Review of Agricultural Product Classification Based on Computer Vision	Bingshan Niu, Zhenbo Li
	[#14] Design and study of proportional control valve for electro-hydraulic lifter of unmanned hill tractor	Mingxi Shao, Zhe Xin, Yan'an Zhang,
	[#16] Application of PBSID and Structured H_{∞} Methods in Unmanned Helicopter System Identification	Meiliwen Wu, Marco Lovera, Ming Chen
	[#20] Multi-spectral Image Fusion Method for Identifying Similar-colored Tomato Organs	Qingchun Feng, Jian Chen, Xinxu Li, Cuilin Li, Xiu Wang
	[#49] Multi-bit Upset Mitigation with Double Matrix Codes in Memories for Space Applications	Fei Zhang, Jie Yan, Lixue Ma, Yan Li, and Wu Gao
	[#58] Research on Laser Jamming Model of Infrared Imaging System	Hao Liu, Kai Zhang, Xiaoshuang Jiao, Guoliang Chen, Jiayi Wei, Jie Yan
	[#11] Automatic dairy cow body condition scoring using depth images and 3D surface fitting	Wen-Yong Li, Yang Shen, Du-Jin Wang, Zhan-Kui Yang, Xin-Ting Yang
10:00 – 10:20	Coffee break	
10:20 – 12:40	[#42] The Study For Path Following of Robot Fish Based on ADRC	Ze-peng Gao and Xiao-ru Song
	[#45] The variable anchor box region proposal network based on confidence non-maximum suppression	Chenghao Li and Le Ru
	[#50] The Evaluation of Infrared Image Features Based on Modified RELIEF Algorithms	Xitao Zhang, Lin Yan, Xiaodong Bai, Heng Zhou
	[#53] Research on Intelligent Target	Xiaodong Zhao and Xunying

	Detection and Coderdecoder Technology Based on Embedded Platform	Zhang,
	[#57] Cascade LADRC for Hypersonic Vehicle with Rigid-Aeroservoelasticity-Sloshing Coupling	Wenhui Ma and Kang Chen
	[#04] Super-Resolution Reconstruction Method for Single Space Object Image based on Optimized Convolution Neural Network	Xubin Feng and XinQin Su
	[#05] Effects of Rain fall Intensity on Run off and Sediment Yield in Black Soil Slope	HongtaoLiu and Qiqi Li
	[#25] Graph theory based scheme design synthesis for tractor fixed shaft gearbox	Shenghui Fu and Liang Wang
	[#35] Automatic Drainage Pipeline Defect Detection Method Using Handcrafted and Network Features	Xinyu Shang and Ce Li
	[#55]Attitude tracking control of E-sail in Earth-Mars transfer using feedback linearization and sliding mode control	Xin Shi and Mingyin Huo
	[#33] A 3D Modeling Algorithm of Ground Crop Based on Light Multi-rotor UAV Lidar Remote Sensing Data	Hao Meng and Guangqi Wang
	[#34] Timing-based Sensor Fusion Mapping Method for Indoor Remote Surveying Robot	Nannan Du and Zichao Zhang
	[#43] Hand Tracking Accuracy Enhancement by Data Fusion Using Leap Motion and Myo Armband	Jingxiang Chen, Chao Liu, Rongxin Cui, Chenguang Yang*
	[#76] Research on Fault Detection and Health Monitoring System of Turntable	Gongrong Ma and Fanjun Meng

Parallel Session III:**November 17, 8:30-12:40; Juya Banquet Hall (聚雅厅)****Chair: Xing'ang Xu**

Time	Title	Author
8:30 – 10:00	[#21] Collision avoidance of unmanned surface vehicle based on dynamic obstacles trajectory prediction	Xing'ang Xu, Yan Lin
	[#22] Auxiliary navigation system based on Baidu Map JavaScript API for high clearance sprayers	Li Wei, Mao Enrong, Xu Boqiang, Zhu Zhongxiang, Du Yuefeng, Li Zhen
	[#23] Cow tail detection method for body condition score using Faster R-CNN	Xiaoping Huang, Xinru Li, Qiang Zhang, Zelin Hu, Jian Zhang
	[#28] FD-SLAM: Real-time Tracking and Mapping in Dynamic Environments	Hua Xu, Chenguang Yang *, and Ying Feng
	[#39] Attention-gated LSTM for Image Captioning	Cheng Xu, Junzhong Ji, Menglong Zhang, Xiaodan Zhang
	[#40] Neighbouring Relationship Exploration Based on Graph Convolutional Network for Object Detection	Zhuoran Du, Junzhong Ji, Jingyi Wang, Qipeng Hu, Shan Gao, Xiaodan Zhang
	[#66] Design and Development of Pressure & Flow Control System Based on LabWindows/CVI and Compact DAQ	Kaifeng Sun
	[#01] Research on Route Planning of AUV Based on Genetic Algorithms	Shaokun Yan, Feng Pan
	[#31] Rules-Based Longitudinal Trajectory Planning Algorithm of a Solar Powered Communication/Remote-Sensing UAV	Jian Chen, Hao Meng, Nannan Du, Ben Ma, Kai Zhang, Yu Han
10:00 – 10:20	Coffee break	
10:20 – 12:40	[#59] Application Research of Distributed Simulation System Based on Data Distribution	Yanfang Fu, Lingling Hao and DengDeng Guo
	[#60] Design of Missile Attitude Constraint Control under New Disturbance Observation Compensation	MinZhou Dong, ZhaoPeng Chen, HaoDi Zhang, HaoDi Zhang, Feng Xie, Xin Du and Jia Jun Yin
	[#61] General Architecture of Distributed Hardware-in-the-loop Simulation Supporting Dynamic Interactive Relationships	Hao Xu, Xinyan Zhang, Ning Xu, Qing Zhao, Qing Zhao, Congmin Li and Wei Ge,
	[#62] Fault Detection of Redundant SIMU Based on DBN	Kai Chen and Hao Fan, Na Yin
	[#63] Systematic Design of A Low-Cost Vision	Laiquan Luo, Yu Han, Jian

	Following Control System	Chen and Yi Cao, Zhuo Cheng, Laizhu Luo
	[#30] Longitudinal Modelling and Trajectory Tracking Control of a Solar Powered Communication/Remote-Sensing UAV	Jian Chen, Nannan Du, Zichao Zhang, Xuzan Liu, Ben Ma and Yu Han
	[#32] Gaussian Pseudospectral Longitudinal Trajectory Optimization Algorithm of a Solar Powered Communication/Remote-Sensing UAV	Jian Chen, Yi Cao, Yi Zuo, Nannan Du, Zichao Zhang, Xuzan Liu and Yu Han
	[#36] Autonomous Obstacle Avoidance Algorithm of UAVs for Automatic Terrain Following Application	Yue-Jiao Wang, Zhong Ma, Xue-Han Tang and Zhu-Ping Wang
	[#13] Hydrodynamic Noise Characteristics of Marine Current Turbine Designed for Unmanned Underwater Mooring Platforms	Zhigao Dang, Zhaoyong Mao, Wenlong Tian, and Baowei Song
	[#15] Recognizing of Fruit Tree Row Centerline Based on Machine Vision Agricultural Unmanned Systems Session	Yu Xiao, Lijun Qi, Zhenzhen Cheng, Zepeng Yang, Yalei Wu and Hao Zhang
	[#41] Optical Flow Prediction in Auto Driving from Single Image via Conditional Variational Auto-Encoder	Jianyu Yan, Lu Xu and Kuizhi Mei
	[#44] Adversarial Deep Mutual Learning	Xuan Lai and Yanyun Qu
	[#75] Design of Variable Structure Attitude Control System for Unmanned Underwater Vehicle	Guanshan Liu, Jing Fang, Qiaogao Huang and Suhe Huang
	[#74] The optimization study on the mitigation strategy of hinge moment of aircraft with multi-control surfaces	Huan Xie, Lixia Zhao, Wei Li, Bin Chen, ShengLin Xia and Jun Yin

Keynote Speech

November 16, 8:50 - 12:30; Aoxiang Banquet Hall (翱翔厅)

Chair: Bin Jiang

8:50 - 9:30	飞行应用的自适应故障调整	姜斌	南京航空航天大学
9:30 - 10:10	群体智能赋能协同感知与控制	吕金虎	北京航空航天大学
10:10 - 10:30	Coffee break		
10:30 - 11:10	类脑智能机器人	乔红	中国科学院
11:10 - 11:50	人机语音交互:从声信号感知到声场感知	陈景东	西北工业大学

Invited Talks

November 16, 13:00 – 17:10; Juya Banquet Hall (聚雅厅)

Chair: Chenguang Yang

Time	Title	Author	Institution
13:00 - 13:20	人机技能传递与仿人机器人控制设计	杨辰光	华南理工大学
13:20-13:40	网络系统协同抗干扰控制	虞文武	东南大学
13:40-14:00	深海可控式可视化采样器及其强化学习智能运动控制方法	宋士吉	清华大学
14:00-14:20	可解释的深层神经网络	彭玺	四川大学
14:20-14:40	多无人机协同任务规划	陈谋	南京航空航天大学
14:40-15:00	分布式编队合围控制技术及其在无人机集群中的应用	董希旺	北京航空航天大学
15:00-15:20	分布式连续非线性系统的异步 Lebesgue 近似模型	吴争光	浙江大学
15:30 – 15:50	Coffee break		
15:50 - 16:10	柔性机械臂建模与控制	贺威	北京科技大学
16:10 - 16:30	网络控制系统的稳定性分析、控制器设计和安全性	孙健	北京理工大学
16:30 - 16:50	时滞随机扰动模糊控制系统的分析与综合	苏晓杰	重庆大学
16:50 - 17:10	海洋无人艇环境智能感知与应用	蒲华燕	上海大学

Keynote Speech 1

飞行应用的自适应故障调整

姜斌教授

南京航空航天大学

摘要: 基于飞行控制的背景, 本文主要围绕复杂动态系统的自适应故障调节问题, 并介绍了连续时间、离散时间和混合系统的一系列故障检测、估计和调节结果。讨论了它们在卫星、近空间飞行器、直升机等热点问题上的应用。并且提供了一些在此方向的透视图。



姜斌, 1995 年在沈阳东北大学获得自动控制博士学位。他曾经在新加坡、法国、美国和加拿大担任博士后、研究员、特邀教授、客座教授。现任教育部长江学者计划讲座教授(首席教授)、南京航空航天大学副校长。他担任 IEEE Trans 等多家期刊的副主编、编辑委员会成员。(关于控制系统技术; 神经计算; 富兰克林研究所, 宇航杂志; 控制与决策等。)他是 IEEE 的高级成员, IEEE 南京分部控制系统分会主席, IFAC 技术委员会关于故障检测、监督和技术过程安全的成员。他的主要研究领域包括故障诊断和容错控制及其在直升机、卫星和高速列车上的应用。

姜斌曾任国家自然科学基金项目的主要研究员。他著有 8 本书, 发表了超过 200 多篇国际期刊论文和会议论文。他在 2018 年获得国家自然科学二等奖。

Keynote Speech 2

群体智能赋能协同感知与控制

吕金虎教授

北京航空航天大学

摘要：人工智能技术的迅猛发展，群体智能广泛应用于目标的协同感知、控制与识别。首先简要介绍人工智能与群体智能的发展历程与科学前沿。随后介绍群体目标的协同感知及其网络设计，分布式群组系统的系统控制与结构识别等一些重要进展。最后展望群体智能技术的发展前景。



吕金虎，北京航空航天大学大数据科学与脑机智能高精尖创新中心首席科学家、自动化科学与电气工程学院院长，全国科技创新领军人才联盟理事长，中国指挥与控制学会副理事长。IEEE Fellow、国家基金委创新群体学术带头人、国家杰青、IEEE TH共同主编等。将层次结构引入网络同步动力学分析，建立了多层网络同步的主稳定函数方法，奠定了多层网络层内、层间和全局同步稳定性分析的理论基础。获何梁何利科学与技术进步奖、3项国家自然科学二等奖(2项第一，1项第二)、中国工程院光华工程科技奖、中国青年科技奖等。

Keynote Speech 3

类脑智能机器人

乔红教授

中国科学院

摘要：机器人是无人系统的典型代表，也是人工智能的重要载体，在国民经济和国防工业中有着不可替代的地位。目前，机器人系统广泛应用于工业、服务业和国防领域，它与多学科深度融合，包括信息、机械、材料、神经科学等等，它又是软硬件的融合体。团队受人的机制启发，长期从事机器人整体系统的研究，为机器人的性能服务，并拓宽了机器人与人协作、共融的可能，扩大了国产机器人的应用范围。



乔红，国家杰出青年科学基金获得者，中科院“百人计划”研究员，IEEE Fellow。目前担任复杂系统管理与控制国家重点实验室副主任、北京市机器人“手-眼-脑”融合智能研究与应用重点实验室主任、九三学社中央科技委副主任。

乔红长期从事机器人“手”-“眼”-“脑”融合智能研究与应用，包括工业机器人操作与控制（手）、机器人视觉（眼）、生物启发式与类脑智能机器人（脑）等。她作为第一完成人获 2014 年国家自然科学奖二等奖、2012 年北京市科学技术奖一等奖、2015 年北京市科学技术奖和 2018 年中国自动化学会技术发明一等奖。发表学术论文 282 篇，授权国家发明专利 37 项。她当选并连任全球 IEEE RAS（机器人与自动化学会）管理委员会委员（RAS 主要理事机构，委员会成员 18 人，全球会员 1 万 4 千人），为大陆学者首次当选和连任。她受邀担任装配领域国际知名 SCI 期刊 *Assembly Automation* 主编，并担任包括多种 IEEE Trans 在内的著名国际 SCI 期刊编委。

Keynote Speech 4

人机语音交互:从声信号感知到声场感知

陈景东教授

西北工业大学

摘要：声信号的感知与处理人机语音交互系统的核心组成部分，该领域的研究已经有了很长的历史，在语音增强、说话人定位、语音识别、说话人识别等单一声学事件的感知、获取与重构等方面取得了很大突破。但相关技术仍远无法满足智能交互产品的需求。在这个报告中，我将和大家分享一下声信号感知与处理的一般过程和所要解决的主要科学问题；然后讨论目前声信号感知与处理面临的主要挑战以及应对这些挑战的主要途径。



陈景东，1998 至 2010 年期间分别在日本的 ATR、澳大利亚的 Griffith 大学、美国的贝尔实验室等机构任职，主要从事音频信号处理、噪声/回声控制、麦克风阵列处理、语音识别、人工智能等领域的的研发工作，所开发的部分技术已成功用于电话会议、远程合作、宇航服、智能音箱、车载导航等系统之中。于 2011 年全职加入西北工业大学，任国家特聘教授，并创立了智能声学与临境通信中心。现已出版专著 12 部，在信号处理领域的著名学术期刊及会议上发表论文两百余篇。曾荣获 IEEE 信号处理学会最佳论文奖，贝尔实验室模范团队奖和 NASA 技术创新奖等。于 1998 年荣获日本高技术中心人才基金的资助， 2014 年荣获国家“杰出青年科学基金” 的资助。

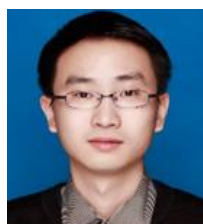
Invited Talks 1

人机技能传递与仿人机器人控制设计

杨辰光教授

华南理工大学

摘要：随着用户需求的提升，传统的大批量生产方式受到了挑战。为了适应个性化、多品种、小批量的工业 4.0 生产模式，需要引入具有人机协作能力的机器人系统。人机示教可将人的技能高效传递给机器人，使机器人具备人的操作能力与柔性，是目前国际研究热点。在本报告中，我们将介绍在示教和人机技能传递与机器人仿人控制方面的研究工作。在示教和技能传递研究中，我们首先考虑构建一个基本的机器人学习系统，实现运动技能在空间中的可拓展性，并保证运动技能的稳定复现。进一步地，我们基于肌电信号在技能建模和传递中加入了刚度信息，使得机器人能够使用不同刚度与不同环境进行交互，以完成变化多样的任务。进而对示教信息进行自动处理，包括运动技能分割，运动序列对齐等。另一方面，在机器人仿人控制研究中，我们设计一种基于有限时间收敛的机器人参数辨识算法，并将该控制器拓展到双臂机器人系统。提出了一种基于切换控制的全局稳定的双臂机器人暂态控制器。进一步，提出一种多层次阻抗控制与阻抗学习方法，并用于冗余自由度仿人机械臂，实现柔顺的人机交互柔性控制。



杨辰光，华南理工大学教授、博导，广东省智能系统控制工程技术研究中心主任，海外高层次人才引进计划青年项目入选者，欧盟玛丽居里国际引进学者。曾获 IEEE Transactions on Robotics 最佳论文奖以及 10 项国际会议最佳论文奖。任英国 Higher Education Academy Fellow，美国 IEEE 高级会员，以及 IEEE Transactions on Systems, Man and Cybernetics: System 等多个国际期刊副编，发表论文 200 余篇，国家发明专利授权 12 项。主要研究方向为人机交互、智能控制等。

Invited Talks 2

网络系统协同抗干扰控制

虞文武教授

东南大学

摘要：在过去的几十年中，由于在无人机，分布式传感网络，太空探索，海洋探索中的广泛应用，多智能体系统分布式协同控制引发了人们的广泛研究。此外，由于干扰在实际系统中是普遍存在的，多智能体系统分布式协同抗干扰控制的研究也显得越发重要。报告介绍分布式协同变结构控制，分布式协同滑模控制，干扰观测器的分布式协同抗干扰控制，分布式协同输出调节控制等主要的分布式协同抗干扰控制方法。



虞文武，1982 年生，2004 年和 2007 年分别在东南大学获得学士和硕士学位，2010 年在香港城市大学电子工程系获得博士学位。东南大学教授（首批青年首席教授），数学、网络空间安全、控制科学与工程、统计学等学科研究生导师；江苏省网络群体智能重点实验室常务副主任、网络空间安全学院复杂网络应用与安全研究中心主任、澳大利亚 RMIT 皇家墨尔本理工大学客座教授；入选国家“万人计划”青年拔尖人才、教育部“长江奖励计划”青年学者、国家优秀青年科学基金获得者；2014-2018 连续五次入选科睿唯安/原汤森路透全球高引科学家（工程学）。

主要从事复杂网络系统协同分析、控制、优化及其应用（复杂网络与复杂系统、多智能体系统、神经网络、网络系统控制与优化、网络智能与安全控制、无人系统、智能电网、智能交通、物联网与智慧城市、大数据分析）等相关研究，Springer 合编书和 Wiley 专著各 1 部，发表 IEEE 汇刊、Automatica、SIAM 杂志论文近 100 篇；Google 引用过万次，SCI 他引 7000 余次，SCI H 指数 47；32 篇 ESI 高被引论文(学科前 1%)。

担任 IEEE Trans. Industrial Informatics (SCI IF: 7.358)、IEEE Trans. Systems, Man, and Cybernetics: Systems (SCI IF: 7.351)、IEEE Trans. Circuits and Systems II (SCI IF: 3.250)、中国科学信息科学 (SCI IF: 2.731)和中国科学技术科学 (SCI IF: 2.180)等杂志编委；曾获国家自然科学基金二等奖 1 项（排名第 2），省部级二等奖以上 3 项（1 项排名第 1）及国家一级学会科学技术奖一等奖 1 项（排名第 1）、Scopus “青年科学之星”信息科学领域金奖、亚洲控制会议最佳论文奖等 6 篇国内外学术会议和机构论文奖。

Invited Talks 3

深海可控式可视化采样器及其强化学习智能运动控制方法

宋士吉教授

清华大学

摘要：介绍深海采样器关键技术、重点阐述强化学习技术在深海机器人水下路径规划和运动控制两个领域的理论及应用成果，主要包括：（1）在水下机器人动力学模型缺失的条件下，基于强化学习方法的精准运动控制。（2）在递归神经网络和机器人好奇心机制下，基于强化学习方法的热液羽状流的追踪。（3）在复杂感知输入的水下作业环境下，基于分层强化学习结构的水下机器人作业控制及其应用。



宋士吉，男，1965年生，清华大学自动化系教授、博士生导师。1996年获得哈尔滨工业大学基础数学专业博士学位。1996年至2000年，分别在中国海洋大学、东南大学两次完成博士后研究。长期致力于复杂生产线智能优化与调度方法、鲁棒随机分层优化建模与分析求解方法、机器学习理论方法及其应用等方向研究。

担任 IEEE Transactions on Systems, Man, and Cybernetics: Systems 编委，国际期刊 The Scientific World Journal: Operations Research 编委；曾任《中国科学-信息科学》与《自动化学报》等期刊编委。在国内外重要学术期刊会议发表论文 240 余篇，其中 IEEE Transactions 系列期刊长文、国内外著名期刊 SCI 检索论文 120 余篇，其中高被引论文 5 篇；论文在 Web of Science 中被他引超过 1600 次，已授权或申请发明专利 22 项。

近五年来，主持国家自然科学基金钢铁联合基金重点项目、重大科学仪器研制项目、面上项目、科技部 863 项目、教育部博士点基金优先发展主题、中国大洋协会信息系统项目累计 20 余项。获得 2018 年中国人工智能学会自然科学一等奖、2016 年教育部高等学校自然科学二等奖、2017 年中国自动化学会教学成果一等奖。获得 2006 年江苏省自然科学一等奖、2007 年教育部高等学校自然科学二等奖。

Invited Talks 4

可解释的深层神经网络

彭玺教授

四川大学

摘要：一般的深层架构，通常被称为“黑盒”方法，依赖于堆叠一些特定的模块，这使得解释它们的工作机制变得困难。尽管有一些假设和直觉，但很难理解深层模型的工作原理、如何分析它们以及它们与经典机器学习模型的关系。在这篇演讲中，我将从可微编程的角度介绍一些可解释的深神经网络（DNN），这是一个热门词汇，用来表示将神经网络视为语言而不是机器学习方法的想法。与传统的DNN可解释性研究不同，我们的方法具有结构和网络输出的可解释性。换句话说，我们不试图解释现有的神经网络，如这些作品所做的。相反，我们直接开发了新的可解释神经网络，用于各种应用，例如图像分类、视频异常检测、图像去叠和去噪。



彭玺，现任四川大学计算机学院研究教授。从2014年至2017年在新加坡科技研究机构（A*STAR）信息通信研究所（Institute for Infocomm）担任科研人员和首席执行官。他目前的研究方向主要集中在机器学习研究，特别是无监督表示学习、聚类、可微编程及其在图像处理、计算机视觉和自然语言处理中的应用在这些领域，他撰写了大约50篇关于ICML、CVPR、ICCV、IJCAI、AAAI、TPAMI、TIP、TNNLS、TIFS、TCYB等的文章。他曾担任多家期刊的助理/客座编辑，如“IEEE Trans on SMC:Systems”，VASE'20的项目主席，ECCV16的组织联合主席，VCIP'17的特别会议的组织联合主席，AAAI'16和IJCAI'18的会议主席，IJCAI'16和ICME'20的区域主席/SPC100多个国际会议和国际期刊的项目委员会成员和评审员。他曾经受到VASE'18 and ECCV'16的邀请进行学术演讲。

Invited Talks 5

多无人机协同任务规划

陈谋教授

南京航空航天大学

摘要：在最近的几年里，无人机在军事领域中扮演着越来越重要的角色。面对现代战场作战任务的多样性和复杂性，无人机的作战模式已逐渐从单一的无人机作战转化为多架无人机的协同作战。本文将主要介绍多无人机的协同作战，内容包括无人机协同任务规划的研究目的和意义。建立了协同作战系统的模型，介绍了基于多目标优化方法的任务分配问题。与此同时，一些相关联的技术将会被进行协同任务分配、基于契约网模型的动态任务分配、以及基于改进蚁群算法的路径规划技术及其在协同规划中的应用等。



陈谋，2004 年在南京航空航天大学获得控制理论与控制工程的博士学位。现任南京航空航天大学自动化学院的教授、副院长。他也是国家自然科学基金委授予的杰出青年学者。从 2007 年 11 月至 2009 年 2 月，他在英国拉夫堡大学航空与汽车工程系担任访问学者。从 2008 年 6 月至 2009 年 9 月，担任新加坡国立大学电气与计算机工程系研究员。从 2014 年 5 月至 2014 年 11 月，他在澳大利亚阿德莱德大学电气与电子工程学院担任高级学术访问者。他是 *IEEE Transactions on Systems, Man, and Cybernetics: Systems* 研究方向的副主编；他也担任中国航空科学杂志、中国科学信息科学杂志的副主编。他的研究方向包括非线性系统控制、智能控制和飞行控制。

Invited Talks 6

分布式编队合围控制技术及在无人机集群中的应用

董希旺教授

北京航空航天大学

摘要: 集群智能是人工智能的重要研究领域,也是单体智能未来发展的必然趋势。无人机是智能化无人系统中的典型对象,在军事及民用领域都有着广阔的应用空间。随着无人机应用场景的复杂化及任务要求的不断提升,传统单架无人机能力的不足也日益凸显,使用多架无人机,甚至无人机集群协同作业正在成为学术界和产业界共同关注的热点。以无人机集群为代表的智能集群系统具有大规模性、开放性、高动态性及强鲁棒性等典型特征。这些特征使得针对智能集群系统协同控制的相关算法需要能够分布式实现。基于此,本报告主要针对智能集群系统协同控制中的分布式时变编队控制技术、编队跟踪控制技术及编队-合围技术进行分别介绍,并结合在多无人机系统上的系列飞行试验对所提出技术的有效性进行演示验证,最后以所参加的 2018 年首届空军“无人争锋”智能无人机集群系统挑战赛密集编队穿越竞速的比赛为例进行应用展示。



董希旺, 清华大学博士, 新加坡南洋理工大学博士后, 先后在北京航空航天大学自动化科学与电气工程学院任讲师、副教授和院长助理。主要研究集群智能与协同控制相关理论及应用。在 *Automatica* 及 IEEE 旗舰汇刊等发表 SCI 论文 60 余篇, 出版 Springer 英文专著 1 本, 其中 6 篇论文长期入选前 1%ESI 高被引论文, 4 篇论文获 IEEE 和 IFAC 系列会议最佳论文/最佳论文提名。担任中国自动化学会青年工作委员会副秘书长、IEEE Access 和航空兵器编委等职务。曾获得中国指挥与控制学会创新奖一等奖、吴文俊人工智能优秀青年奖、IEEE CSS Beijing Chapter 青年作者奖、Springer 全球优秀博士论文、中国自动化学会优秀博士论文提名等奖励和荣誉, 并入选中国科协青年人才托举工程及国家优青等国家人才计划。

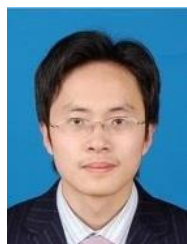
Invited Talks 7

分布式连续非线性系统的异步Lebesgue近似模型

吴争光教授

浙江大学

摘要: 近似模型的精确性以及计算效率问题对于以模型为基础的方法来说至关重要。主要研究分布式异步的离散时间模型来近似分布式的连续时间非线性系统，其中的子系统间存在物理耦合且能够与邻居节点交换信息。构建了一个分布式的时间触发系统，该系统的状态轨迹与 Lebesgue 近似模型的轨迹一致。基于此，进一步给出了 Lebesgue 近似模型渐近稳定、近似误差有界、避免出现 Zeno 行为的条件。最后，汽车悬架系统的仿真表明了该方法的优势和有效性。



吴争光，男，博士，研究员，博士生导师，入选国家“万人计划”青年拔尖人才。主要开展信息物理系统与智能电网的工作。目前主持国家自然科学基金面上项目一项，青年基金项目一项，浙江省杰出青年科学基金一项。在 2014 年-2018 年连续五年入选 Elsevier 中国高被引学者榜单，在 2017 年-2018 年连续两年入选 Clarivate Analytics 全球高被引科学家榜单。曾获得浙江省 2011 年优秀博士研究生学位论文奖、教育部 2015 年度高等学校科学研究优秀成果奖（自然科学一等奖）、2017 年浙江省自然科学二等奖。在 IEEE 系列汇刊和 Automatica 上发表（含录用）论文 90 余篇，2 篇论文分别入选 2013 年和 2014 年中国百篇最具影响国际学术论文，在 Springer 出版社出版英文专著 3 部。论文被 SCI 他引 3500 多次，共有 41 篇论文入选 ESI 高被引论文，h 指数为 40。目前担任国际期刊 IEEE Transactions on Systems, Man and Cybernetics: Systems, International Journal of Control, Automation, and Systems, IEEE Access, 和 Journal of The Franklin Institute 的 Associate Editor/Editorial Board Member, 美国《数学评论》评论员, IEEE CSS 会议编委会的 Associate Editor, 以及多个国际会议的程序委员会主席/成员。

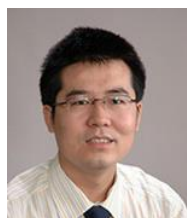
Invited Talks 8

柔性机械臂建模与控制

贺威教授

北京科技大学

摘要：与刚性机械臂相比较，柔性机械臂具有结构轻、载重/自重比高等性能，因而具有较低的能耗、较大的操作空间和很高的效率，在工业生产、医疗、航天等应用领域中占有十分重要的地位。本报告以柔性机械臂为研究对象，分析系统的动力学特性并建模，采用边界控制法来展开对柔性机械臂的控制研究。首先，直接基于无穷维的 PDE 系统模型，设计边界控制算法。其次，运用假设模态法，将无穷维的系统描述为有限个关键模态的动力学特性，通过设计合适的神经网络控制算法来实现对整个系统的控制。这两种控制方法都实现了柔性机械臂对给定位置角度的跟踪，同时抑制臂身的振动。最后，再以数字仿真和 Quanser 柔性机械臂实验平台实验进一步验证两种控制算法的控制性能。通过理论仿真与实验结果的结合，展现所设计的控制策略的有效性与可行性。



贺威，北京科技大学自动化学院教授、博导、副院长。2006 年和 2008 年在华南理工大学自动化学院分别获得学士和硕士学位，2011 年在新加坡国立大学获得博士学位。发表 SCI 论文 90 余篇，申请或授权国家发明专利 30 余项。目前担任 IEEE TRO、IEEE TNNLS、IEEE TSMCA、IEEE/CAA JAS、《自动化学报》等杂志编委。获 2015 年国家优秀青年科学基金、2016 年 WCICA “谈自忠最佳理论论文奖”、2017 年英国皇家学会“牛顿高级学者基金”、2017 年 IEEE SMC 学会 Andrew P. Sage 最佳汇刊论文奖、2017 年中国自动化学会自然科学一等奖（第二完成人）、2019 年中国自动化学会青年科学家奖、2019 年吴文俊人工智能自然科学一等奖（第一完成人），入选 2017 年教育部青年长江学者、2019 年第四批国家“万人计划”科技创新领军人才。目前担任中国自动化学会理事、青年工作委员会主任、IEEE SMC 学会北京分会主席。先后主持国家自然科学基金重点项目、优青项目、军委科技委国防特区创新项目、装备预研教育部联合基金项目、国家 973 项目子课题、国家 863 项目子课题、北京市自然科学基金项目等 20 余项科研项目。主要研究方向为：仿生扑翼飞行机器人、柔性机器人系统建模与控制、分布参数系统控制。

Invited Talks 9

网络控制系统的稳定性分析、控制器设计和安全性

孙健教授

北京理工大学

摘要：近年来，网络控制系统已经逐渐发展成为一个热门话题并且受到了广泛的关注。由于网络诱导约束的存在，例如：传输延迟和数据丢失的问题，因此网络控制系统的分析和整合是非常具有挑战性的。本文主要讨论网络控制系统的稳定性分析、控制器设计和安全性问题。本文介绍了一些新的研究进展，包括一些不太保守的稳定性准则、基于预测的控制器设计方法和最优开关故障数据注入攻击方法。



孙健，1978 年出生于中国吉林省。2001 年获吉林工业大学自动化与电气工程系学士学位，2004 年获中国科学院长春光学精细机械物理研究所硕士学位，2007 年获中国科学院自动化研究所博士学位。2008 年 4 月至 2009 年 10 月，他担任英国格拉摩根大学高级技术学院研究员。2007 年 12 月至 2010 年 5 月，任北京理工大学博士后研究员。2010 年 5 月，他加入北京理工大学自动化学院，2013 年起任该院教授。

他是 IEEE 系统、人与控制论的编辑委员会成员：（系统、系统科学与复杂性杂志和中国自动化学报）系统、系统科学与复杂性杂志和中国自动化学报。他目前的研究方向包括网络控制系统、时滞系统和网络物理系统的安全。

Invited Talks 10

时滞随机扰动模糊控制系统的分析与综合

苏晓杰教授

重庆大学

摘要：由于非线性系统的复杂性，对非线性系统的分析和设计是一个经常存在的问题。表示非线性动态系统的一种有效方法被称为 Takagi-Sugeno 模糊模型，它由一系列表示系统局部线性输入输出关系的模糊 IF-THEN 规则所控制。基于模糊模型，采用并行分布式补偿方案进行控制设计。该策略是为每个局部线性模型设计一个线性状态反馈控制器。得到的控制器总体上是非线性的。本文介绍了模糊控制系统的一些研究进展和新方法。针对模糊时滞系统和模糊随机系统的分析和综合提出了一系列问题的解决方案，包括稳定性分析和稳定化、动态输出反馈控制、滤波器设计和模型逼近。



苏晓杰，重庆大学自动化学院副院长、教授/博导，中组部万人计划“青年拔尖人才”，重庆市杰出青年基金获得者，重庆五四青年奖章获得者。主要从事智能控制理论及智能机器人控制等领域研究，已在国际权威期刊发表学术论文 50 余篇，多篇论文入选 ESI 高被引论文。作为负责人主持国家自然科学基金及省部级人才项目等共 10 余项。曾获得黑龙江省自然科学一等奖、重庆市科学技术协会自然科学优秀学术论文奖、重庆市科技进步一等奖等。2017 年和 2018 年入选全球高被引科学家（工程领域）。现担任七个 SCI 国际期刊的编委和中国自动化学会理事。

Invited Talks 11

海洋无人艇环境智能感知与应用

蒲华燕教授

上海大学

摘要：海洋无人艇也称海洋机器人，是具有自主导航、自主避障能力，并可以自主完成海面海下环境信息感知、目标探测及各种作业任务的水面无人平台。本报告以无人艇在环境感知中的高稳定扰动抑制、强隐身噪声控制和智能环境感知为主线介绍海洋无人艇在海洋环境探测方面的研究进展及应用。



蒲华燕，女，上海大学教授，一直从事智能与自主机器人的研究与应用工作，研制了成功应用于南极罗斯海浮冰海域、东海岛礁群复杂海域、南海岛礁海域、东海桑吉号撞船海域、核电等极端环境的自主机器人探测装备，完成了南极科考、海图测绘、事故海域应急救援等作业任务，服务于国家海洋强国战略、极地海洋战略和国家安全；成果获得了上海市技术发明一等奖、国家技术发明二等奖、上海市科技进步一等奖、中国国际工业博览会创新金奖、中国机械工业科学技术一等奖、IEEE 最佳论文奖。获得了中国自动化学会青年科学家奖，上海市青年科技杰出贡献奖、全国青年岗位能手、上海科技英才、上海市曙光学者等荣誉称号。

Abstract

Saturday, November 16, 2019

Session SaO I: 13:30-18:10

Address: Xianyun Banquet Hall
(贤云厅)

Session SaO I-A: 13:30-15:30

[#03] Cooperative Collision Avoidance Method for MultiUAV Based on Kalman Filter and Model Predictive Control

Hanqiao Huang and Huan Zhou, Unmanned System Research Institute Northwest Polytechnical University Xi'an, China

Collision avoidance is the primary problem to be solved in formation flight of multiple Unmanned aerial vehicles(UAVs). Firstly, a cooperative collision avoidance architecture of multiple UAVs is designed according to the requirement of autonomous collision avoidance of single UAV. Then a new cooperative collision avoidance method of multiple UAVs based on Kalman filter and model predictive control(MPC) is proposed. In this method, extended Kalman filter(EKF) is used to estimate the state of obstacles and target points in uncertain environment space, and to predict the trajectory of obstacles and target points. At the same time, relevant performance index functions and constraints are set up. On the basis of sharing environmental information, model predictive control strategy is used to guide and make cooperative collision avoidance decisions for multiple UAVs. The simulation results show that the proposed method is effective in uncertain environment perception and UAV collision avoidance, and the cooperative mechanism has obvious advantages.

[#08] A Point Cloud Density Enhancement Method Based on Super-resolution Convolutional Neural Network

Hao Meng and Yu Han, College of Engineering China Agricultural University Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment Beijing, China

The data acquired by airborne lidar are mainly spatial points, commonly known as point clouds. Density, as an important attribute of point cloud data, is a measure to distinguish the fineness of terrain. The higher the density of point cloud, the smaller the target can be detected, and the more precise the characteristics and rules of terrain and terrain can be described. In this paper, a point cloud density enhancement method based on super-resolution convolution neural network is proposed. Firstly, three-dimensional laser point cloud data are transformed into depth maps, then depth maps are sent to super-resolution convolution neural network for super-clarity. Finally, the super-clarity depth maps obtained by us are transformed into three-dimensional point cloud data. And we verify it through experiments. Through our method, the density of point cloud has been obviously enhanced.

[#26] Current Research Status of Omnidirectional Mobile Robots with Four Mecanum Wheels Tracking based on Sliding Mode Control

Hao Xu and DengXiu Yu, School of Mechanical Engineering Northwestern Polytechnical University Xi'an, China

This paper introduces the current research status of sliding mode control (SMC) in omnidirectional mobile robot control, and gives some researches we have done recently, as well as our researches in future work. Some researches about trajectory tracking of omnidirectional mobile robots, which are driven by using SMC, are summarized. The advantages and disadvantages in previous researches are analyzed. The kinematics and dynamics of omnidirectional mobile robots with four mecanum wheels (OMRFMW) are established. Based on the kinematics and dynamics models, the control law of OMRFMW is put forward to realize trajectory tracking. Then, stability of the proposed control strategy is analyzed. Simulations of the proposed control strategy for OMRFMW are carried out. The simulation results show that the proposed strategy performs well and has good tracking performance. Index Terms—omnidirectional mobile robots with four mecanum wheels, sliding mode control, trajectory tracking

[#51]Research on Autonomous Navigation Algorithm of Aircraft

MinZhou Dong and HaoDi Zhang, School of Astronautics

In order to make up for the deficiency of the SINS/GNS integrated navigation system in attitude correction, based on the geomagnetic matching algorithm, a new scheme is proposed. First, the principle of this SINS/GNS autonomous integrated navigation system is explored, and the corresponding mathematical model is established.

[#52] Optimal Coverage Path Planning Algorithm of the Tractor-formation Based on Probabilistic Roadmaps

Yi Cao and Yu Han , Unmanned Systems Research Center College of Engineering China Agricultural University Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment Beijing, China

The loss of farm labor and rising wages have forced farmers to use heavy tractors, which have helped boost productivity and saved labor costs. However, driving heavy tractors on the soil can increase soil erosion and reduce crop yields. To reduce damage to soil fertility, multiple light tractors could be used instead of a single heavy tractor for field operations. However, multiple tractors require multiple operators, which increases labor costs. In order to solve the above problems, this paper proposes an optimal coverage path planning algorithm based on probabilistic roadmaps. Firstly, three light tractors are formed into a reverse-v formation, which not only reduces the damage to soil fertility, but also ensures the working efficiency. In addition, the algorithm can be applied to a wide range of scenarios, including convex region, concave region, region with obstacles and region without obstacles. In addition, the coverage time is relatively small, the coverage can reach 98% at the minimum, and the repetition rate is no more than 2% at the maximum.

[#54] Fuzzy path planning of unmanned underwater vehicle based on adaptive fireworks algorithm optimization

Y. Ma and Z.Y.Mao, School of Marine Science and Technology, Northwestern Polytechnical University

Aiming at the typical problem of unmanned underwater vehicle (UAV) path planning, this paper proposes a fuzzy optimization algorithm based on adaptive fireworks. Firstly, the track performance index with a multi-objective fuzzy optimization strategy based on energy consumption and buoy threat was established. Then, the adaptive fireworks search algorithm was used for track planning. Finally, three groups of simulation and comparison experiments with different levels of complex environment were carried out. The results showed that the fuzzy optimization algorithm based on adaptive fireworks can effectively solve the multi-objective fuzzy optimization problem. The method proposed in this paper provided a useful reference for unmanned underwater vehicle path planning.

[#56] Position Tracking for Continuum Robots with Joint Limit Constraints

Dengliang Lin, Xin Dong, Chenguang Yang*

This paper presents a novel tip-following approach for real-time position tracking and avoiding obstacle of continuum robots with joint limit constraints. This type of hyperredundant robot, which is more flexible and compliant to explore in complex and constrained environments, such as in pipeline or narrow entrance. However, traditional method based on inverse kinematic model is difficult to control the end-effector of continuum robot to avoid obstacles in the constrained circumstance. Therefore a new tip-following method based on forward kinematic model is proposed to control the robot and make it inspect the environment. For the method, we use nonlinear programming approach to solve the optimization problem, which is used to find minimum of constrained nonlinear objective function to ensure that the end-effector of the robot follow the desired position with minimal error. In this paper, we employ a 24 DoF continuum robot with continuous backbone and compliant joint to the simulation, and it is testified that the proposed approach can ensure joint limit avoidance, track the end position in real time and minimize the tracking errors.

[#02] Self-Compensation Method of Constant Drift Error of Gyroscope

Jianqiang Zheng and Qinghua Ma

Department of guidance and control technology Xi'an Modern Control Technology Research Institute Xi'an, China

To solve the problem of gyroscope constant drift divergence in strapdown inertial navigation system, a self-compensation method using missile rotation to adjust is proposed. The constant drift of gyroscope can be modulated into periodic signal by spin modulation of missile body without special rotating mechanism. The influence of constant drift can be effectively eliminated by integral operation. The simulation results show that the method can effectively suppress the error growth, improve the navigation accuracy of SINS, and has good adaptability to the change of missile rotation speed.

[#06] Research on autonomous obstacle avoidance module of walking-swimming submersible

Weidong Liu and Wei Sun, School of Marine Science and Technology Northwestern Polytechnical University Xi'an, China

This paper first introduces the basic principle of sonar detection. Considering that the method error of judging

obstacles directly based on sonar data is large, the sonar data is first generated, then the image is processed by digital image processing, and the pool experiment is carried out. Verify it. Then the left-shift priority obstacle avoidance strategy is proposed, and the specific flow chart of this strategy is given. Finally, the obstacle avoidance strategy is simulated on the platform below MATLAB. The results of the pool experiment show that the obstacle avoidance sonar can detect the position of the underwater obstacle more accurately. The simulation results show that the obstacle avoidance algorithm can guide the submersible to avoid obstacles and move along the established plan.

[#29] Neural Network Control Using Composite Learning for USVs with Output Error Constraints

Puyong Xu, Chenguang Yang*, Shi-Lu Dai and Zhaoyong Mao

This paper proposes a trajectory tracking control scheme for unmanned surface vessel (USV) considering uncertain dynamics and output error constraints. Firstly, a tan-type barrier Lyapunov function (BLF) has been employed to constrain the output error. Secondly, we use radial basis function neural network (RBF NN) to approximate the uncertain dynamics. Considering that the estimated parameters convergence can not be achieved in the absence of persistent excitation (PE) conditions, the composite learning update law of the weight matrix in the NN is adopted to guarantee the parameters convergence under interval excitation (IE) conditions which is easier to reach. In simulation studies, it is proven that the USV can track the reference trajectory with small tracking error and the parameters convergence can be ensured.

[#18] Single Image Super-Resolution Based on Self-Attention

Lujie Zong and Lianna Chen, China Jiliang University Hangzhou, China

Single image super-resolution (SISR) is a challenging task and has collected extensive attention in both academia and industry. The most challenging problem in super resolution is how to recover the finer texture details. And we find the generated images usually have low-scale contrast. In this paper, we present a novel super-resolution method based on generative adversarial networks (GAN). Our model is based on SRGAN, instead, we remove most of the batch normalization layers in generator to get higher-scale contrast images and accelerate training speed. Because batch normalization layers can get rid of range flexibility from networks, this causes the generated images have lower-scale contrast compared to the origin images. We also add the self-attention module into generator to get more global dependencies when convolution operations can capture enough local dependencies but little global dependencies. We take advantage of both local dependencies and global dependencies to improve super-resolved texture details and structural, we call our model SASRGAN. The images generated by our model have higher Structural Similarity Index Measure (SSIM), it proves that our model has available performance.

[#19] A PID based approximation-free controller with prescribed performance function for model helicopter attitude control

Bin Zhu and Ruisheng Sun, School of Energy and Power Engineering Nanjing University of Science and Technology Nanjing, China

In this paper, a prescribed performance function (PPF) is combined with the PID control, and a novel control scheme

for helicopter attitude control is proposed, which is subject to the nonlinear dynamics and external disturbances. The proposed control scheme is based on classical PID control and retains the advantages of simple algorithm of PID control. At the same time, by introducing the preset performance function, we can design the transient process of control more accurately. Therefore, our controller can not only satisfy the required performance constraints, but also have a simple parameter tuning process. The complex function approximation or modeling accurately which are widely used in nonlinear control at present is not necessary. The proposed control scheme is a simple and effective function approximation-free nonlinear controller, which effectively reduces the complexity of control system design on the premise of guaranteeing performance. Finally, the simulation results show the effectiveness of the designed control system.

Session SaO I-B: 15:50-18:10

[#64] Optimal Path Planning Based On Hybrid GeneticCuckoo Search Algorithm

Junrui Wang,Xiang Shang,Ten Guo,Jinchao Zhou,Sining Jia and Chuang Wang, North Minzu Univesity

Three-dimensional path planning is one of the most important factor to decide the efficiency of the space robot moving. early research through mathematical modeling got some mathematical model to solve this problem. However, With different scenarios of the constraints on the robot path gradually increased. Intelligent algorithm which has global optimization increased advantages and ability to deal with multiple constraints has gradually become the mainstream. In this paper, a hybrid intelligent algorithm —Hybrid Geneticcuckoo search algorithm is proposed, which can take into account the actual size of the robot and the strong global search ability of the genetic algorithm as the premise, and combine with the adaptive cuckoo algorithm to enhance the local search ability of the algorithm in the later stage, so as to improve the practicability of the intelligent algorithm. Simulation results show that the proposed algorithm can avoid obstacles reasonably in multi-constrained 3D environment, and the result is better than the single intelligent optimization algorithm.

[#67] Reliability Allocation Method for Unmanned Underwater System Based on Intuitionistic Fuzzy

Xiangyao Meng, Naval research academy

This paper is devoted to the reliability allocation problem for the Underwater Unmanned System taking into account of the uncertainty. To reduce the error introduced by the real number processing and thus unavoidable neglecton of certain fuzzy information as in the existing allocation methods, a reliable allocation method is proposed based on intuitionistic fuzzy set, AHP and fuzzy comprehensive evaluation. By utilizing the knowledge and experience of experts and relevant data, the proposed approach can efficiently solve the uncertainty problem in the allocation of Underwater Unmanned System in the preliminary design process

[#68] Infrared target detecting in severe jamming using detector based on Deep Learning

Yangguang Hu, Mingqing Xiao and Zhaozheng Liu, Air Force Engineering University

**Jiaojiao Meng , Northwestern Polytechnical University
Mingjian Kuang , Unit of 95156**

In recent years, detection algorithms based on deep learning have made great progress. It also provided a new solution to solve the issue to detecting the target in severe jamming. In this paper, the application of deep detectors in infrared target detecting was explored. Experimental results show that YOLOv3 outperformed Faster R-CNN in the aerial target tracking based on infrared images. The target detection algorithm in the field of artificial intelligence has good applicability in the field of infrared target detection.

[#69] Time Registration Algorithm Based on MultiMissiles Cooperative Target Detection

Xinliang Wang , Kai Chen, Mingang Wang and Qiqi Xue, Northwestern Polytechnical University

Aiming at the problems of time delay of fusion center in multi-missile cooperative target detection system due to the different starting time of sensor measurement of each missile, a time registration algorithm based on modified gain extended Kalman filter (MGEKF) is introduced. In this algorithm, the extended Kalman filter (EKF) is improved to carry out high-precision unbiased estimation of the target motion state, which is used for time compensation of the target motion state estimation of the missiles, and data fusion is conducted from the estimation registration of the missiles motion state to the fusion moment. The simulation results show that the algorithm can effectively reduce the system time registration error, improve the system time registration accuracy, and provide a good foundation for data fusion.

[#70] A Summary of the Development of Cooperative and Intelligent Technology for Multi-UA V Systems

Huan Zhou and Jingguang Yang, Air Force Engineering University

Qian Su, Wenxing Fu and Meiyun Zheng , Northwest Polytechnical University

Cheng Xu, Science and Technology on Complex System Control and Intelligent Agent Cooperation Laboratory

In the process of formation cooperative autonomous flight and mission execution, multi-UAV systems have the characteristics of large disturbance, strong coupling of multi variables, high degree of uncertainty and complex cooperative factors, so there are many difficulties in the design of cooperative and intelligent control system. How to effectively develop the cooperative and intelligent technology of multiUAV systems has become an urgent problem in the field of unmanned system and artificial intelligence. This paper first introduces the key technologies involved in UAV system at present, and then analyzes the challenges faced by the development of UAV system. Finally, it focuses on the development trend of multi-UAV systems cooperation and intelligent technology in the future. The research results have strong theoretical guidance significance for the cooperation and intelligent development of multi-UAV systems in China.

[#37] Vision-based UA V Obstacle Avoidance Algorithm on the Embedded Platform

Xupeí Zhang, Zhong Ma, Zhanzhuang He and Zhuping Wang, Xi'an Microelectronic Technology Institute

Due to the limited budget for power and memory consumption on the mobile/IoT platforms make deep learning algorithm hard to get the ideal efficiency and accuracy on the obstacle detection and avoidance for unmanned aerial vehicle (UAV) with monocular version. To

resolve this, we design a learning based virtual odometry method and combine it with a quantization scheme which can be added into the training framework. During the obstacle detection networks training process it will reduce the accuracy loss on the original models caused by the quantization. By evaluating the feature detection and matching we used in the avoidance detection on MSCOCO dataset, our method can archive 8-bit inference accuracy loss less than 3%, almost close to the float pipeline.

[#48] Effects of Uneven Asymmetric Ice Accretion on Aircraft Flight

Yupeng Feng , Shiyu Liu, Yandong Cai, Ning Liu, Xiang Huang and Pei Hu, Chengdu Aircraft Industrial (Group)

The ice accretion of airplane has influence on its performance, stability ability, and dynamical response, which is also the main reason that contributes to the aviation accidents. Additionally, the uneven asymmetric ice accretion of airplane is the most dangerous one in condition of ice accretion. To find out the aircraft dynamic response and effects of flight safety in condition of uneven asymmetric ice accretion, the dynamic model, based on the 6-degree-of-freedom dynamics equation, considering the uneven asymmetric ice accretion is established to study the effect of the stability region. Moreover, compared to the change of the stability region under ice-free and evenly iced model, the influence of uneven icing on both the stability region and dynamic response characteristics of the aircraft is analyzed. Together with an exact icing severity calculation model, the asymmetric icing effect model is adopted to study the dynamic response characteristics, which is caused by asymmetric icing under different icing severities. The results of simulation demonstrate that: (1) To compared to both ice-free and even ice model, uneven icing aircraft affect the rolling and yawing moment more severity and then the stability and handling quality is reduced significantly. (2) Various dynamical response is produced by various icing severities. With the icing severities increasing by, both the aircraft control ability and aerodynamic performance are reduced badly and the values of trim aileron and rudder are becoming big.

[#27] An Integral Evasion and Pursuit Guidance Strategy for an Unpowered Air-to-Ground Vehicle in Descending Phase

Hang Guo, Wenxing Fu, Kang Chen and Jie Yan, Northwestern Polytechnical University

During the descending phase, an unpowered air-to-ground vehicle should accomplish an integral mission, which requires it to evade from a defender and then to attack a target with high precision. On the basis of appropriate hypothesis, the mathematical model of Target-Attacker-Defender (TAD) engagement scenario is established. Then, control saturation, terminal angle constraints on states and velocity are introduced under practical circumstances. Next, the three-dimensional problem is divided into vertical plane and horizontal plane. In vertical plane, a combined guidance strategy with programmed trajectory tracking and trajectory shaping guidance is put forward. The strategy balances the loss of velocity, terminal angle constraint and homing precision. And in horizontal plane, a novel integral guidance law synthesizing evasion and pursuit with specific miss distance is proposed. Eventually, the guidance strategies in two planes are integrated to the original threedimensional problem. By numerical simulation, the optimal starting point of descending phase is obtained. Consequently, the integral guidance strategy can guarantee the vehicle to evade from the defender with a miss distance larger than 5m and to intercept

the target with the precision less than 1m. In addition, the terminal flight path angle approaches to -70 degree while the landing velocity is larger than 2Ma.

[#71] Distributed Coordination of Heterogeneous Multi-Agent Systems with Output feedback Control

Shixun Xiong, Qingxian Wu and Yuhui Wang, Nanjing University of Aeronautics and Astronautics

This paper investigates a heterogeneous multi-agent system consensus control problem under the leader-follower formation. The state dimensions of multi-agent systems (MASs) are diverse, which makes it difficult to analyze and design the controller for the multi-agent formation consistency problem. Therefore, an output feedback control scheme is designed for MAS consensus, which can guarantee the output convergence with the tracking the trajectory of a leader for each follower. First, a discrete-time model of the leader-follower system is established. Then, an output feedback controller is provided with formation topology to ensure the formation consensus of the heterogeneous MAS. Finally, simulation results are given to verify the designed control strategies..

[#72] A Study on The Modified Proportional Guidance of LOS Angle Acceleration

Xingan Li, Wenxing Fu, Meiyun Zheng and Xiaofei Chang, Northwestern Polytechnical University

Cheng Xu, Science and Technology on Complex System Control and Intelligent Agent Cooperation Laboratory

Di Zhang, Shanghai Academy of Spaceflight Technology

Because of the increasing mobility of air targets and the trend of heavy using of UAV in the future, the paper analyzes the parameters and ballistic characteristics of the proportional guidance method based on the revised idea of proportional guidance. The method has certain defects in the face of high maneuvering targets, so we have derived a kind of modified proportional guidance law, and designed a new modified proportional guidance law which can effectively overcome the target maneuvering interference. The digital simulation results show that the modified guidance law can effectively overcome the interference factors such as target maneuvering, and it is easy to implement in engineering

[#73] Hybrid guidance for Common Aero Vehicle equilibrium glide reentry with multi-constraints

Yang Ren , Jingguang Yang and Wei Xiong , Air Force Engineering University

Aimed at the multi-objective guidance of the Common Aero Vehicle reentry, a hybrid guidance method was put forward which combined Standard trajectory guidance with predictor-corrector guidance. Analysis was done about the selection of guidance mode switching point. Standard trajectory guidance law was designed based on the fuzzy sliding mode control by the simplification of longitudinal kinematical equation. The longitudinal guidance law combined fuzzy approximation with state feedback was put forward, and the lateral guidance logic based on the horizontal parameters borders was designed at the same time. Considering the characteristics of predictor-corrector guidance based on energy, the longitudinal and lateral guidance law of the later period was designed with the adjustment of power angle. Simulation results improved the effectiveness of this scheme which could reach higher accuracy in a relatively short time and had a good real-time performance and adaptability also.

[#10] Application of Shielding Coils in Efficiency Optimization for Underwater Wireless Power Transmission Systems

Yushan Wang , Zhaoyong Mao and Kehan Zhang, Northwestern Polytechnical University

Underwater base and wireless power transfer (WPT) technology can enhance the endurance of the autonomous underwater vehicles(AUV). WPT that based on electromagnetic theory will bring eddy current loss(ECL) in seawater and decreases efficiency. In this paper, we introduce a method that making use of shielding coils to weaken the electromagnetic field(EMF) in loss medium to improve transmission efficiency. Simplified circuit models are proposed to give an intuitive and comprehensive analysis of transfer efficiency and finite element analysis(FEA) is used to simulate the distribution of the EMF. By comparing the power transfer efficiency of the underwater WPT systems with and without shielding coils, we learn that systems with shielding coils perform better when the work frequency is relatively high and their maximum efficiency is higher than the systems without shielding coils. The results show that shielding coils can be used in underwater WPT systems to improve power transmission efficiency.

[#24] Design and Analysis of Permanent Magnet Generator for unmanned V ehicles

Yan'an Zhang, Zhe Xin , Mingxi Shao, Houfu Yang and Qiubo Jiang, China Agricultural University

With the development of artificial intelligence and driverless technology, the requirements for unmanned vehicle permanent magnet generators are gradually increasing. The unmanned vehicle permanent magnet generator has the characteristics of high power density, high capacity and high reliability. With the industrial production of rare earth permanent magnet materials, the cost is reduced; the corresponding innovation of power electronic devices and the rapid development of manufacturing technology The technical level of rare earth permanent magnet generators for unmanned vehicles is more mature. In this paper, a built-in double-radial NdFeB permanent magnet generator for unmanned vehicles is designed. The main structural parameters are calculated and verified by finite element simulation. The results show that it is normal radial structure. Compared with the generator, the built-in dual-radial NdFeB permanent magnet generator has a more reasonable magnetic density distribution and a smaller permanent magnet volume, which verifies the feasibility of the design.

[#38] Pipeline Image Dehazing Algorithm Based on Atmospheric Scattering Model and Multi-Scale Retinex Strategy

Tan He, Ce Li, Ruili Liu, Xiao Wang and Longshuai Sheng, China University of Mining & Technology

Pipeline defect detection is very important application of pipeline robots for the security of underground drainage pipeline facilities. The detection performance of existing methods is closely related to the image definition in the complex pipeline environment in terms of darkness, water fog, haze, etc. In this work, we proposed a dehazing algorithm based on the optimized contrast enhancement. The proposed algorithm first selects the atmospheric light in a hazy image using the quad-tree based subdivision. Then, the proposed algorithm determines transmission values, which are adaptive to scene depths, to increase the contrast of the restored image. To overcome the issue of low image contrast, we incorporated the information loss cost into the optimized transmission computation. In addition, we use multi-scale

Retinex strategy as color restoration algorithm to enhance the improved dark primary color method to further improve the image clarity. The experimental results show that the algorithm has a good effect on the pipe image dehazing, especially for the larger reflection area. In the future, the algorithm will be applied to pipeline robots to ensure the normal operation of underground pipelines.

Sunday, November 17, 2019

Session SuO II: 8:30-12:40

Address: Xianyun Banquet Hall
(贤云厅)

Session SuO II-A: 8:30-10:00

[#7] A Tractor Formation Coverage Path Planning Method Based on Rotating Calipers and Probabilistic Roadmaps Algorithm

Yi Cao, Yu Han, Jian Chen*, Xuzan Liu, Zichao Zhang, Kai Zhang, China Agricultural University

Severe labor shortages and rising daily wages are forcing farmers to use heavy tractors to sow seeds, which increases efficiency and saves labor costs. But driving heavy tractors on soil for growing plants causes permanent damage to the soil, leading to crop failures. In order to reduce the damage to soil fertility, a formation of several light tractors can replace a single heavy tractor for field operations. However, multiple tractors require multiple operators, which adds to labor costs. In order to solve the above problems, this paper presents an algorithm for coverage path planning of tractors formation based on the Rotating Calipers and Probabilistic Roadmaps. First, the algorithm uses five light tractors to form a reverse “V” formation, which not only reduces damage to soil fertility, but also ensures operational efficiency. In addition, this algorithm can achieve autonomous path coverage and obtain time-optimal coverage trajectory, which lays a foundation for realizing autonomous operation of tractors and reduces labor cost. And this method can be used to coverage path planning of both convex and concave polygons.

[#9] A Coverage Path Planning Method Based on Multiple Solar Powered Unmanned Aerial Vehicles
Nannan Du, Zichao Zhang, Jian Chen*, Xuzan Liu, Kai Zhang, Ben Ma, China Agricultural University

This paper proposes a solution to solve the coverage path planning (CPP) problem of multi-solar unmanned aerial vehicles (UAVs), and the research content of this paper is as follows. First, the energy production model and consumption model of the solar UAV are established, and according to this model, the flying speed of the solar UAV are determined. Besides, the energy flow efficiency is defined to evaluate the energy utilization efficiency of this operation. After that, transform the CPP problem into vehicle routing problem (VRP), and a mixed integer linear programming (MILP) model is established to determine the flight path of each UAV with the objective of minimizing operation time. In this method, the solar UAV is used for CPP, which solves the problem of short flight time of traditional UAV. Operation time is used as the objective function to solve the CPP, so that the task can be completed as soon as possible. And the calculation of energy flow efficiency can be used to evaluate the operation efficiency of solar UAV.

[#12] Review of Agricultural Product Classification Based on Computer Vision

Bingshan Niu, Zhenbo Li, China Agricultural University

Computer vision technology has made great progress in practice in recent years, and it also has broad application prospects in agricultural product classification. China is a big

agricultural country, therefore, the classification of agricultural products has always been an important topic for researchers. However, there are some limitations in time cost, money cost, convenience and accuracy in the current agricultural product classification process. Currently, there is no comparison and analysis of these methods and devices in a framework. Therefore, this paper introduces agricultural product grading method based computer vision in detail, with data types, data sources, data preprocessing methods, grading methods, grading equipment, grading evaluation indicators, and overall performance. According to two image sources including RGB image and hyperspectral image, this paper divides the existing research methods into two types and points out the applicable scenarios of the classification methods. The purpose of this paper is to review the development status of existing methods of agricultural product grading based on computer vision, existing problems, future research directions, and the establishment of a unified framework including grading methods and grading equipment.

[#14] Design and study of proportional control valve for electro-hydraulic lifter of unmanned hill tractor

Mingxi Shao, Zhe Xin, Yan'an Zhang, China Agricultural University

Electro-hydraulic lifters are used as key components for hanging and lowering agricultural implements on unmanned hill tractors. They play an important role in unmanned hill tractor plowing operations. The lifter control valve is the core control unit of the electrohydraulic lifter. It affects the working level and efficiency of the unmanned hill tractor unit. In this study, a closed-loop load sensing hydraulic system circuit of an electro-hydraulic lifter proportional control valve was designed. Based on the functional requirements of proportional control valves during plowing operations of the unmanned hill tractor, a threaded cartridge valve was analyzed and selected using a plate type valve. The valve block design idea was used to complete the overall layout and hole arrangement of the threaded cartridge valve, and a three-dimensional model of the proportional control valve was established using SolidWorks. The pressure loss analysis of the proportional control valve was carried out using computational fluid dynamics (CFD). The results showed that the pressure loss of the proportional control valve met the requirements for use.

[#16] Application of PBSID and Structured H_{∞} Methods in Unmanned Helicopter System Identification

Meiliwen Wu, Marco Lovera, Politecnico di Milano
Ming Chen, Beihang University

In this work, the problem of model identification for an unmanned agriculture helicopter is considered. Two model identification methods, a time-domain subspace method and a combined method are evaluated. The identified results are compared in detail in terms of time-domain simulations and in frequency response analyses. Results show that both methods can predict the time-domain and frequency-domain responses in good agreement with the original data. The combined method is reliable in extracting structured dynamics model.

[#20] Multi-spectral Image Fusion Method for Identifying Similar-colored Tomato Organs

Qingchun Feng, Beijing Academy of Agriculture and Forestry Sciences

Jian Chen, China Agricultural University

Xinxu Li, Beijing Agricultural Technology Extension Station

Cuillin Li, Beijing Research Center of Intelligent Equipment for Agriculture
Xiu Wang, National Research Center of Intelligent Equipment for Agriculture

Aiming at robotic cultivation for greenhouse tomato, the multi-spectral image fusion method was researched, so as to enhance the image brightness difference between tomato's similar-colored organ, such as stem, leaf and green fruit, and simplify visual identification on them. According to the 300nm-1000nm spectral characteristics of the three kinds of organs, the Lasso penalty function was adopted to obtain the parameters of the functional logistic regression model for classifying the organ's spectral data, and the wavelengths of 450nm, 600nm and 900nm with the non-zero coefficients were selected as the optimal imaging wavelengths. A weight-fusion model on the multi-spectral images was proposed, and the fusion coefficients was estimated, through solve the problem to maximize the target-background difference and minimize the background-background difference based on NSGA- II algorithm. A result showed, the fusion results for recognizing the three organs all could enhance the brightness difference with the other background organs, and the ratios of image gray value SAD between the target-background and backgroundbackground organs in the fused images for fruit, leaf and stem respectively were 7.89, 13.56 and 2.06 times of the ratios in original images. The research was supposed to improve the identification on similar-colored plant organs under agricultural condition.

[#49] Multi-bit Upset Mitigation with Double Matrix Codes in Memories for Space Applications

Fei Zhang, Jie Yan, Lixue Ma, Yan Li, and Wu Gao, Northwestern Polytechnical University

As transistor size shrinks due to CMOS scaling (namely the node is 65 nm or less), multi-bit upset (MBU) becomes an increasingly important problem. The mostly adopted error-detection-and-correction codes, including the parity code, the Hamming code and the matrix code have the limitation of bit numbers of detection and correction. An emergent technique is required to deal with the cases of more than two-bit upset errors. In this paper, we propose a double matrix code to address this issue. The double matrix code, which is implemented by two-dimensional matrix codes and logic interleaving, is taken one step further for the sake of the enhancement of the correction capability of memories. The encoding-and-decoding procedure is described in detail. The results of fault-injection experiments and the discussion are also given. The tested results show that the proposed scheme can improve the reliability of memories. Meanwhile, the proposed scheme can obtain the best results of the mean-time-to-failure (MTTF). The cost of the proposed technique is less than traditional methods, while the fault coverage is approximately equal to the complex Bose-Chaudhuri-Hocquenghem (BCH) codes. Thus, the proposed scheme can be applied into radiation hardness of general SRAMs for space applications.

[#58] Research on Laser Jamming Model of Infrared Imaging System

Hao Liu, Kai Zhang, Northwestern Polytechnical University
Xiaoshuang Jiao, Academy of Space Information System
Guoliang Chen, Jiayi Wei, Jie Yan, Northwestern Polytechnical University

With the application of laser jamming technology in the field of infrared imaging guidance weapons, the research on laser

jamming performance and anti-jamming technology are paid more and more attention, and they are related to laser jamming model research closely. In order to construct a high confidence laser jamming model. Firstly, we analyzed the physical model of the laser jamming and the characteristics of full link transmission, and established a theoretical model of laser jamming. At the same time, we analyzed the influence law of different wavelength lasers in atmospheric transmission and the variation law of irradiance of different divergence angles with distance. Finally, by comparing the results of laser irradiation infrared camera experiment and digital simulation, we verified the coherence between the laser jamming model and the laser jamming image generated by experiment.

[#11] Automatic dairy cow body condition scoring using depth images and 3D surface fitting

Wen-Yong Li, National Engineering Research Center for Information Technology in Agriculture
Yang Shen, Du-Jin Wang, Tianjin University of Science & Technology
Zhan-Kui Yang, Beijing University of Technology
Xin-Ting Yang, National Engineering Research Center for Information Technology in Agriculture

Automatic and objective dairy cow body condition scoring has received considerable attention as a tool to aid in the management of nutritional programs in dairy herds. This paper presents a 3-dimensional algorithm that provides a topographical understanding of the cow's body to estimate BCS. The hypothesis tested was that the body shape of a fatter cow is rounder than that of a thin cow and, therefore, may better fit a paraboloid surface. Image processing and regression algorithms were developed and included the following steps: (1) object recognition and separation, identification and separation of the cows; (2) image surface fitting; and (3) parameters determination in BCS model. All steps were performed automatically, including image acquisition and model training. The novelty in this study compared to the previous ones was completing the full-automation of the system. The model was implemented and its outputs were validated against manual body condition scoring (BCS). Pearson correlation between the proposed BCS and the manual BCS was 0.84 for the test data set.

Session SuO II-B: 10:20-12:40

[#42] The Study For Path Following of Robot Fish Based on ADRC

Ze-peng Gao and Xiao-ru Song, School of Electronic and Information Engineering

The multi-joint robot fish is often subject to unknown external and internal disturbances during path following in water areas. In this paper, a path following control method based on active disturbance rejection control (ADRC) is proposed for obtaining high-quality tracking effect. Combining the kinematics and dynamics equations of the three-joint robot fish, the model of error for path following is established in the Serret-Frenet coordinate system by setting the virtual mobile robot. Based on the introduction of expectation angle, the guidance of forwarding and steering control law are designed respectively. Then the second-order path following controller based on ADRC is established to improve the robustness and rapidity of the robot fish in the path following. For the control of such systems, a disturbance observer and related techniques have provided a powerful tool to dynamically estimate and compensated the diverse

disturbances and offered desired control performances. The experiment shows that the method proposed in this paper enables the robot fish to follow the given path at around 3s, and the error of position maintained at positive or negative 0.1m. Compared with the conventional PID control method, the results show that path following controller based the ADRC can restrain overshoot very well and follow the given path quickly, resulting in an improvement of path tracking time and accuracy.

[#45] The variable anchor box region proposal network based on confidence non-maximum suppression
Chenghao Li and Le Ru, Aeronautics Engineering Institute Air Force Engineering University

The traditional target detection algorithm based on manual features has achieved good results in the past time, but the computation amount and running speed of the algorithm are not satisfactory. At present, the algorithm based on deep convolutional neural network has become the first choice and widely used. In this paper, attention guidance module is introduced in the detection based on the deep convolutional neural network, which guides the anchor box of region proposal network (RPN), making the selection of anchor box shape and size more effective. At the same time, a confidence factor non- maximum suppression (NMS) method is proposed to solve the problem of false detection and missed detection in the traditional post-processing, which makes a great contribution to the overall performance of the model. In the experiment, we found that our method has good detection performance in both RPN variants and existing advanced algorithms.

[#50] The Evaluation of Infrared Image Features Based on Modified RELIEF Algorithms

Xitao Zhang, Lin Yan, Xiaodong Bai, Heng Zhou
Luoyang Opto-Electro Technology Development Center, Luoyang , China

The infrared image features are the basis of the automatic target recognition (ATR) algorithm for seeker in the countermeasure environment. The complication of the IR countermeasure environment will inevitably lead to the constantly appearance of the new features and the features' combinations while lack of the importance evaluation of the new features. Aiming at this problem, this paper proposes a method of performance evaluation of infrared image features based on RELIEF algorithm. Firstly, the feature set is summed up by the analysis of the common ATR algorithms. Secondly, the feature space is formed by removing the redundant features using the method of information theory. In addition, the importance of the features is evaluated by the modified RELIEF algorithm. The experimental results show that this paper's algorithm is an effective performance evaluation metric for image features. It has certain theoretical and applicable values.

[#53]Research on Intelligent Target Detection and Coderdecoder Technology Based on Embedded Platform

Xiaodong Zhao and Xunying Zhang, Unmanned System Research Institute Northwestern Polytechnical University Xi'an, China

In order to meet the embedded application requirements of machine learning algorithm, the intelligent target detection and recognition algorithm based on convolutional neural network and corresponding optimal process are studied. Detailed network structure analysis and network performance analysis are carried out. Based on GPU embedded platform, TensorRT technology is used to accelerate the embedded application of intelligent target detection and recognition

algorithm, including fp16 and int8 inference modes. Satisfactory verification results are achieved on embedded platform. In addition, an integrated system of real-time machine learning and H.265 encoding and decoding technology is realized. Firstly, the compressed image data sent by the camera is received by embedded platform and decoded in real time in H.265 format. Then the real-time intelligent target detection and recognition algorithm basing on TensorRT technology is done for RGB data obtained by hardware decoding process. Finally, the data is compressed in H.265 format, and subsequently storage and data transmission are carried out. The experimental results show that TensorRT technology can improve the inference speed of neural network in embedded platform. The network structure optimized by TensorRT technology can achieve three times the speed increase, with limited accuracy loss. Hardware coding and decoding of H.265 can also cause corresponding delay to program inevitably.

[#57] Cascade LADRC for Hypersonic Vehicle with Rigid-Aeroservoelasticity-Sloshing Coupling
Wenhui Ma and Kang Chen, School of Automation Northwestern Polytechnical University

In this paper, active disturbance rejection control technique is presented for the rigid-aeroservoelasticity (ASE) sloshing hypersonic vehicle model subject to uncertainties and external disturbance. The statically unstable hypersonic vehicle model outlined here takes into accounts the interactions between liquid sloshing and flexible structure of aircraft. In order to overcome the high nonlinearity, strong coupling and uncertain factors, cascade linear active disturbance rejection controller (LADRC) is utilized to estimate and eliminate internal uncertainty and exogenous disturbances. Finally, simulation results show that the effectiveness of the proposed controller which is validated by the nonlinear model and the proposed method exhibits promising robustness to mismatched uncertainties.

[#04] Super-Resolution Reconstruction Method for Single Space Object Image based on Optimized Convolution Neural Network

Xubin Feng and XinQin Su, University of Chinese Academy of Sciences2 China

Hitherto, a large number of platforms are sent to the outer space. People pay much more attention to the space object images. But high quality space images are difficult to be obtained. One of the most important reasons is the sensor technology is not good enough. Inspired by a typical deep CNN based super-resolution reconstruction method, a single space object image deep CNN-based super-resolution reconstruction method is proposed in this article. This method uses Nesterov Accelerated Gradient method to train the network. The experimental results demonstrate the feasibility of our proposed method in reconstructing high resolution space object images.

[#05] Effects of Rain fall Intensity on Run off and Sediment Yield in Black Soil Slope

HongtaoLiu and Qiqi Li, College of Water and Environmental Engineering Changchun Institute of Technology Changchun, China

Soil erosion in the black soil region of Northeast China are extremely severe, leading to harmful effects on the safety of local embankment slope. In this paper, the characteristics of sediment yield on slopes under different rainfall intensities (30, 50, and 70 mm/h) are studied through rainfall simulation test. The results show that the runoff yield time decreases with the increase of rainfall intensity, and the runoff and sediment yield fluctuate more significantly. The variation of

the sediment yield with rainfall duration can be described by a power function. The erosion morphology of slope is mainly characterized by splash and sheet erosion. The area with severe erosion is 0.158 m², accounting for 26.3 % of the slope area. Generally speaking, with the increase of rainfall intensity, the disturbance effect on runoff and sediment yield is enhanced, and the degree of erosion damage on slope is increased.

[#25] Graph theory based scheme design synthesis for tractor fixed shaft gearbox

Shenghui Fu and Liang Wang, College of Engineering China Agricultural University Beijing, China

The traditional transmission scheme design of tractor fixed shaft gearbox mainly depends on the trial-and-error method, the design experience and the inspiration of designers, which usually lead to many problems such as low design efficiency, serious motion interference and easy to lose the better design etc. and could not meet the innovative design requirement of gearbox for multi-shift, systematization and intellectualization. Therefore, a graphic theory-based design method for transmission scheme of fixed-axle gearbox was proposed. Based on graph theory and gearbox design principle, the type synthesis and number synthesis of gearbox transmission schemes were realized, and the transmission path analysis of the optimal transmission scheme was done with the depth-first search algorithm. Finally, the example design results show that the transmission scheme design of fixed shaft gearbox based on graph theory could effectively reduce the design difficulty, avoid missing the optimal transmission schemes, and provide some theoretical support for the innovative design and intelligent design of tractor gearbox transmission scheme.

[#35] Automatic Drainage Pipeline Defect Detection Method Using Handcrafted and Network Features

Xinyu Shang and Ce Li, School of Mechanical Electronic & Information Engineering China University of Mining & Technology, Beijing Beijing, China

Effective maintenance of urban drainage pipeline networks is critical to the healthy development of cities. Routine CCTV surveys are costly, time-consuming and rely on technicians. In this paper, we propose a method to detect pipeline defects automatically, which can improve the efficiency of pipeline maintenance and save cost and reduce dependence on technicians. We use image restoration method to remove the interference of ropes in the pipeline image, before using Canny edge detection operator to extract the texture information of the defects. Then look for contours regionally to identify suspected defect areas. We combine the hybrid LBP handcrafted and VGG network features of suspected defect areas and use SVM classifier to predict pipeline defects. This method is more than 90% accurate on the test set. Furthermore, the high efficiency of this method enables it to compete with the performance of trained technicians. In general, this method of automatically detection pipeline defects provides a new option for the Urban Drainage Group and has a good development prospect.

[#55] Attitude tracking control of E-sail in Earth-Mars transfer using feedback linearization and sliding mode control

Xin Shi and Mingyin Huo

For the attitude tracking control of E-sail-based spacecraft in Earth-Mars transfer, a hybrid control method is proposed to handle the strong nonlinearity, coupling and uncertainty in the dynamics of E-sail. The attitude channel of E-sail was coupled into two SISO linear systems by the means of feedback-linearization.

[#33] A 3D Modeling Algorithm of Ground Crop Based on Light Multi-rotor UAV Lidar Remote Sensing Data

Hao Meng and Guangqi Wang, College of Engineering China Agricultural University Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment Beijing, China

With the rapid development of remote sensor data acquisition technology, more and more remote sensors will be applied to the agricultural sector. Aiming at the need of establishing accurate 3D (three-dimensional) crop model in the field of agricultural mapping and remote sensing. Firstly, an airborne lidar remote sensing system was built in this paper, including Lidar, GPS (Global Position System)/IMU (Inertial Measurement Unit), and tablet PC. This system uses a light multi-rotor UAV (unmanned aerial vehicle) as a carrier to perform remote sensing operations on ground crops. At the same time, it can obtain point cloud data of ground crops and measure the attitude angle and latitude and longitude of the UAV in real time. Then, a method for establishing a three dimensional model of ground crops was proposed. The noise data of the point cloud data of the target area is removed by the mathematical form filtering method. Finally, MATLAB was used to linearly interpolate point cloud data and successfully establish a three-dimensional digital model of the target ground crops Anemone and Sedum Spectabile Boreau. The height error of the three-dimensional digital model of the above two ground crops is 7.3% and 8.6%.

[#34] Timing-based Sensor Fusion Mapping Method for Indoor Remote Surveying Robot

Nannan Du and Zichao Zhang, College of Engineering China Agricultural University Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment Beijing, China

For large indoor environments including protected agriculture or controlled environmental agriculture, it is inefficient to carry out indoor mapping by manpower. This paper proposes a surveying and mapping robot that can independently perform indoor surveying and mapping work through WLAN remote control. The robot uses SLAM technology to map the environment. In SLAM, a single sensor has the disadvantages of slow construction speed, missing obstacle recognition, and small measuring range. This paper uses a two-wheeled robot as a platform, equipped with a 2DLidar and a RGB-D camera, and proposes a timing-based sensor fusion mapping method. It can get a more accurate map, shorten the mapping time to make the surveying work more efficient.

[#43] Hand Tracking Accuracy Enhancement by Data Fusion Using Leap Motion and Myo Armband

Jingxiang Chen, Chao Liu, Rongxin Cui, Chenguang Yang*

In this paper, by using the combination of Leap Motion and Myo armband, two methods for hand tracking and online hand gesture identification are proposed. With the proposed methods, We have improved the measurement accuracy of the palm direction and solved the problem of insufficient accuracy when the palm is at the limit of the measurement range. We use the Kalman filter algorithm and the neural network classification method to process the data measured by Leap Motion and Myo, so that the tracking of the operator's hand gesture is more accurate and robust even when the hand is at positions close to the measurement limit of one single sensor. The methods, which improve the hand tracking accuracy, can be used for robotic control, demonstration or teleoperation. The effectiveness of the

proposed methods has been demonstrated through comparative experiments.

[#76] Research on Fault Detection and Health Monitoring System of Turntable

**Gongrong Ma and Fanjun Meng , Turntable Department
the Beijing Precision Engineering Institute for Aircraft
Industry Beijing, China**

In this paper, two main fault monitoring methods are tried and combined. Firstly, the analytical model method is used to perform health monitoring of the turntable, then the residual observation value is used as the training sample, and the neural network method is used to detect the fault of the turntable.

Sunday, November 17, 2019

Session SuO III: 8:30-12:40

Address: Juya Banquet Hall (聚雅厅)

Session SuO III-A: 8:30-10:00

[#21] Collision avoidance of unmanned surface vehicle based on dynamic obstacles trajectory prediction
Xing'ang Xu, Yan Lin, Dalian University of Technology

For the purpose of improving collision avoidance performance of unmanned surface vehicle (USV) and reducing energy loss caused by unnecessary course angle change, based on Gaussian process (GP), an adaptive Gaussian process regression (AGPR) model is proposed by optimizing the selection of kernel functions. Based on the real-time trajectory of dynamic obstacles measured by onboard sensors, the model predicts the trajectory of obstacles at future time steps, and realizes the collision avoidance of USV by combining with the International Regulations for Preventing Collisions at Sea (COLREGS). The simulation results show that AGPR model can predict the trajectory of dynamic obstacles in a certain period of time with considerable errors, and the prediction process is stable and accurate. Finally, collision avoidance of USV that complies with COLREGS is realized by using the predicted obstacle trajectory and the improved artificial potential field method.

[#22] Auxiliary navigation system based on Baidu Map JavaScript API for high clearance sprayers
Li Wei, Mao Enrong, Xu Boqiang, Zhu Zhongxiang, Du Yuefeng, Li Zhen, China Agricultural University

For the purpose of improving collision avoidance performance of unmanned surface vehicle (USV) and reducing energy loss caused by unnecessary course angle change, based on Gaussian process (GP), an adaptive Gaussian process regression (AGPR) model is proposed by optimizing the selection of kernel functions. Based on the real-time trajectory of dynamic obstacles measured by onboard sensors, the model predicts the trajectory of obstacles at future time steps, and realizes the collision avoidance of USV by combining with the International Regulations for Preventing Collisions at Sea (COLREGS). The simulation results show that AGPR model can predict the trajectory of dynamic obstacles in a certain period of time with considerable errors, and the prediction process is stable and accurate. Finally, collision avoidance of USV that complies with COLREGS is realized by using the predicted obstacle trajectory and the improved artificial potential field method.

[#23] Cow tail detection method for body condition score using Faster R-CNN
Xiaoping Huang, Xinru Li, University of Science and Technology of China
Qiang Zhang, University of Manitoba

Zelin Hu, Jian Zhang, Hualong Li, University of Science and Technology of China

Body condition score (BCS) is an important parameter to measure cow energy reserve for feeding management. Currently, measuring BCS mainly relies on veterinary experts or skilled scorers by observing and touching animals, which is time consuming and costly, especially on largescale farms. In this study, a method of image processing and deep learning is employed to estimate cow BCS. Firstly, the network cameras were used to capture the back view images of the cows, resulting in 5470 images that constituted the sample data set, in which the key body parts (tail, pins and rump) of the cow were labeled manually. Secondly, Faster RegionConvolutional Neural Networks (Faster R-CNN) method was used to position and classify the cow tail images which were correlated to the value of BCS. Compared with other deep learning algorithms like the Single Shot multibox Detector (SSD), Faster R-CNN had a slightly higher accuracy. Specifically, the detection accuracy for cow tails was 84%, and the BCS classification had an average accuracy 70%. The low BCS classification rate was mainly due to the insufficient image data in this study for cows with certain ranges of BCS.

[#28] FD-SLAM: Real-time Tracking and Mapping in Dynamic Environments

Hua Xu, Chenguang Yang*, and Ying Feng

A robot needs the ability of Simultaneous Localization and Mapping (SLAM) in an unknown environment. It can help the robot navigation and tracking. The traditional method only considers that the robot works in a static environment. But in most cases, the robot should work in a highly dynamic environment like people. This paper presents a novel SLAM system named FD-SLAM, building on ORB-SLAM2 [1], which adds the abilities of dynamic object detection and fusion of depth image and semantic image to better estimate the position of people in an image. To improve the real-time performance of FDSLAM, it has five threads that run simultaneously in FD-SLAM: tracking, semantic segmentation, local mapping, loop closing, and point cloud mapping. FD-SLAM uses the deep neural network algorithm to detect the dynamic object and combine the depth image with the corresponding semantic image to obtain a more accurate position of a dynamic object thus reducing the impact of dynamic objects to more accurately estimate the pose of the camera. Finally, the point cloud thread uses each keyframe to create a point cloud map. We experiment with a public dataset. The results show that the absolute trajectory error of FD-SLAM is smaller than that of ORB-SLAM and DS-SLAM, and it has better real-time performance than other SLAM systems for a dynamic environment.

[#39] Attention-gated LSTM for Image Captioning
Cheng Xu, Junzhong Ji, Menglong Zhang, Xiaodan Zhang, Beijing University of Technology

Attention mechanism has been successfully applied in image captioning under the neural encoder-decoder frameworks. However, these methods are limited to introduce attention to the language model, e.g., LSTM (long short-term memory), straightforwardly: the attention is embedded into LSTM outside the core hidden layer, and the current attention is irrelevant to the previous one. In this paper, through exploring the inner relationship of attention mechanism and the gates of LSTM, we propose a new attention-gated LSTM model (AGL) that introduces dynamic attention to the language model. In this method, the visual attention is incorporated into the output gate of LSTM and propagates along with the sequential cell state. Thus the attention in

AGL obtains dynamic characteristics, which means the current focused visual region can give remote guidance to the later state. Experiments on the MS COCO dataset demonstrate the superiority of the proposed method.

[#40] Neighbouring Relationship Exploration Based on Graph Convolutional Network for Object Detection
Zhuoran Du, Junzhong Ji, Beijing University of Technology

Jingyi Wang, Xi'an Jiaotong University
Qipeng Hu, Beijing University of Technology
Shan Gao, Northwestern Polytechnical University
Xiaodan Zhang*, Beijing University of Technology

Current object detection methods are mostly based on the Faster R-CNN which is composed of two stages: 1) the region proposal network which roughly sifts anchors and produces object proposals and 2) the detection network which inputs the generated region proposals and makes predictions of category and bounding box for each region. However, the object proposals are always treated individually in the detection network without taking their relationship into consideration. Specifically, most researches utilize the non-maximum suppression algorithm to reduce the number of proposals by subtracting the neighbouring proposals for either training or testing process. Though a single proposal may be not accurate enough, a union of its neighbouring proposals and itself would represent this object region more comprehensively. Since the neighbouring relationship can be expressed by an edge between two proposals (nodes), the set of region proposals can be modelled in a graph structure. In this paper, we propose a novel neighbouring relationship exploration model (NREM) to improve the object detection by aggregating the neighbouring proposal graph (NPG) based on the graph convolutional network (GCN). Owing to the effective exploration of complementary relationship among neighbouring proposals, our method can improve the detection results significantly. Experiments on the PASCAL VOC 2007 dataset demonstrate the superiority of our proposed method.

[#66] Design and Development of Pressure & Flow Control System Based on LabWindows/CVI and Compact DAQ

Kaifeng Sun, Xi'an Precision Machinery Institute

In order to solve the problems of difficult wiring in the test site and high requirements on the precision of pipe pressure control, CompactDAQ technology is used to build the hardware platform of the control system, and LabWindows/CVI is used as the system software development platform. All the CompactDAQ modules are built in a portable cabinet to solve the problem of difficult wiring on the test site, and the system response speed is improved by using multi-threading technology and PID control algorithm, which solves the problem of control accuracy. The test results show that the control system is stable in operation, fast in data updating, able to display the current pipeline parameters in real time, effectively controls the pipeline pressure and meets the test requirements.

[#01] Research on Route Planning of AUV Based on Genetic Algorithms

Shaokun Yan, Feng Pan, Jiangsu Automation Research Institute

In order to solve the problem of premature and long search time of traditional genetic algorithm, the paper proposes an improved genetic algorithm and builds a route planning model based on the improved genetic algorithm. The paper

not only adjusts the crossover probability and mutation probability adaptively, but also changes the evaluation criteria of population diversity, where the premature problem of simple genetic algorithm is solved. In addition, a model of obstacle avoidance is established to ensure that there is no collision in the whole route planning. Finally, combined with the AUV path planning problem, it is verified that the improved genetic algorithm model can not only solve the problem of premature algorithm, ensure that AUV and obstacles do not collide, but also significantly shorten the route planning time and the path length.

[#31] Rules-Based Longitudinal Trajectory Planning Algorithm of a Solar Powered Communication/Remote-Sensing UAV

Jian Chen, Hao Meng, Nannan Du, Ben Ma, Kai Zhang, Yu Han*, China Agricultural University

This paper proposes a simplified particle model to increase the efficiency of trajectory planning. The energy flow model including solar cells module, propulsion system module, and battery module are also proposed. From expert experiences, a rules-based longitudinal trajectory planning algorithm with better energy efficiency is developed. Simulations verify that the proposed algorithm basically satisfies the requirements, but it is hard to meet all the constraints and a globally optimization algorithm must be developed in the next step.

Session SuO III-B: 10:20-12:40

[#59] Application Research of Distributed Simulation System Based on Data Distribution

Yanfang Fu, Lingling Hao and DengDeng Guo, Xi'an University of Technology

DDS (Data Distribution Service) is a set of API and interoperability protocol specifications developed by OMG. It adopts a datacentric publish/subscribe architecture to meet the demand of high efficiency and real-time communication. This paper designed a kind of DDS based on data distribution system and used in distributed simulation system at first through the analysis of DDS communication principle. Then, it achieved the system from the design of communication interface to the construction of distributed simulation system. And by means of Quality of Service (QoS) Strategy in DDS, the particularly modified QoS Strategy designed for distributed simulation system is proposed. Finally, through the analysis on effect of disturbance (system average transmission delay, jittering and the amount of packet loss) on real-time and reliability requirements of system, the test results indicate that the distributed simulation system based on DDS can meet the real-time and reliability of general distributed systems.

[#60] Design of Missile Attitude Constraint Control under New Disturbance Observation Compensation

MinZhou Dong, ZhaoPeng Chen, HaoDi Zhang, HaoDi Zhang, Feng Xie, Xin Du and Jia Jun Yin, Northwestern Polytechnical University

An output information-based constrained control method with disturbance compensation is proposed for missiles subjected to attitude constraints. Firstly, the attitude model of missile is transferred to the matched representation, and a novel observer based on output and its integral information is

presented to precisely estimate the unknown state and disturbances simultaneously in finite time. Then, the constrained attitude control method is designed using the backstepping approach and second-order filter technique. As consequence, the bounded stability of the closed-loop system is achieved and the constraints will not be violated. Finally, the numerical simulations for the missile attitude system verify the effectiveness of the proposed method.

[#61] General Architecture of Distributed Hardware-in-the-loop Simulation Supporting Dynamic Interactive Relationships

Hao Xu, Xinyan Zhang, Ning Xu, Qing Zhao, Qing Zhao, Congmin Li and Wei Ge, Beijing Institute of Control and Electronics Technology

Aiming at the problems that the construction process of distributed hardware-in-the-loop simulation (HILS) system is tedious and inflexible due to the lack of general architecture, and the previous distributed simulation architectures cannot meet the dynamic interactive relationships, a general architecture of distributed HILS supporting dynamic interactive relationships is developed. Based on this architecture, a rapid construction of distributed HILS systems can be carried out. The architecture supports the dynamic change of the data sending and receiving relationships in the distributed simulation. After testing, the architecture can support the real-time advance of distributed HILS in 1 millisecond step and meet the requirement of millisecond delay in data sending and receiving.

[#62] Fault Detection of Redundant SIMU Based on DBN

Kai Chen and Hao Fan, Northwestern Polytechnical University

Na Yin, Xi'an Aerospace Propulsion Institute

Aiming at the problems of inaccurate fault modeling and difficulty in manually extracting features in the existing redundant strapdown inertial measurement unit fault detection algorithm, the Deep Belief Network (DBN) is introduced. The energy function is introduced into the model. The maximum likelihood learning method is used to train the DBN layer by layer. The back propagation (BP) algorithm is used to fine tune the parameters of the DBN to realize the fault detection of redundant strapdown inertial measurement unit (SIMU). The simulation results show that for small amplitude step faults ($1^\circ/\text{h} \sim 2^\circ/\text{h}$), fault detection algorithm based on DBN is better than the classical algorithm, its delay time is 0.23s~0.38s and the probability of correct detection is 81%~94%. Compared with the direct comparison method, the probability of correct detection is improved by 74%~80%, and the detection delay time is reduced by 32.1%~36.1%.

[#63] Systematic Design of A Low-Cost Vision Following Control System

Laiquan Luo, Yu Han, Jian Chen and Yi Cao, China Agricultural University

Zhuo Cheng, China Software Testing Center,

Laizhu Luo, Tianjin Star and River Law Firm

We describe a leader-follower control system that allows a follower vehicle to track the leader vehicle with a give lateral and longitudinal offset. Our approach, using a monocular camera for detection and tracking, provides a low-cost solution for the leader-follower system. The speed and steering control algorithm was based on the projection of the offset in longitudinal and lateral directions, we proved that our approach guarantees stability and convergence. The

system was mounted on nonholonomic robots and tested on both straight and curved paths, test results showed that our approach is very robust within a two-vehicle system and the follower can track the preceding vehicle precisely in the longitudinal and lateral direction.

[#30] Longitudinal Modelling and Trajectory Tracking Control of a Solar Powered Communication/Remote-Sensing UAV

Jian Chen, Nannan Du, Zichao Zhang, Xuzan Liu, Ben Ma and Yu Han, China Agricultural University

This paper firstly sorts out the energy flow relationship and formulates the motion model of the solar powered communication/remote-sensing UAV. Based on the Newton's second law, the longitudinal three-degree-of-freedom nonlinear kinematics and dynamics equations of the solar powered UAV are established. By utilizing the multi-loop PID control algorithm, the height and speed controllers are designed to track the reference height and speed. Finally, numerical simulations are carried out to verify the trajectory tracking performances.

[#32] Gaussian Pseudospectral Longitudinal Trajectory Optimization Algorithm of a Solar Powered Communication/Remote-Sensing UAV

Jian Chen, Yi Cao, Yi Zuo, Nannan Du, Zichao Zhang, Xuzan Liu and Yu Han, China Agricultural University

Existing empirical rules-based flight strategy of a solar powered communication/remote-sensing UAV is difficult to meet all the constraints. In order to get a more reasonable flight strategy, the flight path must be optimized globally. This paper analyzes and mathematically abstracts the trajectory design problem of solar energy flow and summarizes the problem of solar powered UAV trajectory optimization as a typical optimal control problem. Gaussian pseudospectral method is used to design and simulate the optimal trajectory of the solar powered UAV. Simulation results verify that the optimized trajectory can well satisfy the given constraints.

[#36] Autonomous Obstacle Avoidance Algorithm of UAVs for Automatic Terrain Following Application

Yue-Jiao Wang, Zhong Ma, Xue-Han Tang and Zhu-Ping Wang, Xi'an Microelectronics Technology Institute

Autonomous obstacle avoidance flight is a key capability for unmanned aerial vehicles (UAVs) in the automatic terrain following application, which ensures that the UAVs can perform complex, versatile and difficult movements in the flight. Existing obstacle avoidance methods such as the visual SLAM, generally require artificially specifying the feature values that need to be extracted and are susceptible to illumination and obstacle positions. While artificial intelligence technology has made breakthroughs in many fields, the advantages of the neural networks overcome these shortcomings. Therefore, we propose an autonomous obstacle avoidance algorithm using deep reinforcement learning method. Concretely, a virtual three-dimensional visual simulation environment is established firstly, which simulates the flight states of the UAV and output the state image in real time according to the control decision. A deep convolutional neural network is then built as the brain of the intelligent agent, which takes the state image of the UAV as input, and outputs the discretized control decision to control the UAV. Moreover, The Deep Q Network method is

employed to train the convolutional neural network in an autonomous way, that is the intelligent agent can try to control the UAV to avoid the obstacle by itself. After training, the UAV is controlled by the trained convolutional neural network to complete the autonomous obstacle avoidance task during the flight. This algorithm is realized through continuous self-learning and self-evolution, which enables the UAVs to utilize visual information in complex scenes, adjust flight height in real time according to terrain height and obstacle height. The research results will have a strong application prospects in both military and civilian areas.

[#13] Hydrodynamic Noise Characteristics of Marine Current Turbine Designed for Unmanned Underwater Mooring Platforms

Zhigao Dang, Zhaoyong Mao, Wenlong Tian, and Baowei Song, Northwestern Polytechnical University

A kind of horizontal axis water turbine (HAWT) of marine current turbines was designed to provide power for the unmanned underwater mooring platforms (UUMPs) to extend its service life in the ocean. However, it was found there was loud noise during the experimental tests in the towing tank. Considering the working conditions in the ocean, the hydrodynamic noise of the HAWT has to be emphasized to reduce the harm to the marine organisms and the threat to the high-precision mechanical equipment. However, the specific noise characteristics of the marine current turbines are not evaluated though several researchers have realized the harm of the released noise to the marine ecological environment. In this paper, large eddy simulations (LES) combined with the Ffowcs Williams and Hawkins (FW-H) equation were applied to simulate the hydrodynamic noise of the HAWT. The noise characteristics at the near-field and far-field are studied, individually. The results showed that the transmission characteristics of the hydrodynamic noise are totally different in the three chosen planes, and the noise energy transmits easily in the axis direction of the turbine. The results in this paper could provide some guidance for the noise characteristics investigation of the HAWT, and it could also help to reduce the harm to the ocean environment.

[#15] Recognizing of Fruit Tree Row Centerline Based on Machine Vision Agricultural Unmanned Systems Session

Yu Xiao, Lijun Qi, Zhenzhen Cheng, Zepeng Yang, Yalei Wu and Hao Zhang, China Agricultural University

The flight path has a significant impact on the plant protection effect of the drone. The centerline identification of the fruit tree row has important significance for the flight path planning of plant protection drone. This paper adopts the image processing method based on machine vision technology, through the greenness extraction, Butterworth filter processing based on two-dimensional discrete Fourier transform, Otsu's thresholding method, morphological closed operation, median filtering, threshold method and morphological refinement to obtain a binary image of the fruit tree row. For the fruit trees whose binary image pixels accumulation curves are different in shape, the centerline of the fruit tree row is identified by Fourier series fitting and statistical moment method respectively. By comparing with the actual centerline obtained by the ground truth method, the effective recognition rate is 97%. At the same time, the average recognition error is 4.25 pixels and the average algorithm time is 0.4085s, which meets the accuracy and real-time requirements of Unmanned Aerial Vehicle (UAV) flight path planning.

[#41] Optical Flow Prediction in Auto Driving from Single Image via Conditional Variational Auto-Encoder

Jiayu Yan, Lu Xu and Kuizhi Mei, Xi'an Jiaotong University

In auto-driving tasks, visual prediction is very meaningful and difficult, because the motion of the predicted target has many possible outputs. It is very effective to predict the motion of the target by optical flow, but the output of the previous optical flow models is fixed. In this paper, we proposed an optical flow prediction model via Conditional Variational Auto-Encoder. In experiment, the model can effectively predict a variety of possible optical motions in the real world. A number of experimental results show that our models outperform all prior state-of-the-art on the test of a recent optical flow prediction competition.

[#44] Adversarial Deep Mutual Learning

Xuan Lai and Yanyun Qu, Xiamen University

Recently more attention has been paid to neural network compression due to the increasing requirements about limit memory with high performance. The typical methods based on knowledge distillation have to fix a pre-trained teacher model, and most result-orient methods are limited by the teacher model. In this work, we propose a novel lightweight network training method, which apply adversarial learning to deep mutual learning and train multiple networks in just one framework without pre-trained. We focus on the potential relationships among all networks in our framework to form the ingenious loss rather than these manual designed. Extensive experimental results on several datasets illustrate that the proposed method can significantly outperform other state-of-the-art methods.

[#75] Design of Variable Structure Attitude Control System for Unmanned Underwater Vehicle

Guanshan Liu, Jing Fang, Qiaogao Huang and Suhe Huang, China State Ship Building Corporation Limited

For the feature that Unmanned underwater vehicle(UUV) model is coupling and nonlinear under some complex conditions, a variable structure attitude control method for UUV is proposed. The attitude model of UUV is transformed into large-scale interconnected system, and the attitude control system is designed by variable structure control method. The stability of the control system is verified by utilizing Lyapunov theory. The simulation results show that the designed control method has strong robustness.

[#74] The optimization study on the mitigation strategy of hinge moment of aircraft with multi-control surfaces

Huan Xie, Lixia Zhao, Wei Li, Bin Chen, ShengLin Xia and Jun Yin, Chengdu Aircraft Industrial (Group) CO.,Ltd

For the unique aircraft configuration, control surface efficiency and control characters of irregular aerodynamic configuration aircraft, a mitigation strategy of maneuver load of aircraft with multi-control surfaces has been put forward in this paper. Through comprehensive analysis of the contribution to the aerodynamic characteristics of the whole aircraft and the effect on hinge moment of control surface, take the advantage that the control surfaces are at the trailing edge of the airfoil, a optimization strategy, combined deflection of control surfaces of same function but non-equal angle, is adapted. Based on the optimization strategy, several control surface combination deflection schemes are proposed

and comprehensively analyzed to make a reasonable control surface configuration, so as to reduce the hinge moment, improve the aerodynamic characteristics of the high angle of attack, improve the maneuverability and expand the maneuver envelope, thus the purpose of optimizing the aerodynamic characteristics of the whole aircraft and reduction of the hinge moment of the control surface is achieved.

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Shixun Xiong	SaO I-B	Xiaoshuang Jiao	SuO II-A
Shubo Wang	SaO I-A	Xiaoxi Du	SuO II-B
	SuO II-A	Xin Dong	SaO I-A
		Xin Shi	SuO II-B
		Xingan Li	SaO I-B

