IWACIII2021
The 7th International Workshop on Advanced Computational Intelligence and Intelligent Informatics
Oct.31-Nov.3, 2021, Beijing, China

PROGRAMME

Organizers & Co-organizers:

Co-sponsors:

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Welcome to IWACIII2021

The 7th International Workshop on Advanced Computational Intelligence and Intelligent Informatics (IWACIII2021) will be held from Oct. 31 to Nov. 3, 2021 in Beijing, China. On behalf of the organizing committee of IWACIII, we would like to express our warmest welcome to the all participants.

During the past years, under kind concerns from the researchers and scientists, IWACIII has been actively developing their domestic and international scientific and technical exchanges, which is influential and considerable especially in the Asia area.

Due to the COVID-19 pandemic, IWACIII2021 will be held online and/or offline (for attendees in China), which makes IWACIII2021 very special. However, IWACIII2021 with the great support of many researchers and scholars continuously contributes to the development of advanced computational intelligence and information technology as well as their various applications. It has no suspicion that the exchanges about computational intelligence, information technology, and their applications are quite favorable not only for the universities but also for the close relationship between industry and academy.

Dear Friends, IWACIII2021 closely relies on your support, while the development of computational intelligence also ties up our participation. IWACIII2021 is an important occasion that could give a general comment of the recent years’ global science and technology, and we can also expect to see that IWACIII2021 will indicate us the future development directions. May we join together to contribute more to develop computational intelligence, information technology and their applications, to advance both the theory and application for endeavor to create the brilliant future.

Thanks again for your attendance to IWACIII2021.

From

Kaoru Hirota
Founding Chair

Dawei Shi
Organized Committee Chairs

Xiangyuan Zeng

Shinichi Yoshida

Huifang Li
Publication Chair

Yuan Li
Local Affairs

Rongli Li
Secretary

and all other organizing committee members.
Greetings from General Chairs

We would like to thank the honorary chair, Prof. Kaoru Hirota, for his great support of BIT to organize the workshop, even under the severe impact of the new coronavirus epidemic. On behalf of the Beijing Institute of Technology and Beijing Association of Automation, it is our great pleasure to welcome you to the 7th International Workshop on Advanced Computational Intelligence and Intelligent Informatics (IWACIII2021) which will be held from Oct. 31 to Nov. 3, 2021 in Beijing, China.

The highlights of IWACIII2021 include 6 keynotes by oversea top-notch researchers – Ryuichi Yokoyama, Yaochu Jin, Yoichiro Maeda, Takao Terano, Ahmad Lotfi, and Yi Mei; 5 keynotes by Chinese top-notch researchers – Lei Guo, Daizhan Cheng, Zen-Guang Hou, Zhaohui Zhang, and Zhun Fan; and about 30 sessions on different aspects of computational intelligence, intelligent informatics, and their applications.

Apart from the technical programs, participants are also cordially invited to attend various social events, such as welcome reception, banquet, round table discussion, etc. As the workshop will be held at the beginning of November, the weather in the duration will be very nice and you can enjoy beautiful scenes of Beijing comfortably.

We sincerely thank all keynote speakers, the authors, reviewers, members of the organizing committee, and volunteers for your great support of IWACIII2021. Wish every participant enjoy a lot from IWACIII2021.
Greetings from Advisory Board

The great success of IWACIII has been witnessed by the previous six times of successful holding. IWACIII provides a very good opportunity to exchange ideas among researchers and scholars who are dedicated to computational intelligence, intelligent informatics, and their applications. They are getting more and more influential and considerable especially in the Asia area.

We believe that this time, the 7th IWACIII, with the great effort of the organizing committee and the contribution of all authors and presenters, would be an excellent occasion for exchanging academic ideas and developing and promoting friendships. Thank you for your contribution to IWACIII2021. We hope that IWACIII2021 would be a wonderful memory to you.
Greetings from Beijing Association of Automation

Qunxiong Zhu
Yuan Xu

On behalf of Beijing Association of Automation, we are pleased to organize the 7th International Workshop on Advanced Computational Intelligence and Intelligent Informatics (IWACIII2021) with Beijing Institute of Technology. We need to express our sincere welcome to all attendees of IWACIII2021 and we hope our collaboration can make you enjoy a pleasant trip to Beijing.

First of all, we would like to express our sincere gratitude to everyone who made contributions and various support to this workshop, especially the team of BIT who has done hard work which makes this great event possible. We would provide our continuous support with the growth of this event as well as the growth of our association.

As co-organizer of this great event, we would also like to thank all sponsors. Your support to this workshop adds the value of this workshop and help to promote this event as a platform for academic exchange.

Besides, we would also like to give our special thanks to Fuji Technology Press for their continuous great support to our past conferences and this workshop.

And we welcome the members of Beijing Association of Automation, for your attendance and continuous support to this workshop.

We hope that this workshop will be successful and fruitful with all your great efforts and time.
Thank you again for your cooperation and participation for IWACIII2021.
Greetings from Program Committee Chairs

On behalf of the program committee of the 7th International Workshop on Advanced Computational Intelligence and Intelligent Informatics (IWACIII2021), we would like to express our gratitude to all those who submitted research papers and to volunteer reviewers who took on hard reviewing work for the workshop. Undoubtedly, their great efforts and contributions are critical for the success of the workshop.

We received full submissions from over 50 research institutions. Each submitted paper has been reviewed by at least two reviewers in terms of originality, importance, presentation, English usage, and overall quality. The program committee has finally accepted 145 papers and 6 long abstracts for oral presentations. The workshop proceedings have been indexed by EI since 2009, and selected excellent papers will be published in the special issue of the Journal of Advanced Computational Intelligence and Intelligent Informatics, which is indexed by ESCI/SCOPUS/EI. The technical program includes 14 general sessions and 11 organized sessions that cover a broad range of topics related to computational intelligence and intelligent informatics.

We hope that the workshop will provide a great opportunity for exchanging research activities and fostering research collaboration in the future.

Thank you again for your cooperation and participation for IWACIII2021.
Organizing Committee

Honorary Chair
Kaoru Hirota (BIT, China)

General Chairs
Hongbin Ma (BIT, China)
Naoyuki Kubota (TMU, Japan)

Advisory Board
Yaping Dai (BIT, China)
Toshio Fukuda (Meijo Univ., Japan)

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Bin Xin (BIT, China)
Jinhua She (TUT, Japan)

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Publicity Chairs
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Qing Wang (BIT, China)

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Liqun Han (CSEDS, China)

Local Organizing Chairs
Yuan Li (BIT, China)
Zhen Li (BIT, China)

Registration Chairs
Ru Lai (BIT, China)
Zhuoyue Song (BIT, China)

General Affairs
Rongli Li (BIT, China)
# Program Committee Members

(Alphabetical Order)

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Dear IWACIII2021 Participants:

First of all, thank you very much for your contribution to IWACIII2021. Because the COVID-19 pandemic is still continuing in some countries, IWACIII2021 will be held in hybrid form, i.e. online (mainly by Tencent Meeting and VooV Meeting) and offline at Beijing Institute of Technology International Education Exchange Building in Beijing during Nov. 1–2. The details will be posted on the official website of this workshop (http://iwaciii2021.bit.edu.cn/) soon, please pay close attention.

IWACIII2021 Organizing Committee
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<td>9:00-9:40</td>
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<td>Speaker: Takao TERANO</td>
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<td>Speaker: Zeng-Guang HOU</td>
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<td>17:20-18:00</td>
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<td>Speaker: Yoichiro MAEDA</td>
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<td>10:30-11:10</td>
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<td>Speaker: Zhun FAN</td>
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<td>11:10-11:50</td>
<td>Keynote Speech 9</td>
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<td>Speaker: Yi MEI</td>
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<td>11:50-13:00</td>
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<td>13:00-13:40</td>
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<td>Speaker: Ryuichi YOKOYAMA</td>
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## Program in Detail

### Nov. 1 (Mon.)

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<td>8:30-8:50</td>
<td>Opening Ceremony</td>
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</table>
| 9:00-9:40  | **Keynote Speech 1**  
Chair: Hongbin MA  
Towards Understanding Game-Based Control Systems  
Lei GUO  
Chinese Academy of Sciences | Meeting Room 1    |
| 9:40-10:20 | **Keynote Speech 2**  
Chair: Shinichi YOSHIDA  
Understanding Complex Social-Technical Systems Through Agent and Gaming Simulation  
Takao TERANO  
Chiba University of Commerce | Meeting Room 1    |
| 10:30-11:10| **Keynote Speech 3**  
Chair: Zhiyang JIA  
Enhancement of Engagement for Active Control of Rehabilitation Robot  
Zeng-Guang HOU  
Chinese Academy of Sciences | Meeting Room 1    |
| 11:10-11:50| **Keynote Speech 4**  
Chair: Dawei SHI  
Online Measurement Techniques of Multi-Quantities in an Electrolysing Cell  
Zhaohui ZHANG  
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| 11:50-14:00| Lunch                                                                 |                  |
| 14:00-15:30| **Parallel Session 1**  
M1-1: Human Behavior and Knowledge Retrieval  
Chair: Hiroki SHIBATA and Eri SATO-SHIMOKAWARA | Meeting Room 1    |
| 14:00-14:15| Proposal of Action Recommendation System Based on User Contexts in Daily Life  
Hiroki SHIBATA, Yu SHIRAI, and Yasufumi TAKAMA |                  |
| 14:15-14:30| Multi-View Evolutionary Strategy Consensus Based Pose  
Wei QUAN and Naoyuki KUBOTA |                  |
| 14:30-14:45| Design and Implementation of Intelligent Question-Answer System Based on Campus Network Service  
Yuanyuan CAO, Jiaqi HUANG, Zhiyong XU, Yuanjun ZOU, Wei SU, Xuefeng PAN, and Xiaorui HOU |                  |
| 14:45-15:00| Dynamically Weighted Ensemble Models Based on the Behavioral Similarity Towards Sentiment Estimation  
Akihiro MATSUFUJI, Eri SATO-SHIMOKAWARA, Toru YAMAGUCHI, and Lieu-Hen CHEN |                  |
| 15:00-15:15| Comparative Study on Neural Network Models of Human Behavior Recognition Methods  
Jiazhi LI, Ning LIU, Dedi ZHANG, and Fuchao LIU |                  |
| 15:15-15:30| Video Action Retrieval System Based on Behavior Gesture Recognition Technology  
Wenshan LYU, Bolong TANG, Haoping HU, Dan CHEN, and Hongbin MA |                  |
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<th>Time</th>
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<td>Room 2</td>
<td>Economical Optimal of Virtual Power Plant with Source, Load and Storage</td>
<td>Xiaohui CHANG, Wei CHEN, and Chunquan MI</td>
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<td>M1-2-1</td>
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<td>Space MMF Harmonic Rotor Losses Under Healthy and Open Circuit Conditions</td>
<td>Xing GUAN, Zhen CHEN, and Yumeng LI</td>
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<td>M1-2-2</td>
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<td>Optimal Dispatch Strategy of Renewable Energy Power System Based on Wind Power Forecasting</td>
<td>Yulong HAN, Licai GUO, and Haibo HE</td>
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<td>M1-2-3</td>
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<td>Energy Management of Hybrid Storage in Distributed Generation System</td>
<td>Bin LI, Jilei YE, Yu ZHANG, Shanshan SHI, and Mingzhe LI</td>
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<td>M1-2-4</td>
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<td>Deep Learning Based Multi-Objective Power Grid Investment Behavior Analysis and Income Prediction</td>
<td>Wendong XIAO</td>
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<td>M1-2-5</td>
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<td>Design of Variable Frequency Control System of Direct-Drive Wind Motor</td>
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<td>Gan WU, Dong WEI, and Shuo FANG</td>
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<td>Ying ZHANG, Yuntao SHI, Xiang YIN, Meng ZHOU, Weichuan LIU, and Daqian LI</td>
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<td>M1-3-3</td>
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<td>Adaptive Optimal Control for a Class of Continuous-Time Unknown Nonlinear Systems via Generative Adversarial Networks</td>
<td>Chenglong WANG, Haiyang FANG, and Shuping HE</td>
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<td>M1-3-4</td>
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<td>Model Free Adaptive Iterative Learning Control for Power Inverter</td>
<td>Zhenxuan LI, Yilong ZHANG, Jiia ZONG, and Guo-Xin ZHAO</td>
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<td>M1-3-5</td>
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<td>Research on Fault Diagnosis Algorithm of Substation Equipment Based on Improved Mask R-CNN</td>
<td>Yang YANG, Guanxun DIAO, Ning YANG, Mei WANG, Pengfei JIA, Chengchen QIAN, and Lihua LI</td>
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<td>14:00-15:30</td>
<td>M1-4: Intelligent Computing in Networks</td>
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<td>IoT Gateway with Edge Computing Function</td>
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<td>M1-4-2</td>
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Jianwei LI, Xiaoyan ZHAO, Ruiguang CHEN, Chunlei LI, Yan CHEN, Tianyao ZHANG, Jiawei WANG, Yihao WANG, and Zhaohui ZHANG

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Shuo YUAN

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**Convergence Analysis and Strategy Control of Evolutionary Games on Square Lattice**
Ge CHEN and Yongyuan YU

#### M1-5-3
**The Combat Game on a Plane Between Two Agents**
Yazhe DING, Yifen MU, Hongbin MA, and Xiaoguang YANG

#### M1-5-4
**Regulation on Nash Equilibriums in Game-Based Control Systems**
Yongyuan YU and Renren ZHANG

#### M1-5-5
**Confrontation Analysis of Wargame Deduction in Zero-Sum Game Based on Petri Net**
Xiangri LU and Hongbin MA

#### M1-5-6
**Dynamic Games with Dynamic Uncertainty**
Renren ZHANG

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Xiaoping ZHANG, Yihao LIU, Dunli HU, and Lei LIU

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**A Heuristic Route Planning Algorithm for Air-Ground Collaborative Surveillance**
Yulong DING, Bin XIN, Lihua DOU, and Jie CHEN

#### M1-6-3
**An Improved Fuzzy Neural Network for Obstacle Avoidance of Mobile Robot**
Tian GAO, Qinglin WANG, Yaping DAI, and Zhiyang JIA

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Mutsumi IWASA, Naoyuki KUBOTA, and Yuichiro TODA

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Jinge SI, Shoukun WANG, Bin LI, Hao ZHANG, and Junzheng WANG

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Keming JIAO, Jie CHEN, Bin XIN, Li LI, Yifan ZHENG, and Zhixin ZHAO

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Xiao LING, Shan ZHAO, and Hongyu ZHAI

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**Research on the Path of Developing Information Literacy of Teachers from Colleges of Foreign Languages from the Perspective of Artificial Intelligence**
Kexin ZHANG

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**A Multi-Modal Fusion Algorithm for Cross-Modal Video Moment Retrieval**
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### Separable Algorithms for Matrix Factorization with Presence of Missing Data
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### Conditional Motion and Content Decomposed GAN for Zero-Shot Video Generation
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### The Cars’ Type Recognition Algorithm Based on Ensemble Learning and Multi-Features Fusion
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### Feature Contribution in Accidents Severity Based on Light GBM-TPE
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Multi-Objective Evolutionary Federated Neural Architecture Search
Yaochu JIN
Bielefeld University

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Chair: Yaping DAI
On Dimension-Varying Dynamic (Control) Systems
Daizhan CHENG
Chinese Academy of Sciences

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**Keynote Speech 7**
Chair: Naoyuki KUBOTA
Human Symbiotic Systems Including Human Intelligence and Artificial Intelligence
Yoichiro MAEDA
Ritsumeikan University

**10:30-11:10**
**Keynote Speech 8**
Chair: Yuan LI
Design Automation of Intelligent Robotic Systems Based on Evolutionary Computation
Zhun FAN
Shantou University
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<td>Lin CHENG, Jiayu LIU, Juyi LI, and Jianzhong TANG</td>
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<td>Zelong ZHANG, Kaoru HIROTA, Yaping DAI, and Zhiyang JIA</td>
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<td>Multi-Step Predictive Models for Excess Air Coefficient of Engine Based on TCN</td>
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<td>T1-6-2</td>
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<td>T1-6-3</td>
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<td>Yuyao HUANG, Wangyang WU, Liang LI, and Jianhua SUN</td>
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<td>Rate and Temperature Dependent Hysteresis Online Identification for Magnetostrictive Actuator</td>
<td>Sicheng YI, Yuchao YAN, Hujun FAN, and Quan ZHANG</td>
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<td>T1-6-5</td>
<td>Hybrid Gradient Descent Algorithms for the Exponential Autoregressive Model</td>
<td>Si-Min QIAN, Min GAN, and Guang-Yong CHEN</td>
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<td>T2-1-1</td>
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<td>Guanghao XU, Huiqiang LI, Ruitao YANG, and Fenxi YAO</td>
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<td>Miao WANG, Bin XIN, and Qing WANG</td>
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<td>Shuai CHEN, Chengpeng JIANG, Jinglin LI, Jinwei XIANG, and Wendong XIAO</td>
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<td>Takenori OBO, Takumi SENCHI, and Tomoyuki KATO</td>
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<td>Enqi LIU, Yaping DAI, and Hongfeng WANG</td>
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<td>Shuxin DING, Tao ZHANG, Rongsheng WANG, Chunde ZHANG, Sai LU, and Bin XIN</td>
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<td>15:30-17:00</td>
<td>T2-2-1</td>
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<td>Jian TANG, Guo-Xin ZHAO, Xiang-Dong JIAO, and Xue-Peng DING</td>
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<td>15:30-17:00</td>
<td>T2-2-2</td>
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<td>Weibo NING, Jiaqi ZHU, Guijie ZHU, Hongjiang CHEN, Wenning HUANG, Jun HU, Yibiao RONG, Yuwei CAI, and Zhun FAN</td>
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<td>15:30-17:00</td>
<td>T2-2-3</td>
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<td>Shuang WANG and Xuefei MAO</td>
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<td>Seita SUKISAKI and Hajime NOBUHARA</td>
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<td>Design and Realization of a Closed-Loop Constant Flow Rate Air Sampler Using Differential Pressure Sensor</td>
<td>Bojin SHANG, Yaping DAI, Xiaohan WANG, Junyi YUAN, and Zhiyang JIA</td>
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<td>15:30-17:00</td>
<td>T2-2-6</td>
<td>Hydration and Dehydration Processes of Lactose Monohydrate Studied by THz Time Domain Spectroscopy</td>
<td>Muhammad Adnan ALVI, Zhaohui ZHANG, Xiaoyan ZHAO, Yang YU, Tianyao ZHANG, and Jawad ASLAM</td>
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<td>15:30-17:00</td>
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<td>A Combined Prediction Model Based on Double Echo State Network with Improved Immune Genetic Algorithm (IIGA)</td>
<td>Yuan XU, Jianlong YIN, Yanlin HE, and Qunxiong ZHU</td>
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<td>Rate and Temperature Dependent Hysteresis Online Identification for Magnetostrictive Actuator</td>
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<td>T2-3-4</td>
<td>Hybrid Gradient Descent Algorithms for the Exponential Autoregressive Model</td>
<td>Si-Min QIAN, Min GAN, and Guang-Yong CHEN</td>
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<td>T2-3-1</td>
<td>Digitization-Oriented Business Ethics Judgement Knowledge Structure and Application</td>
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<td>T2-3-2</td>
<td>A Basic Research to Develop a Method to Classify Game Logs and Analyze Them by Clusters</td>
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<td>Akinobu SAKATA, Takamasa KIKUCHI, Ryuichi OKUMURA, Masaaki KUNIGAMI, Atsushi YOSHIIKA, Masayuki YAMAMURA, and Takao TERANO</td>
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<td>T2-3-3</td>
<td>Web-Questionnaire-Based Method for Creating Corpus Containing a Large Number of Morphemes</td>
<td>16:00-16:15</td>
<td>Kazuaki SHIMA, Jinhua SHE, Yasunari OBUCHI, and Abdullaah M. ILYASU</td>
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<td>T2-3-4</td>
<td>Application of Neural Network Based on Long and Short Term Memory in Rumor Detection</td>
<td>16:15-16:30</td>
<td>Zhiyan WANG and Mingzhao LI</td>
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<td>T2-3-5</td>
<td>Establishment of a Traceability Model of Fresh Milk Based on Blockchain</td>
<td>16:30-16:45</td>
<td>Dengmei JIANG, Jiandong FANG, and Yudong ZHAO</td>
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<td>T2-4-1</td>
<td>A Prediction Method of Driving Range Based on LSTM Combined with Causal Convolution</td>
<td>15:30-15:45</td>
<td>Zhe ZUO, Ning XU, Zhenyu ZHANG, Yuheng YAN, Weilong LV, and Ziyang XU</td>
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<td>T2-4-2</td>
<td>Design of Predictive Alarm System for Artificial Pancreas</td>
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<td>Wenjing WU, Xiao YANG, and Dawei SHI</td>
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<td>T2-4-5</td>
<td>Research on Infrared Fault Warning Method of Hotline Tap Clamp of Substation Equipment Based on Hybrid Segmentation</td>
<td>16:30-16:45</td>
<td>Peifeng SHEN, Yang YANG, Yong LI, Lihua LI, Ting CHEN, and Ning YANG</td>
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<td>T2-4-6</td>
<td>An XGB-Based Runtime Prediction Algorithm for Cloud Workflow Tasks</td>
<td>16:45-17:00</td>
<td>Jingwei HUANG, Huifang LI, Yizhu WANG, and Lingguo CUI</td>
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<td>T2-5-1</td>
<td>PSO-SVM Optimized Kriging for Geological Modeling of Coal-Bearing Formation</td>
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<td>Mingdi MA, Luofeng CHEN, Min LI, Min WU, Witold PEDRYCZ, and Kaoru HIROTA</td>
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<td>T2-5-2</td>
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<td>15:45-16:00</td>
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<td>Development of Ultrasonic Internal Detection Experimental System for Corrosion of Crude Oil Pipeline</td>
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<td>Jian TANG, Guo-Xin ZHAO, Bo DAI, and Xue-Peng DING</td>
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<td>T2-5-4</td>
<td>Design of Smart Campus System Based on Virtual Platform of Campus Card</td>
<td>16:15-16:30</td>
<td>Qichen HUANG, Yinru ZHU, Tongtong GAO, Yunji FENG, and Xuyang LIU</td>
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<td>Multi-Scopic Simulation for Human-Robot Interactions Based on Multi-Objective Behavior Coordination</td>
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<td>15:30-17:00</td>
<td><strong>Special Session</strong></td>
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<td><em>Innovations in Basic Theory of AI</em></td>
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<td>Chair: Liqun HAN and Hongbin MA</td>
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<td>Contents of special session will be announced on the website.</td>
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<td>17:10-17:50</td>
<td><strong>Keynote Speech 11</strong></td>
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<td>Chair: Naoyuki KUBOTA</td>
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<td><em>Computational Intelligence Approaches for Anomaly Detection in Activities of Daily Living</em></td>
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<td>Ahmad LOTFI</td>
<td>Nottingham Trent University</td>
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<td>18:00-18:30</td>
<td><strong>Closing Ceremony</strong></td>
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<td>Closing Ceremony</td>
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Keynote Speech

Towards Understanding Game-Based Control Systems

Abstract: In the traditional framework of control theory, the plant to be controlled usually does not have its own payoff function, however, this is not the case for the control or regulation of many practical systems such as social and economic systems of interests, where the systems or subsystems to be regulated may have their own objectives which may not be the same as that of the global regulator or controller, and we call such hierarchical decision making systems as game-based control systems (GBCS). This lecture will expound the backgrounds of introducing GBCS and present some preliminary results for a basic class of GBCS. It will be shown how the macro-states of the GBCS may be regulated by intervening in the Nash equilibrium that is reached at the micro-level. In particular, we will provide some results on controllability and stabilizability of both deterministic and stochastic linear GBCS with multi-players at the micro-level, and both cases involve the analysis and control of forward-backward (stochastic) differential equations.

BIO: Dr. Lei Guo received his B.S. degree in mathematics from Shandong University in 1982, and Ph.D. degree in control theory from the Chinese Academy of Sciences (CAS) in 1987. He was a postdoctoral fellow at the Australian National University (1987–1989). Since 1992, he has been a Professor of the Institute of Systems Science at the Chinese Academy of Sciences, where he had been Director of the Institute (1999–2002). From 2002 to 2012, he was
the President of the Academy of Mathematics and Systems Science, CAS. He is currently the Director of the National Center for Mathematics and Interdisciplinary Sciences, CAS.

Dr. Guo was elected Fellow of the IEEE in 1998, Member of the Chinese Academy of Sciences in 2001, Fellow of the Academy of Sciences for the Developing World (TWAS) in 2002, Foreign Member of the Royal Swedish Academy of Engineering Sciences in 2007, and Fellow of the International Federation of Automatic Control (IFAC) in 2007 “for fundamental contributions to the theory of adaptive control and estimation of stochastic systems, and to the understanding of the maximum capability of feedback.” In 2014, he was awarded an honorary doctorate by Royal Institute of Technology (KTH), Sweden.
Understanding Complex Social-Technical Systems Through Agent and Gaming Simulation

**Abstract:** Agent-Simulation is a tool to know about a could-be-world. Also, Gaming-Simulation is a language to communicate the future. In this talk, I will discuss a new approach to understand complex socio-technical systems through both concepts. We start basic features on complex and/or complicated socio-technical systems, which address both technical and social issues with human decision-making processes. Then, we explain the importance of new ways of system thinking with human-in-the-loop manners. For the purpose, we propose a methodology to amalgamate agent- and gaming-simulation.

**BIO:** Dr. Terano is a professor of Platform for Liberal Arts and Sciences, Chiba University of Commerce. He received B.A. degree in Mathematical Engineering in 1976, and M.A. degree in Information Engineering in 1978 both from The University of Tokyo, and Doctor of Engineering degree in 1991 from Tokyo Institute of Technology. His interests include Agent-Based Modeling, Knowledge Systems, Evolutionary Computation, and Service Science. He is a member of the editorial board of major Artificial Intelligence- and System Science-related academic societies in Japan and a member of IEEE, and the president of PAAA.
Enhancement of Engagement for Active Control of Rehabilitation Robot

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

BIO: Dr. Hou is a Professor and Deputy Director of the State Key Laboratory of Management and Control for Complex Systems, Institute of Automation, Chinese Academy of Sciences (CAS). He is an IEEE/CAA Fellow, a VP of the Chinese Association of Automation (CAA) and the Asia Pacific Neural Network Society (APNNS), and a member of Board of Governors of International Neural Network Society (INNS). He is an Associate Editor of the IEEE Transactions on Cybernetics and the Neural Networks, a recipient of IEEE Transactions on Neural Networks Outstanding Paper Award in 2013, and the National Natural Science Award of China, and the Outstanding Achievement Award of Asia Pacific Neural Network Society (APNNS) in 2017.
Keynote Speech 4

Zhaohui Zhang
University of Science and Technology Beijing, China

Online Measurement Techniques of Multi-Quantities in an Electrolysing Cell

**BIO:** Dr. Zhang is a professor with Automation and Electrical Engineering School, University of Science and Technology Beijing. He is also a distinguished teacher of Beijing, director of Beijing Engineering Research Center of Industrial Spectrum Imaging, and vice-director of Beijing Association of Automation. The research papers were contributed by his group in Journal of Applied Spectroscopy, Applied Optics, Optical and Quantum Electronics, Chinese Optics Letters, Spectroscopy and Spectral Analysis, Infrared Millimeter and Terahertz Waves, Biophysical Journal, etc. He was selected as Chinese Most Cited Researchers in 2014, 2015 and 2016. His current research interests include industrial online measurements and artificial sensing.
Multi-Objective Evolutionary Federated Neural Architecture Search

Abstract: Federated learning is a privacy-preserving machine learning paradigm. In this talk, I am going to introduce a multi-objective approach to enhancing the performance of federated learning in terms of accuracy, communication efficiency, and computational complexity. I’ll start with a brief introduction to multi-objective machine learning, followed by two evolutionary multi-objective federated learning algorithms for optimizing the architecture of neural network models in federated learning, one for offline, and the other for real-time purposes. Finally, remaining research challenges will be outlined.

BIO: Yaochu Jin received the B.Sc., M.Sc., and Ph.D. degrees from Zhejiang University, Hangzhou, China, in 1988, 1991, and 1996, respectively, and the Dr.-Ing. degree from Ruhr University Bochum, Germany, in 2001. He is currently a Distinguished Chair, Professor in Computational Intelligence, Department of Computer Science, University of Surrey, Guildford, U.K., where he heads the Nature Inspired Computing and Engineering Group. He was a “Finland Distinguished Professor” of University of Jyvaskyla, Finland, a “Changjiang Distinguished Visiting Professor,” Northeastern University, China, and “Distinguished Visiting Scholar,” University of Technology Sydney, Australia. In 2021, he was awarded the Alexander von Humboldt Professorship for Artificial Intelligence by the Federal Ministry of Education and Research of Germany. His main research interests include data-driven surrogate-assisted evolutionary optimization, trustworthy machine learning, multi-objective evolutionary learning, swarm robotics, and evolutionary developmental systems.

Dr. Jin is presently the Editor-in-Chief of the IEEE Transactions on Cognitive and Developmental Systems and the Editor-in-Chief of Complex & Intelligent Systems. He was an IEEE Distinguished Lecturer, and Vice President of the IEEE Computational Intelligence Society. He is the recipient of the 2018 and 2020 IEEE Transactions on Evolutionary Computation Outstanding Paper Award, the 2015, 2017, and 2020 IEEE Computational Intelligence Magazine Outstanding Paper Award, and the Best Paper Award of the 2010 IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology. He is recognized as a Highly Cited Researcher 2019 and 2020 by the Web of Science Group. He is a Member of Academia Europaea and Fellow of IEEE.
On Dimension-Varying Dynamic (Control) Systems

Abstract: Dimension-varying systems exist widely in real world, for instance, docking/undocking of aircrafts, vehicle clutch systems, internet systems, genetic regulatory networks, etc. Classical way to deal with dimension-varying process is “switching,” which ignores the transient process of dimension-varying. In this talk we propose an alternative way to formulate the dimension transient process. First, using semi-tensor product, a cross-dimensional inner product is proposed to connect spaces of different dimensions into a path-wise connected space. A fiber-bundle structure is constructed to describe the relationship between original discrete topology and the norm-based topology. Starting from semi-group system (S-system), a new cross-dimensional dynamic (control) system is defined on quotient space. The properties and trajectory calculations are also revealed. Finally, by projecting and lifting, the realization of cross-dimensional dynamic (control) systems on real world is obtained.

BIO: Dr. Daizhan Cheng graduated from Tsinghua University in 1970, received M.S. from Graduate School, Chinese Academy of Sciences in 1981, and Ph.D. from Washington University, St. Louis, in 1985. Since 1990, he is a professor with Institute of Systems Science, AMSS, Chinese Academy of Sciences. He is the author/coauthor of 17 academic books, over 300 journal papers and over 170 conference papers. He is IEEE Fellow (2006−), IFAC Fellow (2008−). He was member of IEEE CSS Board of Governors (2009, 2015), and IFAC Council Member (2011−2014). He received Second National Natural Science Award of China twice (in 2008 and 2014), Outstanding Science and Technology Achievement Prize of CAS (2015), and the Automatica Best Paper Award (2008−2010), bestowed by IFAC. He is the founder of the semi-tensor product of matrices.
Human Symbiotic Systems Including Human Intelligence and Artificial Intelligence

Abstract: “Human Symbiotic Systems” (HSS) aims at studying the basic principles and methods of designing intelligent interaction in bidirectional communication based on the effective collaboration and symbiosis between humans and artifacts such as robots, agents, and computers. The research on HSS includes a wide range of topics from a variety of fields such as human-agent interaction, human-machine interface, intelligent robotics, Kansei engineering, and so on. I established a special interest group on Human Symbiotic Systems in Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT) in 2007 in order to advance researches in this field. The soft computing method is a technology that bridges the gap between “intelligent systems” which are based on logic and regularity, and “humans” who have ambiguity and flexibility, and is also a core technology for research on Human Symbiotic Systems. Both “human intelligence” and “artificial intelligence” are superior, but it is necessary to build efficient cooperative systems between them in order to achieve excellent human symbiotic systems in the future. In this talk, I will give an overview of the activities of HSS research group in SOFT, and introduce some of my own previous researches related to human symbiotic systems.

BIO: Dr. Maeda Yoichiro is a professor of College of Information Science and Engineering in Ritsumeikan University. He graduated the master course of the Graduate School of Engineering in Osaka University in 1983. Then he worked in the Central Research Laboratory in Mitsubishi Electric Corporation. Next, he acted the senior researcher of Laboratory for International Fuzzy Engineering Research (LIFE) in 1989 to 1992, and the associate professor of Osaka Electro-Communication University in 1995. And after working as the visiting researcher of University of British Columbia (UBC), Canada in 1999 to 2000, he arrived at the associate professor of Faculty of Engineering in University of Fukui in 2002 and then the professor of Osaka Institute of Technology in 2013, Institute of Technologists in 2015, Ritsumeikan University in 2017. His major research interests are in the Human-Robot interaction based on soft computing methods. He was a chairman of the Special Interest Group on Human Symbiotic Systems (HSS) of the Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT) in 2007 to 2020. Now, he is also a president of the academic society SOFT.
Design Automation of Intelligent Robotic Systems Based on Evolutionary Computation

Abstract: The main reason why the performance of domestic robots is generally difficult to reach the same level of that of foreign countries mainly lies in the lack of systematic continuous optimization and design automation. How to form a framework of design automation of intelligent robotic systems is the main topic of this report. This report will mainly focus on multi-angle modeling methods of intelligent robotic systems, solving intelligent robot optimization problems by combining constrained multi-objective evolutionary algorithms and machine learning methods, and applying design automation methods to develop intelligent robots.

BIO: Zhun Fan received the B.S. and M.S. degrees in control engineering from Huazhong University of Science and Technology, Wuhan, China, in 1995 and 2000, respectively, and the Ph.D. degree in electrical and computer engineering from the Michigan State University, Lansing, MI, USA, in 2004. He is currently a Full Professor with Shantou University (STU), Shantou, China. He also serves as the Head of the Department of Electrical Engineering and the Director of the Guangdong Provincial Key Laboratory of Digital Signal and Image Processing. His major research interests include intelligent control and robotic systems, robot vision and cognition, MEMS, computational intelligence, design automation, optimization of mechatronic systems, machine learning, and image processing. He has published more than 190 scientific articles, such as the IEEE Transactions on Image Processing, IEEE Transactions on Evolutionary Computation, IEEE Transactions on Industrial Electronics, and IEEE Transactions on Automation Science and Engineering.

Before joining STU, he was an Associate Professor with the Technical University of Denmark (DTU) from 2007 to 2011, first with the Department of Mechanical Engineering, then with the Department of Management Engineering, and as an Assistant Professor with the Department of Mechanical Engineering in the same university from 2004 to 2007. He has been a Principle Investigator of a number of projects from Danish Research Agency of Science Technology and Innovation and National Natural Science Foundation of China. His research is also supported by the National Natural Science Foundation of China.
Automatic Heuristic Learning for Complex Optimisation Problems with Genetic Programming

Abstract: Many real-world decision making problems are very complex, with large problem size and dynamic environments. It is very hard to design effective decision-making policies/heuristics to make proper decisions. Manually designing such heuristics typically rely on domain expertise and requires a lot of trial-and-error. With the recent rapid progress in AI and machine learning, automatic heuristic design becomes a hot topic in both evolutionary computation and machine learning, as well as automated algorithm design. This seminar will introduce how to automatically learn effective decision-making heuristics with Genetic Programming (GP), a powerful evolutionary computation algorithm. The seminar will cover several key design issues, including solution representation, fitness evaluation, selection, as well as more advanced and trendy topics such as surrogate models and knowledge transfer. It will give several real-world optimisation problems as case studies, such as job shop scheduling, vehicle routing, and cloud resource allocation.

BIO: Dr. Yi Mei is a Senior Lecturer at the School of Engineering and Computer Science, Victoria University of Wellington, Wellington, New Zealand. He received his B.Sc. and Ph.D. degrees from University of Science and Technology of China in 2005 and 2010, respectively. His research interests include evolutionary computation in scheduling, routing and combinatorial optimisation, as well as evolutionary machine learning, hyper-heuristics, genetic programming, feature selection, and dimensionality reduction. Yi has more than 130 fully refereed publications, including the top journals in EC and Operations Research (OR) such as IEEE TEVC, IEEE Transactions on Cybernetics, European Journal of Operational Research, ACM Transactions on Mathematical Software, and top EC conferences (GECCO). He won an IEEE Transactions on Evolutionary Computation Outstanding Paper Award 2017, and a Victoria University of Wellington Early Research Excellence Award 2018. As the sole inventor, he won the 2nd prize of the Competition at IEEE WCCI 2014: Optimisation of Problems with Multiple Interdependent Components. He serves as a Vice-Chair of the IEEE CIS Emergent Technologies Technical Committee, and a member of three IEEE CIS Task Forces and two IEEE CIS Technical Committees. He is an Editorial Board Member of International Journal of Bio-Inspired Computation, an Associate Editor of International Journal of Applied Evolutionary Computation and International Journal of Automation and Control, and a guest editor of a special issue of the Genetic Programming Evolvable Machine journal. He has organised a number of special sessions in international conferences.
conferences such as IEEE CEC. He serves as a reviewer of over 30 international journals including the top journals in EC and OR. He was an Outstanding Reviewer for Applied Soft Computing in 2015 and 2017, and IEEE Transactions on Cybernetics in 2018.
Resilient Networked Microgrid Under Natural Disasters and Autonomous Community for the New Normal Life

Abstract: In this decade, many countries experienced natural and accidental disasters such as typhoons, floods, earthquakes, and nuclear plant accidents causing catastrophic damage to infrastructures. Since the beginning of 2019, all the countries in the world are struggling in the Corona Virus and pursuing the countermeasures including inoculation of vaccine and change of life style and social structures. All these experiences made the residents in the regions keenly aware of the needs for new infrastructures that are resilient and autonomous so that vital life-lines are secured in calamities. A paradigm shift has been taking place toward reorganizing the energy management practice in Japan and other countries by effective use of sustainable energy and new infrastructures. However, such new power sources would affect the power grid through fluctuation of power output and the deterioration of power quality. Therefore, a new social infrastructure and novel energy management system to supply electric power would be required. In this presentation, features and developments of the “Networked microgrid” which is resilient in case of natural disaster by effective use of renewable energy and “autonomous community” which supplies robust sustainable society for the New Normal Life are discussed.

BIO: Ryuichi Yokoyama received the degrees of B.S., M.S., and Ph.D. in electrical engineering from Waseda University, Tokyo, Japan, in 1968, 1970, and 1974, respectively. After working in Mitsubishi Research Institute, from 1978 through 2007, he was a professor in the Faculty of Technology of Tokyo Metropolitan University. Since 2007, he had been a professor of the Graduate School of Environment and Energy Engineering in Waseda University. His fields of interests include planning, operation, control and optimization of large-scale environment and energy systems, and economic analysis and risk management of deregulated power markets. Now, he is a Professor Emeritus of Waseda University, a Life Fellow of IEEE, a Life Fellow of IEEJ. He is also Chairmen of Standardization Commissions of Electric Apparatus in METI Japan. He is a President of Consortium of Reginal Autonomous Microgrid of Japan and CEO of the Energy and Environment Technology Research Institute.
Computational Intelligence Approaches for Anomaly Detection in Activities of Daily Living

Abstract: This talk presents a review of computational intelligence approaches for anomaly detection in activities of daily living. The classical novelty detection process identifies new or unknown data by detecting if test data differs significantly from the data available during training. It is applicable for anomaly detection in a situation where there is sufficiently large training data representing the normal class and little or no training data for the anomalous (or abnormal) class. Anomaly in activities of daily living is identified as any significant deviation from an individual’s usual behavioural routine. There are different approaches to collect information related to the activities of daily living including the sensors installed in the environment, wearable devices or mobile phones. Once the data are gathered, the most important task is to distinguish abnormal patterns of activities. An anomaly such as a fall in activities of daily living is a rare event and classical detection techniques will not work due to lack of training data. Hence, the need for more intelligent techniques to identify anomalies.

BIO: Ahmad Lotfi is currently a Professor of Computational Intelligence and Head of the Department of Computer Science at Nottingham Trent University, Nottingham, where he is also leading the Computational Intelligence and Applications (CIA) research group. Areas of his research interest include computational intelligence, ambient intelligence, assistive robotics, smart homes, and smart industry. His research has been recognised internationally for significant contributions to the application of computational intelligence techniques in control systems and intelligent environments. He has supervised many research fellows and over 20 Ph.D. research students to successful completion. He has worked in collaboration with many healthcare commercial organisations and end-users. He has received external funding from Innovate UK, EU and industrial companies to support his research. He has authored and co-authored over 200 scientific papers in the area of computational intelligence, anomaly detection, and machine learning in highly prestigious journals and international conferences. He has been invited as an Expert Evaluator and Panel Member for many EU Framework Research Programmes. More details are available from: http://www.lotfi.uk
Proposal of Action Recommendation System Based on User Contexts in Daily Life

Hiroki SHIBATA, Yu SHIRAI, and Yasufumi TAKAMA
Graduate School of System Design, Tokyo Metropolitan University, Japan

Abstract: This paper proposes a new combined system to recommend actions in daily life to users based on user context. Bandit algorithm is employed to choose an effective presentation of recommendation to both users and the system. Experiments are conducted on simulated environment using persona that models the typical Japanese people behavior. It shows the performance of the proposed system in supporting user’s life.

Keywords: Recommendation, User Context, Well-Being, Bandit Algorithm, Life Support System

Multi-View Evolutionary Strategy Consensus Based Pose

Wei QUAN and Naoyuki KUBOTA
Graduate School of System Design, Tokyo Metropolitan University, Japan

Abstract: In this paper, we propose a framework for rapidly estimating three-dimensional human pose from two camera views. It is based on an evolutionary algorithm. This system can be applied straightforwardly to inexpensive smart devices and used to evaluate multiple individuals’ calisthenics with two or more smart devices. On the other hand, in order to verify and evaluate input, Evolutionary Strategy Consensus was introduced to estimate fundamental matrix between views. The result shows that two dimensional position of human joints can be estimated into three dimensional pose even with errors.

Keywords: Three-Dimensional Pose Estimation, Evolutionary Algorithm, Evolutionary Strategy Consensus
Design and Implementation of Intelligent Question-Answer System Based on Campus Network Service

Yuanyuan CAO, Jiaqi HUANG, Zhiyong XU, Yuanjun ZOU, Wei SU, Xuefeng PAN, and Xiaorui HOU

School of Medical Information, Changchun University of Chinese Medicine, China

Abstract: In this paper, the intelligent question-answer system based on the campus network service knowledge graph was proposed. The intelligent question-answer system was convenient to the customer of the campus network, and it can promote the efficiency of campus information services. The entity keyword in the question of the customer was extracted by part-of-speech tagging, then the question template that was mostly closed to the question semantic in the system was calculated by the hybrid algorithm based on the term frequency-inverse document frequency (TF-IDF) algorithm and naive Bayesian classifier. Finally, according to the question type of the question template and the entity keywords in the question, the Cypher statement was constructed to complete the retrieval of the answer from the knowledge graph, and the answer would be returned to the customer. The intelligent question-answer system based on the campus network service knowledge graph can help the operation and maintenance staff of the campus network to reduce the workload. The question-answer accuracy test of the system was conducted in this paper, and the results illuminated that the accuracy of answering questions reached to 86%. The compatibility testing of this system was performed, and the results indicated the system compatible with all mainstream operation systems and browsers. At last, the concurrent request processing capability of the system was measured by JMeter, the results indicated that for 20 users, the shortest response time is 153 ms, the longest response time is 1445 ms, the average response time is 395 ms, the median response time is 254 ms, and the error rate is 0, the throughput is 4.1/sec.

Keywords: Knowledge Graph, Intelligent Question-Answer System, Campus Network, Fault Question-Answer

Dynamically Weighted Ensemble Models Based on the Behavioral Similarity Towards Sentiment Estimation

Akihiro MATSUFUJI¹, Eri SATO-SHIMOKAWARA¹, Toru YAMAGUCHI¹, and Lieu-Hen CHEN²

¹Tokyo Metropolitan University, Japan, ²National Chi Nan University, Taiwan

Abstract: Recent emotion recognition applications strongly rely on supervised learning techniques for the distinction of general emotion expressions. However, they are not reliable to unknown person, due to the individual differences between human emotional state and their emotion expressions. In this study, a novel multi classifier ensemble learning using dynamic weights based on the similarity of the emotion expression among different people is proposed to reduce the interference of unreliable decision information and adapt their individual differences. We proposed two dynamic weights definition methods which are based on the statistically feature analysis and the analysis of multi modal time series data using image-conversion. We demonstrated the flexibility of these methods to adapt their individual differences with finding the trained data of person who has similar individual differences between human emotional state and their expressed features.

Keywords: Affective Computing, Multi Classifier Ensemble, Dynamic Weights, Individual Difference, Visualization
**Comparative Study on Neural Network Models of Human Behavior Recognition Methods**

Jiazhi LI$^{1,2}$, Ning LIU$^{1,2}$, Dedi ZHANG$^{1,2}$, and Fuchao LIU$^{1,2}$

$^1$Beijing Key Laboratory of High Dynamic Navigation Technology, Beijing Information Science and Technology University, China, $^2$Key Laboratory of Modern Measurement and Control, China

**Abstract:** To solve the problem of human behavior feature extraction and classification, a human behavior recognition and classification method based on convolutional neural network (CNN) and long short-term memory network (LSTM) was proposed. Due to the strong correlation between the front and back movements of the human body, compared with the single convolutional neural network model, the model integrated with the long and short memory network can more accurately identify the six movements of walking, jogging, going upstairs, coming down, standing and sitting. The convolutional neural network is used to extract the acceleration features, and then the extracted features are input to the long and short term memory network for classification, to complete the human behavior recognition. Through simulation and verification, the CNN-LSTM hybrid model can achieve an average accuracy of 96.9% for action recognition by testing in the open WISDM data set and observing the results of several experiments, which verifies the feasibility of this method.

**Keywords:** Convolutional Neural Network (CNN), Accelerometer, Human Behavior Recognition, Wearable Devices, Long Short-Term Memory Network

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**Video Action Retrieval System Based on Behavior Gesture Recognition Technology**

Wenshan LYU, Bolong TANG, Haoping HU, Dan CHEN, and Hongbin MA

**Abstract:** At present, behavioral gesture recognition technology has a wide range of applications in various fields, including sports. With the 2022 Beijing Winter Olympics approaching, it is highly required to improve the training quality of athletes by developing a video action retrieval system using behavioral gesture recognition technology. This system is based on OpenPose, which enables us to recognize the athlete’s posture in the video and extract each posture feature and its frame number. Bayesian classifier is used to classify the extracted posture feature based on the constructed human posture database. When an athlete retrieves a certain action type in the training video, the classifier finds out all the actions of this type contained in the video. The frame number of all these actions will be converted into the position of the video progress bar and output. The system allows athletes to quickly retrieve specific actions in training videos and better discover the technical issues.

**Keywords:** Behavior Gesture Recognition, OpenCV, Bayesian Classifier, Video Stream Processing, Action Retrieval
**Economical Optimal of Virtual Power Plant with Source, Load and Storage**

Xiaohui CHANG, Wei CHEN, and Chunquan MI  
State Grid Zhangjiakou Power Supply Company, State Grid Jibei Electric Power Company Limited, China

**Abstract:** As an emerging form of energy aggregation, virtual power plant (VPP) can reduce the impact of the uncertainty of the output power of new energy sources such as wind power and photovoltaics on the grid security and improve the reliability of power supply. It is the future development of new energy grid-connected direction. In order to improve the scheduling flexibility of VPP, reduce power generation costs, and obtain better benefits for VPP, based on previous studies, considering the impact of load on VPP, a VPP economic optimization scheduling model considering source-load-storage joint operation is constructed in order to reduce forecast errors and increase VPP revenue, the scheduling model adopts multi-period scale optimization and multi-market profit model. Finally, particle swarm algorithm is used to solve the model and optimize the energy output in VPP. The simulation example analyzes the VPP internal power supply and the VPP output optimization situation, and compares and analyzes the interruptible load participation in the VPP scheduling and the impact of the change in the proportion on the VPP revenue, as well as the economic differences of the VPP under the four different operating modes. The simulation results show that the flexibility and economy of VPP can be improved by aggregating an appropriate proportion of interruptible loads and adopting a reasonable operation mode.

**Keywords:** VPP, Distributed Energy, Time-of-Use Electricity Price, Optimal Dispatch, Operation Strategy

**Space MMF Harmonic Rotor Losses Under Healthy and Open Circuit Conditions**

Xing GUAN¹, Zhen CHEN¹, and Yumeng LI²  
¹Beijing Institute of Technology, China, ²Beijing Institute of Control Engineering, China

**Abstract:** Rotor eddy current losses of a five phase dual-rotor permanent magnet synchronous machine (DR-PMSM) are investigated in both healthy working condition and open circuit fault conditions in this paper. The studied eddy current losses are induced by harmonics of stator magneto-motive force (MMF). The eddy current losses are calculated by finite element method (FEM) using an improved point current model to generate MMFs for different conditions. The calculation results are analyzed and applied in thermal analysis. Finally, experimental measurements and validations are conducted.

**Keywords:** Eddy-Current Loss, Magneto-Motive Force, Space Harmonics, Open Circuit Fault
**Optimal Dispatch Strategy of Renewable Energy Power System Based on Wind Power Forecasting**

Yulong HAN, Licai GUO, and Haibo HE  
State Grid Zhangjiakou Power Supply Company, State Grid Jibei Electric Power Company Limited, China

**Abstract:** China’s electric power system is undergoing a drastic change in which new energy gradually replaces traditional fossil energy. New energy generation represented by wind power has the characteristics of randomness and volatility, which brings challenges to maintain the power balance of the power system, and the problem of new energy consumption is increasingly serious. This paper focuses on the optimization dispatch of new energy power system based on wind power short-term forecast. Under the current situation of increasing proportion of new energy, the power system is stable and the new energy is absorbed as much as possible through optimal dispatching.

**Keywords:** Power System, Wind Power Forecast, Optimal Scheduling, Renewable Energy
General (M1-2): Advanced Control and Optimization for Drive and Energy System  
14:00-15:30, Nov. 1, 2021, Meeting Room 2

M1-2-5 15:00-15:15

Deep Learning Based Multi-Objective Power Grid Investment Behavior Analysis and Income Prediction

Wendong XIAO

M1-2-6 15:15-15:30

Design of Variable Frequency Control System of Direct-Drive Wind Motor

Quan LIU, Zhengjun HUANG, and Yibo ZHANG
Beijing Information Science and Technology University, China

Abstract: Based on the analysis of the principle and traditional control strategy of the converter, according to the design requirements of the converters, the design of the machine-side converter and the grid-side converter is introduced in detail. The converter control adopts zero DC current control and speed outer loop current inner loop control mode, and the grid-side converter adopts voltage outer loop current inner loop control strategy. It provides a theoretical basis for the subsequent establishment of the converter simulation model.

Keywords: Wind Turbine, Direct Drive, Pitch Controller, Variable Frequency Control
Fault Diagnosis of Elevator Safety Circuit Based on Deep Forest

Gan WU¹, Dong WEI², and Shuo FANG¹

¹Department of Electrical and Information Engineering, Beijing University of Civil Engineering and Architecture, China, ²Beijing Key Laboratory of Intelligent Processing for Building Big Data, China

Abstract: There exist some problems in the current diagnosis methods of elevator faults, including complicated calculation, numerous parameters and difficulties in effectively processing information of the faults’ feature. This paper proposes a method of diagnosing the faults of elevator’s safety loop, and designs a structure of the faults’ diagnosis model. Furthermore, on this basis a collection system of elevator’s fault signals is developed, with which, the parameters of corresponding feature can be obtained, and then the information of elevator faults’ feature can be extrated through Multi-Grained scanning. At last, diagnosing the faults of elevator safety loop is realized through Cascade Forest. The experiment result shows that with this method the diagnosis accuracy is 4% higher and the model operation time is 99.1% faster than BPNN.

Keywords: Elevator, Fault Diagnosis, Deep Forest

Characteristic Model-Based Intelligent Adaptive Control of Voice Coil Motor in Vibration Isolation of Airship Camera Stabilized Platform

Junjie GUAN and Shaoping SHEN
Department of Automation, Xiamen University, China

Abstract: Airship is easily disturbed and vibrates during flight, which affects the shooting effect of the on-board camera. However, the current three-axis stabilized platforms do not have the ability to isolate vibrations in the vertical direction. In this paper, we propose an airship camera stabilized platform that uses Voice Coil Motor (VCM) to isolate vibrations in the vertical direction. Firstly, we establish the mathematical model and control model of the VCM. Then we design the Characteristic Model-Based Intelligent Adaptive Controller for the VCM. Simulation experiments show that the adaptive control method is effective in VCM control and improves the stability and anti-interference ability.

Keywords: Voice Coil Motor, Adaptive Control, Vibration Isolation
Perimeter Control for Macroscopic Fundamental Diagram Systems Based on Neural Network and Generalized Predictive Control

Ying ZHANG, Yuntao SHI, Xiang YIN, Meng ZHOU, Weichuan LIU, and Daqian LIU
Key Lab of Field Bus and Automation of Beijing, North China University of Technology, China

Abstract: Macroscopic traffic flow forms show heavily similarity between days, so this paper uses past data to train a neural network for fitting the MFD system. This paper presents a framework for combining neural network with generalized predictive control. First, a region traffic network model is identified by the neural network which can approximate any nonlinear system. Second, the MFD system is transformed into linear system because of linearizing neural network models at each operation point. Third, the optimal perimeter control of the two regions is achieved by the generalized predictive control method with the instantaneous linearization model. Simulation results show that the proposed frame significantly alleviates congestion in the network and reduces the total travel time spend in the traffic network.

Keywords: Macroscopic Fundamental Diagrams, Neural Network, Generalized Predictive Control, Perimeter Control

Adaptive Optimal Control for a Class of Continuous-Time Unknown Nonlinear Systems via Generative Adversarial Networks

Chenglong WANG, Haiyang FANG, and Shuping HE
Key Laboratory of Intelligent Computing and Signal Processing (Ministry of Education), School of Electrical Engineering and Automation, Anhui University, China

Abstract: In this paper, we study the adaptive optimal controller design problems for a class of continuous-time nonlinear systems by using the generative adversarial networks (GANs). Combining the Q-learning algorithm and GANs scheme, we successfully design a new adaptive optimal control algorithm for continuous-time unknown nonlinear systems. We adopt the latest GANs training strategy to stabilize the nonlinear systems and prove the convergence of the designed adaptive optimal control algorithm. Finally, the effectiveness of the proposed method is verified by a simulation example and the superiority of the algorithm is illustrated by comparing the traditional actor-critic algorithm.

Keywords: Generative Adversarial Network (GAN), Adaptive Optimal Control, Nonlinear System, Q-Learning, Reinforcement Learning
Model Free Adaptive Iterative Learning Control for Power Inverter

Zhenxuan LI, Yilong ZHANG, Jijia ZONG, and Guo-Xin ZHAO
Beijing Institute of Petrochemical Technology, China

Abstract: In this paper, a model-free adaptive iterative learning control (MFAILC) scheme based on pulsewidth-modulated (PWM) is proposed for power inverter system. The goal of this work is to achieve a high-quality output voltage and robustness to disturbances and uncertainties in the inverter system. Only the measurement input/output (I/O) data of the controlled plant are used of the power inverter system. Furthermore, the repetitiveness was used by iterative learning control method. Through rigorous analysis, it is shown that the MFAILC method could deal with this class of control problem and greatly decrease the error of the current cycle by using the control input and tracking error information at the past repeated process. In addition, the feasibility and effectiveness of the proposed approach are further verified through case studies with intensive simulations.

Keywords: Power Inverter, Iterative Learning Control (ILC), Model-Free Adaptive Control (MFAC)

Research on Fault Diagnosis Algorithm of Substation Equipment Based on Improved Mask R-CNN

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¹China Electric Power Research Institute, China, ²Shanghai Electric Power Company Maintenance Company, China

Abstract: Electric power networks are composed of various electrical equipment. Any equipment failures can affect the stable operation of the electric networks. By analyzing the infrared images of substation equipment, equipment defects can be found in time to prevent malfunctions effectively. This paper proposes an infrared image fault diagnosis algorithm for substation equipment based on the improved Mask R-CNN. Attention mechanism is introduced into the feature extraction network, and the anchor ratios are modified. Firstly, the improved Mask R-CNN is applied to detect and segment the target equipment, including lightning arresters, current transformers side bushings, current transformers, and voltage transformers. Then the temperature is extracted from the infrared image. Finally, the relative temperature difference method is used to determine the fault type and seriousness. The original method and the proposed method were compared in aspects of split effect and temperature anomaly diagnosis. Experimental results show that the IoU (Intersection over Union) of proposed algorithm improves 6.08% compared with original method.

Keywords: Substation Equipment, Infrared Image, Attention Mechanism, Image Segmentation, Fault Diagnosis
M1-4-1 14:00-14:15

IoT Gateway with Edge Computing Function

Ruiguang CHEN¹², Xiaoyan ZHAO¹², Jianwei LI¹², Chunlei LI¹, Tianyao ZHANG¹, Yan CHEN², Jiawei WANG², Yihao WANG¹ and Zhaohui ZHANG¹³

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Abstract: With the development of cloud computing, distributed IoT systems are also constantly evolving. Due to the different requirements for data collection in different scenarios, the functions of edge IoT systems are also different. Some of the Internet of Things (IoT) data collection load is heavy, but the amount of data that needs to be uploaded is not large. Some IoT needs to prioritize the collected data or filter some private data. For this reason, the gateway built between the IoT and the Internet should have certain functions of calculation and data concentration. This article uses RK3399 as a platform to transplant an embedded operating system, and uses a custom data frame to convert data from sensor network coordinators into a unified format such as ZigBee, Wi-Fi, LoRa, etc. According to different attributes such as type, source, authority, priority, the data is classified, stored, filtered, and calculated. Finally, the saved data is forwarded to the network in the form of a file by the TCP/IP protocol to realize remote data monitoring. Performing certain calculations and classification processing in advance through the gateway reduces the load of the access network and the pressure of data processing for the data aggregation center. In addition, the local data storage function of the gateway not only reduces the risk of data loss, but also provides the possibility for repeated queries. At the same time, the gateway also reserves a corresponding server thread for the access control of the local area network.

Keywords: Internet of Things (IoT), Data Processing, Edge Smart Gateways, Edge Calculation

M1-4-2 14:15-14:30

Research on Wireless Coverage Performance of LTE-V2X in Urban Scenario

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¹China United Network Communications Group Co., Ltd., China, ²School of Electronic and Information Engineering, Beijing University of Aeronautics and Astronautics, China

Abstract: As a ubiquitous connection scenario, IoV is the infrastructure and technical path to realize intelligent transportation. With the development of communication technology, more and more entities are added to the communication network and become the elements of the network. How to reasonably deploy the devices according to the scenario characteristics has become the key point of the development of V2X technology. In this paper, comparison between Uu communication and PC5 communication in LTE-V2X as well as the classification of LTE-V2X are first introduced. Moreover, typical scenarios of V2X communication are analyzed. Finally, test and evaluation work for V2X network quality are conducted and recommendations are made for RSU deployment. It can be concluded that in the urban scenario, the effective coverage distance is about 400 to 500 meters. Surrounding trees and buildings have obvious shielding effect on LTE-V2X signals, and therefore, RSUs cannot cover the next intersection. In actual deployment, some roads should supplement more RSUs to satisfy the coverage requirements. Recommendations for deployment scheme in urban scenarios are also presented.

Keywords: LTE-V2X, RSU Deployment, Network Quality
Gradient-Based Optimizer for Scheduling Deadline-Constrained Workflows in the Cloud

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School of Automation, Beijing Institute of Technology, China

Abstract: In recent years, as cloud computing has become a promising paradigm which can dynamically provide users with elastic computation resources, more and more scientific and business applications represented by workflows have been moved or are in active transition to cloud platforms. Therefore, efficient cloud workflow scheduling methods are in high demand. Inspired by the gradient-based Newton's method, gradient-based optimizer (GBO) is a novel meta-heuristic algorithm which shows promising results due to its enhanced capabilities of exploration, exploitation, and effective avoidance of local optima. Hence in this paper, we design a workflow scheduling algorithm based on GBO, which aims to minimize the execution cost of scheduling workflows under the given deadline constraints. We also conduct extensive comparative experiments with a genetic algorithm and particle swarm optimization over well-known scientific workflows with different sizes and types through WorkflowSim. The experimental results show that the proposed GBO-based scheduling algorithm has better performance than its peers in both constraint satisfiability and cost optimization, which proves its effectiveness in addressing workflow scheduling problems.

Keywords: Gradient-Based Optimizer, Cloud Computing, Workflow Scheduling, Meta-Heuristics
Research on Edge Cloud Load Balancing Strategy Based on Chaotic Hierarchical Gene Replication

Leilei ZHU\textsuperscript{1}, Zhao KE\textsuperscript{1}, Zhichen WU\textsuperscript{1}, Dan LIU\textsuperscript{1}, Wei SU\textsuperscript{2}, and Li LI\textsuperscript{1}

\textsuperscript{1}College of Computer Science and Technology, Changchun University of Science and Technology, China, \textsuperscript{2}College of Medical Information, Changchun University of Chinese Medicine, China

Abstract: Edge cloud is usually used to dispose delay-sensitive business, realize the processing and analysis of local real-time and short-cycle data. However, due to the large number of concurrent requests for edge intensive tasks, the resource allocation strategy will seriously affect the stability of nodes. To solve this problem, an adaptive resource allocation model (CRPSO model) based on chaotic hierarchical gene replication is proposed in this paper. In the model, the concept of chaotic replication ratio is proposed. Based on Kubernetes edge cluster, the resource allocation results of CRPSO model are verified from three aspects: CPU variance, memory variance and total variance of two kinds of resources. Experiments show that the fitness of this model is much higher than that of the comparison algorithm on average, and the convergence rate of this model remains optimal even though the solution space is set to be exponential. In addition, the variance fluctuation range of CPU and memory is lower than that of Kubernetes clustering algorithm after resource allocation. Therefore, this model is suitable for edge large-scale task request scenario.

Keywords: Edge Cloud, Resource Allocation, Chaos Theory, Replication Ratio, Kubernetes

A Data Fusion System for Multi-Protocol Internet of Things

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\textsuperscript{1}School of Automation and Electrical Engineering, University of Science and Technology Beijing, China, \textsuperscript{2}Shunde Graduate School of University of Science and Technology Beijing, China, \textsuperscript{3}Beijing Engineering Research Center of Industrial Spectrum Imaging, University of Science and Technology Beijing, China

Abstract: Due to the heterogeneity of various communication protocols in the Internet of Things (IoT) system, there is no unified communication interface standard for IoT devices. Multi-protocol IoT data fusion system was designed in this paper, which can be applied to the environmental detection of smart community. This system is based on the idea of layered design model. Firstly, various sensors are used in the sensing layer to collect environmental information in the community. Then, four wireless communication protocols, WiFi, ZigBee, LoRa and Bluetooth, are used in the wireless transmission layer to transmit the data in the sensing layer to the next layer. Secondly, protocol adaptation layer is added between wireless transport layer and application layer. In the protocol adaptation layer, a unified communication frame format is formulated. Finally, in the application layer, we developed the upper computer software through QT, and the gateway completes the data interaction with the application layer through TCP/IP protocol. The test results show that the system can support the data acquisition of multiple types of sensors and transmit the data through the above four wireless communication technologies. This system can complete the unified conversion of data format in the protocol adaptation layer and also has a strong data transmission stability, in line with the application requirements.

Keywords: Wireless Communication, Internet of Things (IoT), Data Fusion, Multi-Protocol
Stochastic Adaptive Dynamical Games

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Abstract: In the past half century, game theory and control theory have made great progress. Although game theory, especially dynamic game, is closely connected with control theory, they have been developed in parallel to a great degree. As for adaptive control, there is few research work on systems where there are competitions among agents. And in real world systems, uncertainties always exist in game models, while almost all of the existing studies assume that the model parameters are known to the players. There is few existing result related to such stochastic adaptive game problems, since uncertainty raises the difficulty of making decisions for players. How to design the game strategies when the internal parameters of the game systems are unknown is a meaningful research direction. We attempt to cope with this problem by combining the methods of adaptive control, which use the online measurement information to estimate the unknowns, and then construct the controller by the so called “certainty equivalence principle”. We study the stochastic adaptive dynamical game, focusing on the question how to design adaptive game strategies for linear systems of the pursuit-evasion game and the attack-defense game with quadratic indexes, when the internal parameters of the systems are unknown. Specifically, first of all, the players respectively use the least squares estimation algorithms to estimate the unknown parameter. Secondly, the players construct their adaptive strategies using their own parameter estimators. At last, we prove that, the adaptive strategies makes the system globally stable, and that the action profile is an asymptotic Nash equilibrium solution to our game problem in a certain sense.

Keywords: Stochastic Systems, Dynamic Game, Adaptive Control, Stability, Asymptotic Nash Equilibrium

Convergence Analysis and Strategy Control of Evolutionary Games on Square Lattice

Ge CHEN and Yongyuan YU
The Combat Game on a Plane Between Two Agents

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Abstract: This paper explores the combat game between two agents, which might be the unmanned aerial vehicles (UAV), AIs for electronic games, or robots to play soccer. The game is played on a 2-D latticed plane while the agents have the finite life and capability to attack. The boundedly rational agents will make decisions based on their predictions of their opponents. The evolutionary features of such a system as well as some analysis about the optimal strategies for agents will be investigated.

Keywords: Zero-Sum Game, Level-1 Predictions, Combat Game, Game Dynamics

Regulation on Nash Equilibriums in Game-Based Control Systems

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Abstract: The game-based control system (GBCS), which is a cross between control theory and game theory, was established to investigate objects driven by the external input and their own interests. This paper studies a special type of GBCSs with rational players, openloop Nash equilibrium of which is unique under any given initial state and macro-regulation. To make low-level micro-followers “better” by resorting to macro-regulation, two kinds of regulation on Nash Equilibriums are discussed under Pareto and Kaldor-Hicks criteria, respectively. By resorting to macro-regulation, one occurs the Pareto improvement on Nash Equilibriums, the other achieves the potential Pareto improvement while generating the optimal action profile, both of which reduce the inconsistency between individual and collective rationality. Some conditions are given to determine the solvability of corresponding regulation problems on Nash Equilibriums.

Keywords: Nash Equilibrium, Game-Based Control System, Optimal Control, Differential Game
Confrontation Analysis of Wargame Deduction in Zero-Sum Game Based on Petri Net

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Abstract: According to the major special guidance of the new generation of artificial intelligence, for the needs of future operations, the confrontation agent needs to complete complex tasks autonomously, make correct judgments on the surrounding environment and surrounding dangers at the first time, and have the ability to unsupervised learning and adaptive learning for the agent put forward new requirements. This article assumes that the red and blue each have three tanks to take control of the center of the map. The opposing parties can use their own cooperation and enemy-to-enemy to conduct Wargames. Through the Petri net, the red and blue agent confrontation simulation shows the process of cooperative and non-cooperative game between the red and blue parties. Finally, PIPEv4.3.0 is used to analyze the confrontation effect of the simulated Petri net, whether there are deadlocks and minimum traps. Provide guidance and countermeasures for follow-up operations.

Keywords: Petri Net, Cooperative Game, Non-Cooperative Game, Wargame

Dynamic Games with Dynamic Uncertainty

Renren ZHANG
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Abstract: Uncertainty has been studied a lot in both control theory and game theory. Especially in control theory, how to use feedback to deal with uncertainty is the core problem. The paper initially explores dynamic games with dynamic uncertainty from the perspective of control theory. As a starting point toward investigating the problem, the easy-to-understand boolean dynamic game described by a boolean mapping \( f \) is selected and the dynamic uncertainty is represented by a set of boolean mapping \( F \). All game participants know the dynamics of the system \( f \) is in \( F \) but do not know which one it is. To get some initial insight to the problem, it is formulated as a Bayesian game. Some results of the existence and computation of the Nash equilibrium are given in the paper.
A Maze Robot Autonomous Navigation Method Based on Curiosity and Reinforcement Learning

Xiaoping ZHANG, Yihao LIU, Dunli HU, and Lei LIU
School of Electrical and Control Engineering, North China University of Technology, China

Abstract: Robot navigation gets a lot of attention today, and more and more scholars are trying to find new ways to make robot’s navigation more intelligent. Maze problem is a typical case of robot autonomous navigation, which is also what we study in this paper. In maze problem, finding the exit quickly is one of the important indexes to measure the quality of the algorithm. Reducing unnecessary exploration can solve this problem well. With this in mind, we design an autonomous navigation algorithm for maze robot based on curiosity and Q-learning. The curiosity is designed based on the Sigmoid function, and it influences the probability of the action selection in reinforcement learning way. In addition, a memory module is designed to store nodes and Q-values in sequence. The information that recorded is used for the curiosity on the one hand, and makes global reinforcement on the other hand. We simulate the feasibility and advantages of the algorithm respectively, and results show that the robot can reduce repeated exploration of the environment in the process of autonomous navigation, and it has a faster convergence rate compared with the Q-learning algorithm without curiosity.

Keywords: Curiosity, Autonomous Navigation, Maze Robots, Q-Learning

A Heuristic Route Planning Algorithm for Air-Ground Collaborative Surveillance

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Abstract: This paper addresses a novel route planning problem of an air-ground collaborative system for intelligence, surveillance, and reconnaissance mission. In the collaborative system, a ground vehicle (GV) travels on the road network and its carried unmanned aerial vehicle (UAV) travels in areas beyond the road to visit a number of targets unreached by the GV. The UAV needs to launch and land on the GV frequently to change its battery. We model the two-echelon cooperative route planning problem for the GV and the UAV as a constrained optimization problem which tries to minimize the overall execution time for completing surveillance tasks. To solve this problem, a splitting-based heuristic is proposed to rapidly construct GV and UAV routes. A node selection algorithm is developed and embedded to select the appropriate rendezvous nodes between UAV and GV. Computational results show that the proposed approach can effectively generate better cooperative GV and UAV tours to complete the surveillance missions in a shorter time when compared to other two competitive approaches in the literature.

Keywords: Two-Echelon Routing, Air-Ground Collaboration, Route Planning
M1-6-3 14:30-14:45

An Improved Fuzzy Neural Network for Obstacle Avoidance of Mobile Robot

Tian GAO, Qinglin WANG, Yaping DAI, and Zhiyang JIA
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Abstract: In order to solve the problem of complex structure and heavy computation load of fuzzy neural network (FNN) in the application of mobile robot obstacle avoidance, an improved fuzzy neural network is proposed. The last two layers in conventional FNN are combined and optimized in the proposed network. By matching the connection weights of the last layer in the network with the central values of the membership functions of the output variables, the number of parameters to be tuned is greatly reduced. The structure and calculation of the network are optimized. The simulation result indicates the effectiveness of the proposed network in obstacle avoidance of mobile robot.

Keywords: Fuzzy Neural Network, Obstacle Avoidance, Mobile Robot, Multi-Sensor

M1-6-4 14:45-15:00

Multi-Scale Batch-Learning Growing Neural Gas for Topological Feature Extraction in Navigation of Mobility Support Robots

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Abstract: Recently, the concept of digital twin is applied to various research topics. The aim of digital twin is to simulate and analyze the real world in the cyber space. In order to simulate a real-world phenomenon, we often have to extract features and structures based on graph theory and topology. The methodology of growing neural gas (GNG) is useful to extract topological features hidden in big data. In this paper, we propose a method of multi-scale batch learning (MS-BL) to the realize stable learning of GNG. Next, we apply the proposed method to the topological feature extraction in navigation tasks of mobility support robots. Finally, we show experimental results of the proposed method and discuss the effectiveness of the proposed method.

Keywords: Topological Mapping, Growing Neural Gas, Multi-Scale Batch Learning, Mobility Support Robots
Ground Automatic Recycling System for UAVs in the Wild

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Abstract: The safe recycling is a huge challenge for the unmanned aerial vehicle (UAV) in complex terrains, especially in the wild. A ground automatic recycling system (GARS) is designed for UAVs recycling in this paper, and it aims to provide a safe, moving, flexible, level landing platform for drones. The GARS consists of three parts: the UAV positioning subsystem (UAVPS) for detecting and positioning the drone, the ground tracking subsystem (GTS) for dynamically tracking the landing point and the comprehensive undertaking subsystem (CUS) for reliably recycling. In this paper, the working principle and the hardware structure of the GARS are introduced first. Secondly, the algorithms of three subsystems are designed. Finally, the experiments of the UAV recycle are carried out in the wild. The results show that the system can effectively recycle UAVs in the wild environment, which verifies the effectiveness of the algorithms.

Keywords: UAV Recycling, Aerial Target Positioning, Dynamic Tracking, Stewart Platform

Three Dimensional Path Planning for UAV Based on Chaotic Gravitational Search Algorithm

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Abstract: Path planning is a critical problem for an unmanned aerial vehicle (UAV), which assists UAV to find a desirable path under some constraints. A chaotic gravitational search algorithm (CGSA) is proposed for UAV path planning in three dimensional (3D) environment. Firstly, the cost function considers the path length, turning angle, climbing angle, and maximum and minimum flight heights. Secondly, the chaotic sequence of the sine map is used to determine the size of the Kbest set storing the best agents in gravitational search algorithm (GSA), which improves the balance of exploration and exploitation. Finally, the simulation results demonstrate that CGSA is more effective and better than the moth flame optimization algorithm (MFO) and GSA in 3D path planning.

Keywords: Unmanned Aerial Vehicle (UAV), Path Planning, Gravitational Search Algorithm, Chaos
Quantum Representation for Robot’s Emotions Based on PAD Model

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Abstract: The development line of robotics is marked with the triad: industrial-assistive-social robots, which leads from human-robot separation toward human-robot interaction (HRI). Exploiting the promise of security and efficiency that quantum computing offers, a quantum representation based on the Pleasure-Arousal-Dominance (PAD) emotion model (QRPE) is proposed, which utilizes only $n + 3$ qubits to store robot emotions in a time cycle. Meanwhile, an example to illustrate quantum robot emotional state is given. Furthermore, three unitary operations that can be performed on the QRPE model to achieve specific transitions are designed. They facilitate the construction of complex quantum algorithms to deal with robot’s emotions and the improvement of robot’s ability to provide better service to humans.

Keywords: Quantum Computing, Human-Robot Interaction, Robot’s Emotions, PAD Emotion Model

Research on the Path of Developing Information Literacy of Teachers from Colleges of Foreign Languages from the Perspective of Artificial Intelligence

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Abstract: With the popularization of artificial intelligence in various fields, its application in the education industry has also been deepening. Based on the literature and experts’ opinions on teachers’ information literacy and the application of artificial intelligence in teaching, artificial intelligence is believed to provide more effective supports for the development of teachers’ information literacy in foreign language colleges and universities. The research of this subject is expected to explore an effective path of developing the information literacy of teachers from colleges of foreign languages, so as to provide a useful reference for the further research.

Keywords: Artificial Intelligence, Teachers in Colleges and Universities, Information Literacy
A Multi-Modal Fusion Algorithm for Cross-Modal Video Moment Retrieval

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Abstract: In order to localize the most relevant moment in an untrimmed video according to the given sentence query, a multi-modal fusion algorithm for cross-modal video moment retrieval is proposed. The key idea of the multi-modal fusion algorithm is to separate the consistent features from the information across modalities and then concatenate them. The concatenated consistent features are taken as the input of the coordinates prediction network, and the regression temporal coordinates are obtained. The correlations between the consistent component pairs can enhance the expressiveness and interaction of the video features and sentence features, thus improves the accuracy. The effect of the proposed algorithm is verified on a public benchmark dataset: TACoS. The results show the effectiveness of the proposed algorithm as compared with CTRL and ACRN under TACoS dataset.

Keywords: Video Moment Retrieval, Multi-Modal Fusion, Deep Learning, Attention Mechanism

An Emotion Recognition System Based on Human Behavior in Passenger Transport

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Abstract: Passengers’ abnormal emotions such as nervous and anger often lead to traffic accidents in passenger transport. Surveillance of abnormal emotions possesses significant potential for increased security within passenger transport. An emotion recognition system based on human behavior is designed in this paper. Three emotions of quiet, nervous, and anger are set in research. The system uses long short-term memory to process human behavior data, and recognizes whether passengers have abnormal emotions such as nervous or anger based on behavioral analysis. Experiments on the recognition performance of the system, the experimental results show that the system has an accuracy of more than 95%, and the recognition period is between 2 to 3 seconds.

Keywords: Emotion Recognition, Body Behavior, Recurrent Neural Networks (RNN), Passenger Transport Safety
Facial Emotion Recognition Using Convolution Neural Networks-Based Deep Learning Model
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Abstract: With the development of emotion recognition, learning, and analysis, robotics plays a significant role in human perception, attention, memory, decision-making, and social communication, leading to emotion recognition and human-robot interaction (HRI). This research analyzes the interaction between humans and robots using facial expressions and head pose to achieve robustness in understanding emotions by optimizing the traditional deep neural networks to comprehend the coexistence of multi facial information in HRI using convolution neural networks. A hybrid genetic algorithm with stochastic gradient descent is adopted, which has the capacity of inherent, implicit parallelism and better global optimization of the genetic algorithm to find the better weights of the network. The experiment shows the proposal’s effectiveness in providing complete emotion recognition through single-modal cooperation of HRI that can interact with humans and machines.

Keywords: Convolutional Neural Network (CNN), Deep Learning, Emotion Recognition, Facial Expression, Head Pose

Multi-Objective Route Planning Based on Machine Emotion
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Abstract: Nowadays, driverless technology is developing continuously, and route planning is a key link in driverless technology. To improve the intelligence of route planning, a multi-objective route planning approach based on machine emotion is proposed. The machine emotion adds human like emotion factors in the decision-making process. By combining with linear weighted multi-objective optimization, the human-computer interaction in navigation technology is improved. We used “OpenSceneGraph” software to simulate our method and made a field investigation. The experimental results show that this approach selects a route different from the ordinary one. The approach comprehensively considers the travel time, fuel consumption and passengers’ emotions, which demonstrates the feasibility of our method.

Keywords: Driverless Technology, Machine Emotion, Route Planning, Artificial Emotion Simulation
Design and Implementation of Situation Plotting System Based on Hand-Drawn Sketch Recognition

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Abstract: Military symbology sketch is the most natural human-machine interaction way to express human thinking and also an important means to express battlefield situation. Aiming at the problems of sparse data set, low recognition accuracy and difficult model application of military symbology sketch, this paper proposes a situation plotting system based on hand-drawn sketch recognition. Firstly, through the self-developed military symbology sketch acquisition application, the data set is collected. Then the military symbology sketch is trained based on ResNet34 and the trained model is applied to the Web situation plotting system to realize online military symbology sketch recognition. Finally, the feedback mechanism is introduced to promote the correction of the ResNet34 model, so as to further improve the accuracy of sketch recognition and the human-machine interaction efficiency of the situation plotting system.

Keywords: Situation Plotting System, Military Symbology, Sketch Recognition, ResNet34

A Multi-Scale Feature Fusion Network for Facial Expression Recognition

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Abstract: A multi-scale feature fusion network is proposed for facial expression recognition (FER). The three-branch architecture is employed to extract abundant facial features from various depths and scales. Our main contributions are twofold. First, the feature extraction module is designed to effectively extract multiscale image information and enhance network ability of feature representation. Second, the feature fusion module is presented to adaptively evaluate the importance of different cross-branch features and fully emphasize the role of distinguishable features for expression classification. In addition, the basic feature extraction unit cascaded in feature extraction module is proposed with different receptive field filters to extract multi-scale features. Experimental results on two public datasets, FER2013 and CK+, demonstrate that our proposed method outperforms the previous methods with the accuracies of 72.67% and 96.00% respectively.

Keywords: Facial Expression Recognition, Multi-Scale Feature, Feature Fusion, Deep Neutral Network
A Memory Matching Algorithm Based on Box IoU Features for Pedestrian Flow Counting

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Abstract: Automatic pedestrian flow counting on street view surveillance video is faced with challenges such as occlusion, illumination changes and scale changes. These challenges lead to misdetection which affect the accuracy of pedestrian flow counting. Aiming at these problems, a memory matching algorithm based on box Intersection over Union (IoU) features of inter frame bounding box is proposed. By memorizing the box IoU features between frames, the algorithm can ignore the false detected pedestrians and track the lost pedestrians to a certain extent, so as to improve the accuracy of counting. The experimental results on the UCSD data set show that the algorithm has high accuracy which reaches 97.2%.

Keywords: Pedestrian Flow Counting, Data Association, Neural Network, Pedestrian Detection
Research on Application of Classification Model and Behavior Recognition Based on Support Vector Machine

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Abstract: In order to effectively monitor whether cows have estrus behavior, a combination of background subtraction and external contour feature extraction of cows is proposed to extract cow targets. Use Support Vector Machine (SVM) model to identify its crawling behavior. Use the background subtraction method to extract the moving cow target from the video, preprocess the extracted cow targets; Realize the simulation design of the extraction function of the two geometric features of the cow’s target minimum circumscribed rectangle aspect ratio and centroid aspect ratio; According to the different postures of the cows, an SVM classification and recognition model is established to effectively identify the estrus behavior of the monitored cow. Experimental results show that the proposed method can effectively process the actual video key frames, and the average accuracy of cow behavior recognition can reach 97.5%.

Keywords: Target Detection, Feature Extraction, Behavior Recognition, Support Vector Machine (SVM)

Monitoring of Ruminating Behavior of Dairy Cows Based on Scale-Adaptive KCF

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Abstract: Detecting and tracking the ruminating behavior of dairy cows can obtain information on their physiological activities in time, and provide effective data for dairy cow health monitoring. This study is based on the scale-adaptive KCF (kernel correlation filter). Based on the acquisition of the cow’s mouth area, the cow ruminating activity is tracked in real time, and the ruminating curve is drawn to obtain the cow’s ruminating amount within a certain time range. The experimental results show that the improved scale-adaptive KCF algorithm can accurately analyze the ruminating behavior of dairy cows.

Keywords: Cow Rumination, Target Tracking, Adaptive Scale
Design of a Hybrid Transmission Line Inspection Robot

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Abstract: A hybrid transmission line inspection robot is a combination of a multirotor and a power line landing mechanism, which can perform both airborne and on-wire inspections. An improved design of a hybrid automatic inspection system is demonstrated in this paper, planned to land on a shield line. Installed with a lightweight landing mechanism consists of a belt system drive linear motion mechanism and a gear rack drive wire clamper, the robot can perform both airborne and on-wire inspection to powerlines. The finite element analysis on key components was conducted. In the field, the robot was found to have an acceptable flight performance.

Keywords: Powerline Inspection Robot, Robot Components Design

Calibration and 3D Measurement of Bionic Compound-Eye Vision System

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Beijing Institute of Technology, China

Abstract: In computer vision, the emerging large requirements on large field of view, small size and high sensitivity of interested objects, makes the research on artificial bionic compound eyes a new hot spot. On the basis of previous research, this paper designs and calibrates a compound eye system based on neural network model. The model and calibration can replace tedious developments with intelligent learning, the neural network model parameter identification. The experiments on 3D measurement of close-range objects verified the proposed method.

Keywords: Compound-Eye, Neural Network, Calibration, 3D Measurement
A Robot Partner Communication System for Smart Home Based on Healthcare as a Service

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Abstract: In recent years, population aging has become a severe social problem. By using smart homes that include robot partners, we can monitor the health of the elderly without additional human resources, but it is a challenge to provide personalized intelligent healthcare services for the elderly. This paper explains a human-centric approach to provide personalized services. From the viewpoint of healthcare as a service, we design a cloud-based healthcare system for smart homes. Next, we explain the system’s data structure and information flow, including sensors and service robots. Furthermore, we develop a scenario editor to realize the accessible design of healthcare services. In the demonstration, as a personalized function of essential fall detection, through the scenario editor, we design a situation confirmation function based on robot communication to prove the effectiveness and usability of the system.

Keywords: Healthcare as a Service, Partner Robot, Scenario Editor

Designing and Modeling of Coanda Drone for Controllability

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Abstract: This study proposes an aircraft design that can enable the development of a safe coanda drone without exposing the propeller. In the previously proposed coanda drone design, there is no external force in the yaw axis direction in the linear approximation model; therefore, the model is not controllable. This study proposes redesigning the propulsion mechanism that had previously been designed to be perpendicular to the ground to enable effective control of the yaw axis. The state equation derived shows that the airframe redesigned is controllable. The angle of the propulsion mechanism was changed at an interval of 15 degrees in the range 15–60 degrees, and the difference in response at that time was compared and verified through the simulation experiments conducted. This study shows that the redesigned coanda drone is controllable and useful in future control system designs. Since payload is important in drone systems, it was often assumed that tilting the thrust mechanism of the drone should be minimized; however, the results presented herein show that tilting of the thrust mechanism is not a significant issue from the viewpoint of mobility.

Keywords: Drone, Unmanned Aerial Vehicle (UAV), UAS, Design, Modeling, Control, Coanda Effect
Comparison Study of the State-of-the-Art Algorithms on the Multi-Objective Task Planning of Unmanned Aerial Vehicles with Heterogeneous Payloads

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Abstract: This work presents a comparison of three “state-of-the-art” multi-objective evolutionary algorithms, the non-dominated sorting genetic algorithm II (NSGA-II), the decomposition-based multi-objective evolutionary algorithm with the $\epsilon$-constraint framework (DMOEA-$\epsilon$C) and decomposition-based multiobjective evolutionary algorithm with the adaptive weight vector adjustment (MOEA/D-AWA), when applied to the task planning of unmanned aerial vehicles (UAVs) with heterogeneous payloads. The problem studied in this paper is a mixed-variable optimization problem, which involves the task allocation with inequality constraints and the path planning with neighborhood and curvature constraints. To solve this problem, a bi-level solution scheme is proposed. In the first level, the task allocation is solved by the “state-of-the-art” algorithm with the proposed encoding, the crossover operator, and a series of mutation operators. In the second level, the path planning is solved by a sampling-based heuristic method. In order to verify the performance of these “state-of-the-art” algorithms on the problem of this paper, several random simulation instances with different scales are constructed, and the calculation results are analyzed by using multiple performance evaluation indexes. The comparative results show that DMOEA-$\epsilon$C can find significantly better Pareto fronts in most instances.

Keywords: Multi-Objective Evolutionary Algorithm, Unmanned Aerial Vehicle (UAV), Task Planning, Task Allocation, Path Planning

Multi-Objective Path Planning Based on an Improved GWO-WOA Method

Meng ZHOU, Zihao WANG, Jing WANG, Weifeng ZHAI, and Tonglai XUE

School of Electrical and Control Engineering, North China University of Technology, China

Abstract: The problem of multi-objective path planning for robots is to find the shortest, smoothest and safest path in the presence of obstacles, which can be proposed as a multi-objective optimization problem with generous constraints. In this paper, an improved GWO-WOA method is proposed achieve the solution, which mainly consists the following two improvements: First, a tent chaos mechanism is used to improve the initial population quality of grey wolf optimizer (GWO). Second, the hunting mechanism of the whale optimizer algorithm (WOA) is replaced to the hunting strategy of GWO, which can improve the tracking performance of the optimal global exploration searching solutions and avoid falling into the local optimization. Then, a smooth path is calculated based on the proposed hybrid GWO-WOA with spline interpolation method. To further reduce the computing burden, an one-dimensional search method for iteration process is proposed and compared with two-dimensional search method. Finally, simulation experiments demonstrate the feasibility and effectiveness of the proposed algorithm under different environments.

Keywords: Path Planning, Tent Chaotic Strategy, GWO-WOA Method, Collision Avoidance, Path Smoothness
M2-3-1 15:40-15:54

Analysis of Long-Term Care Insurance Data for Deterioration in Care-Need Level at 3 Cities in Rural Japan

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Abstract: In Japan, Long-Term Care Insurance (LTCI) system has been managed by the municipal governments for providing the care for the elderly by the entire society. We analyzed effects of LTCI services for deterioration in care-need levels in 3 cities of rural area Japan in order to evaluate the difference of LTCI system at each city. We calculated the utilization ratio of LTCI services and hazard ratio (HR) for the deterioration event in 3 years from the first LTCI certification, which the HRs were estimated by survival analysis method. The analysis results showed that the utilization ratios were affected by the initial care-need levels and the participant’s living area. The deterioration events tended to occur at the lower care-need level and the effects of the LTCI services varied by care-need levels and the living area. These results suggested that there existed regional differences in LTCI service system.

Keywords: Long-Term Care Insurance (LTCI), Care Need Level, Survival Analysis

M2-3-2 15:54-16:08

Few-Annotation Training by Data Augmentation in Agriculture

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Abstract: Automation of agricultural management has become important by an aging population and decreasing agricultural population. A deep neural network can be applied to detect vegetables and fruits on a farm. Detecting objects in an image taken from a camera leads to counting the objects. However, the training cost for the deep neural network is generally high, and it requires a high-quality large dataset and time consumption. Also, there are various kinds of vegetables, and it is not feasible to train and tune neural networks for all of them because creating datasets for all vegetables requires a high cost. Then, we propose the method which employs a few-shot model and data augmentation for few-shot and few-annotated datasets. Finally, we create the novel dataset for detecting eggplants as a dataset for our experiment and evaluation. As a result, the proposed method with the few-annotation and few-shot settings obtained 5 to 20 points improvement of accuracy than that of the Faster R-CNN with the few-shot settings on AP50, and the model converges earlier 50–200 epoch than that of Faster R-CNN. However, the few-shot model with the few-shot setting obtains a higher performance than the few-shot and few-annotation settings on AP50 and converging time.

Keywords: Object Detection, Few-Shot Learning, Data Augmentation
Product Selection Support System Based on Ordered Structure by Formal Concept Analysis

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Abstract: With the spread of electronic commerce, it is necessary to find, compare, and select products from a wide variety of products. In a real shop, we can ask staff, but in an online shop, you have to investigate and compare by yourself. In a large-scale net shop, it is possible to accumulate behavior data of many users and make a proposal, but it is difficult to use a similar algorithm in a small-scale net shop because the amount of data is small. In this paper, we propose a recommendation algorithm for small datasets by focusing on the ordered structure obtained by formal concept analysis. Experiments on two datasets confirmed that some recommendation is possible and that performance is improved by using the sequential structure obtained by formal concept analysis.

Keywords: Recommend System, Formal Concept Analysis

Personal Values Modeling with Rough Sets for Collaborative Filtering

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Abstract: This study proposes models to apply recommendation method focusing on personal values to a recommendation explanation. The proposed models use rough sets theory, and the number of extractable If-Then rules can be increased compared to previous studies. The performance of the proposed models is experimentally evaluated and compared to that of the conventional collaborative filtering model in terms of the score prediction accuracy of items, coverage of items, and computation time. The model with the highest accuracy in the proposed models achieves 0.140 for MAE and 0.157 for RMSE smaller than the conventional one. In addition, the proposed models can calculate the similarity between users in 1/7 to 1/4248 of the time compared to the conventional one. The experimental results indicate that the recommendation accuracy is improved by using the actual score as it is without reducing the rating to a binary value, positive or negative. In addition, the proposed models are more effective for datasets with a large number of items in terms of computation time.

Keywords: Personal Values, Rough Sets, Collaborative Filtering, Recommender System, Recommendation Explanation
Genetic Algorithm Based Automatic Layer Selection of Transfer Learning for Object Detection

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Abstract: A method for automatic re-learning layer selection based on a genetic algorithm is proposed to solve the difficulty of conventional transfer learning of deep learning-based object detection models. The genetic algorithm of the proposed method can select the re-learning layers automatically in the transfer learning process instead of a trial-and-error selection of the conventional method. A transfer learning experiment from the COCO dataset to the Global Wheat Head Detection (GWHD for short) dataset was performed using fine-tuning and the proposed method, and the results were compared. Using the training data and the validation data of the GWHD, we compare the mean average precision of the models trained by the conventional and the proposed methods, respectively, on the test data of the GWHD. It is confirmed that the model trained by the proposed method has higher performance than the model trained by the conventional method. The average of mAP of the proposed method, which automatically selects the re-learning layer ($\approx 0.603$), is higher than the average of mAP of the conventional method ($\approx 0.594$). Furthermore, the standard deviation of results obtained by the proposed method is smaller than that of the conventional method, and it shows the stable learning process of the proposed method.

Keywords: Deep Learning, Genetic Algorithm, Object Detection, Transfer Learning

A Comparative Study on Statistical Method and Neural Network in COVID-19 Forecasting

Naoki DOHI and Yukinobu HOSHINO

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Abstract: This study about forecast Japanese confirmed cases of the novel coronavirus to assist in decisions. There are statistical models and machine learning models for forecasting the time series data. Statistical models performed better than machine learning models. The experiment results were confirmed by both comparisons. Therefore, this paper would like to report the forecast confirmed cases of the novel coronavirus. SARIMA (Seasonal AutoRegressive Integrated Moving Average) and RNN (Recurrent Neural Network) are compared by RMSE (Root Mean Square Error). Results show that RNN (with vector inputs) was better than statistical models.

Keywords: Statistical Model, SARIMA, Machine Learning, Deep Learning, Recurrent Neural Networks (RNN), Time Series Forecasting, COVID-19, Novel Coronavirus
Experimental Analysis of Injection Attacks of Various Recommendation Systems Using Real Data

Soichiro HASHIMOTO and Hajime NOBUHARA
University of Tsukuba, Japan

Abstract: Recommendation systems play an important role in modern applications such as Netflix, Amazon, and e-commerce applications. Although the research for improving the accuracy of the recommendation system is increasing because of this importance, the risks in the latest recommendation system have not been sufficiently studied, and the importance of the recommendation system is increasing, and the attack to the improper system of the recommendation by the posting of the false review becomes a problem. The economic impact of the attack on the recommendation system is very large, and it is said that the purchase number of the item fluctuates by 5 to 9% depending on the increase and decrease of one star for the item evaluated by 5 stages. However, in a simple recommendation system, it is difficult to distinguish between a fake user and a normal user, and an algorithm to prevent attacks is required. In this paper, we focus on “injection attacks” among attacks on recommendation systems. An overview of the injection attack is shown in Figure 1. In the injection attack, an attacker creates a profile of a fake user from the data and injects it into a data set, and the data set is learned by the recommendation system. Learning without knowing the attack affects the recommendation function, and there is a risk of recommending different items. Although various studies have been conducted to verify the characteristics of such attacks, in the process of creating false data, the effects of optimization algorithms on attack performance have not been well studied. In this paper, we investigate the attack performance of Bi-Level Optimization.

Keywords: Recommendation, Attack Detection, Security
M2-4-1 15:40-15:55

Multi-Task Planning of Heterogeneous UAVs Based on Indoor Topological Map

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Abstract: The high efficient task assignment and fast path planning for small unmanned aerial vehicles (UAVs) indoor task planning play a crucial role. Considering the complex indoor environment and multi-constraints on UAVs, the paper focuses on the problem of multi-task planning of heterogeneous UAVs with different abilities based on the indoor topological map. First, we model this problem as a multi-objective bi-level optimization problem. The objectives include the completion rate of the tasks and the consumption of UAVs performing the tasks. Then, the constraints on UAVs in an indoor environment are analyzed and the topological map is applied to the UAVs’ path planning. The problem is solved by using four multi-objective optimization algorithms including NSGA-II, SPEA2, MOEA/D, and MOPSO. Finally, computational experiments are conducted with test instances of different scales. The experimental results show that NSGA-II and SPEA2 can find significantly better Pareto fronts.

Keywords: Multi-Task Planning, Path Planning, Multi-Objective Optimization Problem, Topological Map

M2-4-2 15:55-16:10

A UAV Swarm Collaborative Optimization Algorithm to Predict the Perception of Fire

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Abstract: To improve the accuracy of fire information collection, in this paper, a kind of UAV swarm cooperative sensing forest fire prediction algorithm that based on bee colony algorithm and combined with Jiugongge fire development prediction model is proposed. The UAV group’s task planning, queue planning and route planning through the target perception information are realized in the algorithm, cooperatively perceives the fire trend and tracks the fire, and uses the sensor to collect the data, which is sent back to the console, and the console analyzes the data to guide the firefighters to rescue. Experimental simulation shows that the accuracy of fire prediction reaches 81.8%. Compared with single UAV, the information collected by UAV group is more accurate and more suitable for complex environment.

Keywords: UAV Group, Cooperative Perception, Fire Prediction, Data Analysis, Mission Planning
Multi-Vehicle Cooperative Reliability Assessment of Urban Rail Transit

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**Abstract:** As the main way to solve urban public transportation problems, urban rail transit was widely used with the characteristics of energy saving, high traffic density, full-time and less pollution. However, multi vehicle operation is easily affected by random factors such as climate and environmental change. The reliability and safety of multi vehicle operation is especially important. This paper establishes a reliability model of multi vehicle cooperation by analyzing the braking process of cooperative vehicle and investigates the safety conditions that need to be met. Based on the safe running distance of vehicle, the two-vehicle cooperative operation model and unified reliability model are built. To analyze the influence factors of reliability model, the communication delay, driving distance, relative speed and braking performance are studied under multi-vehicle cooperation. The results show that above four factors impact on the safe braking of the vehicle, especially to the communication delay. The proposed reliability model can accurately evaluate the reliability of the vehicle’s cooperative braking process and ensure the safe operation.

**Keywords:** Multi-Vehicle Cooperation, Reliability Model, Urban Rail Transit, Communication Delay, Vehicle Tracking Operation

The Behavior Design of Swarm Robots Based on a Simplified Gene Regulatory Network in Communication-Free Environments

Yuwei CAI, Guijie ZHU, Huaxing HUANG, Zhaojun WANG, Zhun FAN, Wenji LI, Ze SHI, and Weibo NING

Shantou University, China

**Abstract:** Aiming at the problem of frequent failure of swarm robots encirclement strategy in the battlefield environment without communication and unknown environment, this paper proposes a model named S-GRN (Simplified Gene Regulation Network) based on individual cognition, which make swarm robots track and entrap targets in communication-free environments. FSM (Finite-State Machine) model is designed to guide the behavior mode of robot and achieve effective control of swarm robot. Based on the above ideas, the behavior mode of swarm robots in communication-free environments and the emergence method of swarm aggregation form are designed. This method is a distributed control method. Swarm robots recognize the approximate orientation of targets through their own visual sensors, and measure the orientation of obstacles with laser sensors. These information are used as the inputs of S-GRN, then output is target entrapping pattern. Through the control algorithm based on FSM, each robot moves to the target and reaches the pattern point around the target. Finally, as the robot gathers towards the target, cluster tracking and encirclement forms emerge. The effectiveness of this method is verified by experiments.

**Keywords:** Swarm Robots, Communication-Free Environments, Simplified Gene Regulatory Network, Finite-State Machine
Hexagonal War Chess Bot Using Memorized Search and Greedy Strategy

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Abstract: In this paper, we present a robot program for a special hexagonal war chess game that can expand, explore and attack automatically. First, we introduce the rules and process of the hexagonal war chess game. Then, we theoretically analyze the requirements and characteristics of the robot algorithm on the basis of the rules of the game, and then implement the robot by memorizing search and greedy strategy. Through the experiment of simulating the battle between each other, it is verified that our robots have strong fighting power and have high rapidity and accuracy in attacking. To sum up, the memorized search and greedy strategy are practical and effective to improve the aggression of the robot in this game.

Keywords: Memorized Search, Greedy Strategy, Breadth-First Search, Robot

Dynamic Integrated Flexible Job Shop Scheduling with Transportation Robot

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Abstract: The integrated scheduling problem for machines and transportation robots in flexible job shop is a complex but valuable problem. In this paper, the dynamic integrated scheduling problem considering breakdowns, order insertions and battery consumption of robots is studied, which is aiming at minimizing the order completion time (makespan). Adopting an event-driven global rescheduling strategy, three algorithms are designed, including the Genetic Algorithm (GA), the Improved Variable Neighborhood Search (IVNS) algorithm, and the Memetic Algorithm (MA). Finally, numerical experiments are carried out to test the performance of the algorithms. The effectiveness of the rescheduling strategy is verified under dynamic situations.

Keywords: Dynamic Scheduling, Flexible Job Shop, Multi-Agent, Charging
An Improved Two-Stage Network for Video Virtual Try-On

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Abstract: In order to solve the problem that the picture-based virtual try-on model provides consumers with limited information, an improved two-stage video virtual tryon scheme based on deep neural networks is proposed. The network consists of two parts. One is a deep network used to learn Thin Plate Spline (TPS) deformation parameters of clothing, the other is a U-Net module used to generate the try-on effect. In the latter, the network extracts optical flow from the input data, performs DensePose pose annotations, trains on the improved U-Net, and outputs the frame-by-frame tryon effect. Compared with the existing work, the proposed solution obtains a higher quality video, which is embodied in that the facial details retained are more adequate and the edges of the clothing generated are better. The proposed approach is evaluated on VVT and VITON dataset. In the same test sample, the proposed network has a better visual effect than the current neural network-based try-on work.

Keywords: Virtual Try-On, Deep Neural Network, Image Synthesis

A Variable-Small-Filter-Size Residue-Learning Dense CNN for Reconstruction of HEVC Video Frames

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¹Beijing Jiaotong University, China, ²Beijing Institute of Graphic Communication, China

Abstract: The in-loop filter module of High Efficiency Video Coding (HEVC) standard improves the reconstruction quality of compressed video frames, but it also brings bitrate increasing. In this paper, we aim to replace the existing in-loop filter module of HEVC with convolutional neural network (CNN) to facilitate HEVC intra coding performance on both visual quality and bitrate. First, two consecutive 3 × 3 convolutional layers are adopted instead of original 5 × 5 convolutional layer in Variable-filter-size Residue-learning CNN (VRCNN) to increase the nonlinearity and expression ability, then we incrementally utilize dense connection to boost unimpeded information flow among three blocks. Finally, the proposed reconstruction network called Variable-Small-filter-size Residue-learning Dense CNN (VSRDCNN) is obtained. The dataset is gotten by HEVC compression which turns off the in-loop filter module with four quantization parameters (QPs). In a progressive way, the weights of VSRDCNN on the highest QP 37 are obtained by training and are used as initial weights for VSRDCNN on the other three QPs. At last, the trained CNNs are used to replace the in-loop filter in HEVC to get better restoration performance. The proposed VSRDCNN is validated both subjectively and objectively via extensive experiments on HEVC standard test sequences. Experimental results show that the proposed VSRDCNN outperforms HEVC 0.30 dB on BDpsnr and 0.51% reduction on BDrate, and achieves the lowest BDrate compared with the state-of-the-art work.

Keywords: Convolutional Neural Network (CNN), High Efficiency Video Coding (HEVC), In-Loop Filter, Super Resolution
Exploring Effective Channels in Fundus Images for Convolutional Neural Networks

Shoya KUSUNOSE, Yuki SHINOMIYA, and Yukinobu HOSHINO
Kochi University of Technology, Japan

Abstract: This paper focuses on useful channel information for automated diagnosis using fundus images, especially for disease classification using convolutional neural networks (CNNs). In general, only the green channel of the image is used for the analysis of fundus images, and the green channel image is processed in various ways to analyze. The reason for this is that it is difficult to capture features such as blood vessels and optic nerve papillae from other channels. However, CNNs have the potential to acquire features that are difficult for humans to capture because they acquire features in the image by learning. We trained CNNs on fundus images for each combination of channels and compared their accuracy. As a result, we found that the appropriate channel varies depending on the disease, and the green channel is mainly accurate. In addition, the results of learning the appropriate ratio of channels using depth-wise convolution showed that green and red channels were enhanced, and from these results, we considered that the green and red channel are useful in the fundus classification.

Keywords: Convolutional Neural Network (CNN), Fundus, Image Processing
IDRLnet: A Physics-Informed Neural Network Library
Wei PENG, Jun ZHANG, Weien ZHOU, Xiaoyu ZHAO, Wen YAO, and Xiaoqian CHEN
Defense Innovation Institute, Chinese Academy of Military Science, China

Abstract: Physics Informed Neural Network (PINN) is a scientific computing framework used to solve both forward and inverse problems modeled by Partial Differential Equations (PDEs). This paper introduces IDRLnet, a Python toolbox for modeling and solving problems through PINN systematically. IDRLnet constructs the framework for a wide range of PINN algorithms and applications. It provides a structured way to incorporate geometric objects, data sources, artificial neural networks, loss metrics, and optimizers within Python. Furthermore, it provides functionality to solve noisy inverse problems, variational minimization, and integral differential equations. New PINN variants can be integrated into the framework easily. Source code, tutorials, and documentation are available at https://github.com/idrl-lab/idrlnet.

Keywords: Physics Informed Neural Network, Open Source Software, Machine Learning, Numerical Method

Analysis of Trained Convolutional Neural Network Using Generative Adversarial Network
Yasuyuki TSUTSUI, Yuki SHINOMIYA, and Shinichi YOSHIDA
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Abstract: In recent years, the increasing burden on doctors due to the shortage of doctors has become a problem in the medical site, and CNN-based methods that can realize highly accurate diagnosis by image recognition are attracting attention as a method to automate diagnosis to ease the burden on doctors. However, in the medical site, it is required to provide explanations to patients, and CNN-based methods have not been introduced to the site because it is difficult to explain the results. Therefore, we proposed a method using Attention-Guided CycleGAN as a method to analyze the differences in regions and patterns recognized by CNN for the explanation of diagnosis using CNN, and evaluated the validity of analysis from the results of the transformation, the similarity of regions of focus, and the effectiveness of transformation for diagnosis using CNN. The results show that Attention-Guided CycleGAN may be effective for the analysis of CNN, because the transformation results are in line with symptoms between cardiomegaly and asymptomatic patients, and be also effective for diagnosis by CNN.

Keywords: Generative Adversarial Network (GAN), Convolutional Neural Network (CNN), CycleGAN, Explainable Artificial Intelligence (XAI), Medical Information System
**General (M2-6): Fuzzy Systems and Applications**  
15:40-17:10, Nov. 1, 2021, Meeting Room 6

**M2-6-1 15:40-15:55**  
**An Improved Denoising Method for Lidar Echo Signal**  
Xiaomeng LIU, Cong HUANG, Hongbin MA, and Qinyong LIU

**M2-6-2 15:55-16:10**  
**Design and Validation of an Evaluation Function Using the GA for the Fuzzy Inference of the Action Chain Search in RoboCup2D**  
Keigo YOSHIMI and Yukinobu HOSHINO  
Kochi University of Technology, Japan

**Abstract:** In fields such as Go and Shogi, the usefulness of artificial intelligence has been recognized. However, it is impossible to apply the knowledge gained there to real-world problems. If artificial intelligence can be applied to real-world problems, the possibilities for artificial intelligence will expand even further. Therefore, in order to set up a problem close to the real world, we used the “RoboCup Soccer Simulation 2D League” as the subject of our experiment and aimed to improve the strength of the team using artificial intelligence. Experiments were conducted using fuzzy inference methods and genetic algorithms. In this paper, we will design an evaluation function to improve the strength of teams, and examine the usefulness of artificial intelligence-based teams based on the competitive performance of the designed teams.

**Keywords:** RoboCup2D, Artificial Intelligence, Genetic Algorithm, Numeric GA, Fuzzy Reasoning Method, Simplified Inference Method
M2-6-3 16:10-16:25

A Clustering Method Based on Gaussian Process Regression and Fuzzy c-Means Algorithm

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Abstract: With the development of measurement techniques, massive data have been recorded from real-world systems, and partitioning these data can provide important information and useful references. In this paper, a new clustering method named GPR-FCM is proposed to accomplish this work. The proposed clustering method is developed based on fuzzy c-means algorithm. The regression relationship of data instead of the distance among the objects is utilized to evaluate the difference between the clusters, and Gaussian process regression (GPR) is used to evaluate the regression relationship of each cluster. A series of experiments on synthetic and engineering datasets are used to evaluate the performance of the GPR-FCM method. The results demonstrate higher effectiveness and advantages of the GPR-FCM method compared with conventional data clustering algorithms.

Keywords: Data Clustering, Fuzzy c-Means Algorithm, Gaussian Process Regression

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M2-6-4 16:25-16:40

Fuzzy PI Model Predictive DTC for Gas Pressure Regulated Power Generation System

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Abstract: In the gas supply system, the pressure regulation system is required to regulate the gas from high pressure to low pressure on the customer side, where the pressure energy can be recovered by the expander driven generator operation. However, the existing regulator system and generator torque control loop have the problem of difficult PI parameter adjustment, in addition to the strong non-linearity of the hysteresis comparator and switching table in the traditional direct torque control, which causes difficulties in controller design and leads to large fluctuations in generator torque. To this end, this paper constructs fuzzy PI controllers for expander pressure regulation and generator torque control loops respectively, and realizes adaptive adjustment of PI parameters; meanwhile, with the control objective of making the generator torque and flux linkage stable, the optimal voltage vector calculation is performed directly by using model predictive controller instead of the hysteresis comparator and vector switching table in the generator internal loop control loop, which improves the efficiency of the algorithm and improves the control performance by delay compensation. The simulation experimental results show that the proposed control algorithm reduces the generator torque fluctuation range by 84.5%, the speed fluctuation range by 66.7%, and the three-phase current fluctuation range by 65.6% compared with the traditional direct torque control algorithm.

Keywords: Fuzzy PI Control, Model Predictive Control, DTC, Power Generation System
We refer you to the full text for detailed information.
An Efficient Adaptation Method for Model-Based Meta-Reinforcement Learning

Shiro USUKURA and Hajime NOBUHARA
University of Tsukuba, Japan

Abstract: We propose an efficient adaptation method for model-based meta-reinforcement learning by combining two conventional methods. Model-based meta-reinforcement learning can achieve high performance by adapting observed data in every time step in unstable environments. There are two conventional adaptation methods for model-based meta-reinforcement learning which are KShot-adaptation method and the Continued-adaptation method. These methods have similar algorithms, but different characteristics. KShot-adaptation method tends to underfit observed data, while Continued-adaptation method tends to overfit it. Therefore, we propose a method that combines these two conventional methods by introducing a new parameter. We conducted evaluation experiments in a half-cheater-disable-joint environment that reproduces changes of dynamics by disabling the joints. As a result, our method obtained an average reward of 3.9% higher than the KShot-Adaptation method and 31% higher than the Continued-Adaptation method.

Keywords: Meta Reinforcement Learning, Online Learning, Deep Learning

Soft-Voting-Based SVM-KNN Algorithm and its Application in Big Data Modeling

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Abstract: Recent years have witnessed the surge of interest of big data model predictions in various fields. How to improve the accuracy of big data models has become an important issue. Most of the existing big data models use a single algorithm or its improved version. Using the Support Vector Machine (SVM) algorithm and the K-Nearest Neighbor (KNN) algorithm as the base classifiers, this paper aims to the soft voting method in ensemble learning to establish a combined model of SVM-KNN. A comparative experiment on the proposed algorithm and the single algorithm is performed, which show that the SVM-KNN combined model has better performance in the four model evaluation indicators of accuracy, precision, recall, and F1 score.

Keywords: Big Data Model, SVM-KNN, Soft Voting Method
Separable Algorithms for Matrix Factorization with Presence of Missing Data

Shi-Xin WANG, Min GAN, and Guang-Yong CHEN
College of Mathematics and Computer Science, Fuzhou University, China

Abstract: Low-rank matrix factorization (LRMF) frequently appears in various tasks in computer vision, e.g., bundle adjustment. Singular value decomposition (SVD) is a well-known approach to solve LRMF. However, it fails when the matrix is relatively large or the elements of target are lost. In this paper, we formulate the LRMF as a separable nonlinear least squares problem. An iterative algorithm, a combination of variable projection (VP) algorithm and BFGS method (named VP-BFGS), is proposed to solve this problem. The algorithm first utilizes the VP strategy to eliminate part of the parameters (i.e., a matrix), and then the BFGS method is used to estimate the other matrix. In numerical experiments, compared with the joint method, Gauss-Newton method and LM method, the VP-BFGS method achieves competitive performance, especially when the ratio of deficiency to existence is high.

Keywords: Low-Rank Matrix Factorization, Quasi-Newton Method, Variable Projection, Separable Nonlinear Least squares

Conditional Motion and Content Decomposed GAN for Zero-Shot Video Generation

Shun KIMURA and Kazuhiko KAWAMOTO
Chiba University, Japan

Abstract: We propose a conditional generative adversarial network (GAN) model for zero-shot video generation. In this study, we have explored zero-shot conditional generation setting. In other words, we generate unseen videos from training samples with missing classes. The task is an extension of conditional data generation. The key idea is to learn disentangled representations in the latent space of a GAN. To realize this objective, we base our model on the motion and content decomposed GAN and conditional GAN for image generation. We build the model to find better-disentangled representations and to generate good-quality videos. We demonstrate the effectiveness of our proposed model through experiments on the Weizmann action database and the MUG facial expression database.

Keywords: Zero-Shot Video Generation, Generative Adversarial Network (GAN), Disentangled Representation
The Cars’ Type Recognition Algorithm Based on Ensemble Learning and Multi-Features Fusion

Bin CAO, Jiahui WANG, Hongbin MA, and Ying JIN
Beijing Institute of Technology, China

Abstract: The automobile industry is an important industry in the national economy. It has the characteristics of long industrial chain, high accuracy and integrating all kinds of high and new technologies. It has played a leading role in the national economic and social development and the cars’ type recognition plays an important role in automobile intelligent manufacturing. Some scholars are studying the application of deep learning algorithm for cars’ type recognition. However, the problems of lacking samples and high accuracy make it difficult for a single deep learning technology to meet needs from production. Based on the important industrial scene of cars’ type recognition, this paper integrates a variety of image features under the framework of ensemble learning based on the in-depth understanding of automobile intelligent production lines and improves the existing ensemble learning algorithms so as to design a cars’ type recognition algorithm based on multi-features fusion and ensemble learning. The algorithm can meet the stringent requirements of industrial applications and has low dependence on samples, which makes the algorithm have a certain value of popularization in automobile manufacturers. The algorithm proposed in this paper has achieved good results in automobile intelligent production line. Compared with algorithms using single feature, the accuracy of proposed algorithm is higher.

Keywords: Cars’ Type Recognition, Multi-Features Fusion, Ensemble Learning

Feature Contribution in Accidents Severity Based on Light GBM-TPE

Kun LI and Haocheng XU
**Characteristic Behavior: Identifying Body Spatial Trajectory Structure in Indoor Skiing**

Peizhang LI, Qing FEI, and Xiaolan YAO  
School of Automation, Beijing Institute of Technology, China

**Abstract:** Indoor skiing training is one of the ways to improve athletes’ sports level in non-snow season. In order to train more scientifically, it is necessary to extract the main features of the skiing process and analyze and generate guidance opinions. In this paper, we used the video to extract the three dimensional space coordinates of the athlete’s body, and constructed the P matrix based on this. Through the principal components of the complete sports behavior data (P matrix), we obtain the main characteristic behaviors of athletes. Our experiment shows that the main characteristic behaviors can better reconstruct and predict the ski space trajectory, and further, these main characteristic behaviors can be used to evaluate the skiing level of individual athletes. In addition, we also studied the application of the main characteristic behaviors of skiing in groups. We dig out the group characteristics of different groups and use them to calculate the degree of belonging between individuals and groups. Furthermore, the mapping of different individuals on group characteristics can better reflect the degree of intimacy between different individuals. With the continuous enrichment of horizontal data sets, we hope that this technology can be applied to various sports.

**Keywords:** Spatial Trajectory, Behavior Modeling, Characteristic Recognition, Group Characteristic

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**Automating Stroke Subtype Classification from Electromagnetic Signals Using Principal Component Methods**

Jinrui LI¹, Guohun ZHU¹, and Min XI²  
¹School of ITEE, The University of Queensland, Australia, ²Shandong Institute of Medicine and Health, China

**Abstract:** Stroke is an emergency. Automatic stroke classification based on electromagnetic images needs to establish a large correlation matrix array which leads to low computational performance. The paper presents a principal component analysis (PCA) to extract the efficient features to conduct a fast stroke subtypes classification. Firstly, it is shown that stroke classification using a single feature was failed. By discovering the data pattern associated with correlations, the second attempt has proposed a novel PCA feature extraction method, the result has achieved 99% accuracy after the application of PCA and SVM on the extracted features.

**Keywords:** Stroke, PCA, Electromagnetic Image
T1-1-3 14:20-14:35

Scene Classification Based on Visual Feature Channels and SVM

Mingzhao LI and Zhiyan WANG
Jilin International Studies University, China

Abstract: Nowadays, scene classification is widely used as the pre-classification of target detection and behaviour detection, and it is an essential part of computer vision. In this paper, an improved scene classification method is proposed. This method firstly uses the naturalness in the spatial envelope model to classify scenes into base classes. It then classifies scenes more carefully through the visual feature channel model to obtain specific scene categories. Simulation experiments show that, under the exact condition of the SVM classifier, the improved scene classification method in this paper is better than the traditional scene classification method for scene classification. On this basis, the parameters of the SVM classifier are optimized for specific data sets.

Keywords: Scene Classification, Visual Feature Channels, Support Vector Machine (SVM)

T1-1-4 14:35-14:50

Store Scene Recognition and Classification via Multi-Stage Neural Network Model

Kejuan YANG, Sihan GAO, and Hongbin MA
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Abstract: In store scene classification, the variability and versatility lie in abnormal picture shooting angles, diverse text fonts, weak text context connection and samples lacking; hence, to tackle these problems, we propose a multi-stage model based on neural network architecture, which mainly features text information. This network combines three sub-modules – text detection, text recognition and semantic classification. First, a text detection and recognition module based on DBNet and CRNN is designed with a text orientation classifier. Meanwhile, augmented datasets are enlarged to improve the quality of text extraction from images. Then, the derived text acts as input to the Ernie text recognition transfer model. Finally, the store scene classification label is derived. Of note, our model is tested on the DC platform dataset, and the experiment shows that the proposed method extracts the features of store scene images well and classifies them effectively according to the derived context. Compared with current algorithms, our method prompts both classification robustness and generalization ability of the trained model.

Keywords: Image Recognition, Text Detection, Text Recognition, DBNet, CRNN, NLP, Ernie
T1-1-5 14:50-15:05

Research on Classification of Nutrient Forage Species Based on VGG-16 Network

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Abstract: Aiming at the problem of time-consuming, labor-intensive and inaccurate forage recognition traditionally relying mainly on manual direct observation and manual feature extraction, a nutritional forage classification model based on improved VGG-16 convolutional neural network is proposed. Based on the VGG-16 network model, the model optimizes the number of fully connected layers, and replaces the SoftMax classifier in the original VGG-16 network with a 5-label SoftMax classifier, optimizes the model structure and parameters, and shares the pre-trained model through migration learning the weight parameters of the middle convolutional layer and the pooling layer. Five types of nutrient forage images were collected from the forage experimental field in Siziwang Banner as the training data and test data of the classification model. The experimental results show that the model can accurately classify the five types of forage. In terms of the average recognition accuracy rate, the accuracy rate reached 91.3%, realizing the accurate classification of nutrient forages.

Keywords: VGG-16 Network, Image Classification, Transfer Learning

T1-1-6 15:05-15:20

Patient Classification Based on sEMG Signals Using Extreme Gradient Boosting Algorithm

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Abstract: Studying surface electromyography (sEMG) signals of the muscles near the knee joints in patients with gonarthritis is helpful for the diagnosis of knee joint inflammation. If the influence of different sEMG signals and their weights on knee inflammation can be analyzed through machine learning methods, it will greatly improve diagnostic accuracy. The extreme gradient boosting (XGBoost) algorithm is an excellent machine learning algorithm. Inspired by this algorithm, we presented a signal classification method based on the XGBoost algorithm to distinguish between patients with gonarthritis and healthy subjects. The sEMG signals collected from four muscles around the knee are extracted as features, which are used as the input variables to the classification model. The XGBoost algorithm determines the output by improving the objective function based on sample proportion and weight. The experimental results show that the XGBoost algorithm has higher accuracy and better classification performance when compared with the support vector machine (SVM) and the deep neural networks (DNN) algorithms. This indicates that the advantage of the XGBoost algorithm on classifying patients with gonarthritis based on sEMG signals.

Keywords: Surface Electromyography (sEMG), Machine Learning, Extreme Gradient Boosting (XGBoost), Patients with Gonarthritis
Distributed Micro-Displacement Monitoring System for Detecting Pier Settlements

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Abstract: In the construction of large-scale structures, monitoring the displacements increases security and reliability. The existing measuring methods, whether manual techniques or automatic instruments cannot deal with large quantities of objects to be measured. In order to address this problem, we develop a distributed measuring system for detecting micro-displacements to boost precision and automaticity. To reduce the influence of measurement noise, we also develop an algorithm on the basis of linear data reconciliation. The system has already been applied to detecting pier settlements of viaducts used by high-speed railways and proves to be capable to detect displacements with high precision.

Keywords: Micro-Displacement Monitoring, Pier Settlement Detection, Linear Data Reconciliation

An Unsupervised Learning Method for Industrial Anomaly Detection Based on VAE-LSTM Hybrid Model

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Abstract: Anomaly detection is one of the most important tasks in industrial production, and it is a crucial aspect for both safety and efficiency of modern process industries. However, due to the high-dimensional characteristics of time series perception data and the difficulty of data labeling in actual production, there is still a lack of effective anomaly detection methods in industrial scenarios. To solve the above challenges, this research proposes an unsupervised learning method based on a hybrid model of Variational Autoencoder (VAE) and Long Short-term Memory (LSTM). First of all, high-dimensional industrial data is processed by VAE, not only achieves dimensionality reduction and feature extraction, but also reduces the impact of noise. Then the LSTM network is exploited to mine the temporal features of the industrial data and predict the subsequent change trend. Finally, when the difference between the predicted data and the actual measured data exceeds a certain threshold, the production process can be considered abnormal.

Keywords: Industrial Anomaly Detection, Unsupervised Learning, Hybrid Model, VAE, LSTM
Tables Defect Detection Based on Improved ResNet-CBAM

Yanan LIU, Maofan CHENG, Hongbin MA, and Ying JIN
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Abstract: Due to the lack of feature expression ability of traditional image processing methods, it is difficult to identify small defects such as foreign bodies and scratches on the surface of tablets. Aiming at this problem, this paper proposes the use of a deep learning method fused with attention mechanism to realize the defect detection of tablets. Improve the recognition effect of deep learning network by introducing Convolutional Block Attention Module (CBAM). In order to further reduce the complexity of the model and improve the detection accuracy, this paper improves the original CBAM module. Firstly, it is proposed to use one dimensional convolution instead of the fully connected layer in the CBAM channel attention module to capture channel attention information; Secondly, in order to improve the ability of the attention module to extract features of different proportions of defects, the use of multiscale dilated convolution is proposed. Instead of the 7 × 7 convolution in the original CBAM spatial attention module, it aggregates multiscale spatial information while reducing model parameters. Experimental results show that compared with the original CBAM module, the improved visual attention module can more effectively improve the ability of network feature extraction and meet the real-time requirements.

Keywords: Defect Detection, Deep Learning, Deep Residual Network, Attention Mechanism

Research on Security Inspection Method Based on Terahertz Imaging and Convolution Neural Network

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Abstract: According to the requirements of safety inspection in public places such as railway stations and airports, a dangerous goods identification method based on convolution neural network algorithm of terahertz transmission imaging technology and target detection is proposed. The research results show that the average value (MAP) of each category of AP can reach 65.02% and the average detection speed is 22.5 ms when the algorithm is trained by the self-constructed terahertz dangerous goods detection data set. In most public places the detection speed and accuracy of this method can meet the requirements of security check work, providing technical support for the research and development of security check equipment based on terahertz imaging technology.

Keywords: Terahertz Imaging, Security Check, Convolutional Neural Network (CNN), Target Detection
**General (T1-2): Anomaly Detection and Predictive Control**

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**T1-2-5 14:50-15:05**

**Suppression of Disturbances in Networked Control Systems Based on Adaptive Model Predictive Control and Equivalent-Input-Disturbance Approach**

Meiliu LI\(^{1,2}\), Jinhua SHE\(^{3}\), Zhen-Tao LIU\(^{1,2}\), Wangyong HE\(^{1,2}\), Min WU\(^{1,2}\), and Yasuhiro OHYAMA\(^{3}\)

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**Abstract:** This paper presents an adaptive control strategy to compensate for packet losses, time delay, and exogenous disturbances in a networked control system (NCS). An adaptive model predictive controller (AMPC) combined with an equivalent-input-disturbance (EID) estimator to improve the control performance in the structure of an NCS. We use the AMPC to design an adaptive rate, which guarantees the control performance and the tracking performance of the controlled plant with time delay. The EID estimator compensates for the exogenous disturbances and packet losses. A comparison with the conventional EID approach through the experiments demonstrates the validity of the AMPC-EID control method.

**Keywords:** Networked Control System (NCS), Equivalent Input Disturbance (EID), Adaptive Model Predictive Control (AMPC), Disturbance Rejection

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**T1-2-6 15:05-15:20**

**Event-Triggered Predictive Control for Networked Systems Using Allowable Time Delays**

Zhong-Hua PANG, Zhen-Yi LIU, Zhe DONG, and Tong MU

Key Laboratory of Fieldbus Technology and Automation of Beijing, North China University of Technology, China

**Abstract:** In this paper, an event-triggered networked predictive control (NPC) method is proposed for a networked control system with random network delays, packet disorders and packet dropouts in the feedback and forward channels, which makes full use of the allowable time delay of the system. In this method, these random communication constraints are uniformly treated as time delay. Then the controller is designed by the time-delay state feedback control law, and the event-triggered NPC method is used to actively compensate for the part of the network delay that exceeds the allowable time delay. In addition, the introduction of an event-triggered mechanism reduces the communication load and saves network resources. A necessary and sufficient stability condition is derived for the resulting closed-loop system, which is independent of random time delays and related to the allowable time delay. Finally, the effectiveness of the proposed method is verified by simulation results.

**Keywords:** Networked Control System (NCS), Networked Predictive Control, Event-Triggered Mechanism, Random Communication Constraints, Allowable Time Delay
**The Proposal of Region Proposal Method for Outdoor-Camera’s Image by Fuzzy Inference System**

**Junsuke YOKOSEKI and Yukinobu HOSHINO**
Kochi University of Technology, Japan

**Abstract:** In recent years, wild monkeys have been damaging crops in field area in Japan. Since monkeys live in groups, it is necessary to capture all the monkeys in a group to prevent damage. Therefore, we need a system that can detect when a group of monkeys enter a trap by using image recognition. The goal of this research is to detect a group of monkeys by image recognition. We expect to use images from a fixed-point camera installed in an outdoor cage which capture monkeys. The problem with these images are that the color distribution changes dynamically over time by sunlight. In this paper, we propose a method for extracting the regions in an image that contain monkeys. This method converts the image to L*a*b* color space and extracts the regions by fuzzy inference. The result shows that the proposed method is an effective region proposal method. In general, fuzzy reasoning requires less computation and reduces the entropy. Since the capture system will be installed in field areas where power supply is difficult. We consider that the proposed method can assist artificial intelligence and edge computing.

**Keywords:** Wildlife Capture System, Fuzzy Reasoning, Image Recognition, Edge Computing

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**Ordered Object Segmentation Based on Machine Learning Algorithms**

**Md Arif UDDIN, Hongbin MA, Haotian WU, and Ying JIN**
Beijing Institute of Technology, China

**Abstract:** The conventional automatic drug dispenser can significantly contribute to numerous services such as medicine industries, pharmacy shops and medical assistance by reducing the workload of medical workers and allowing patients to take their timely medication. In this paper, we use a segmentation technique to identify the location of drug pillboxes from the medicine shelves with the automatic counting of spiral pillboxes. The proposed method is a solution to a dynamic segmentation framework for recognizing objects from large datasets. Firstly, the picture is filtered to remove the noise to recognize the boundary line. Following that, projection lines are drawn in the center to divide the segments of pillboxes by utilizing the midpoint formula, which supports smooth counting of line detection among objects. Besides, we applied the Mean shift method to accumulate the intersection points. The key role of clustering is to collect intersection midpoints data. The proposed framework identifies the existing area from medicine pillbox images and detects the specific segmentation line that automatically allocates the pillboxes. Furthermore, we obtain 99.83% accuracy and successfully detect pillboxes, which aids in the improvement of segmentation, filtering and clustering algorithms. Such techniques assist us in recognizing the most appropriate segmentation boundary lines for further discoveries in the future.

**Keywords:** Hough Lines, Detection Segmentation Lines, Intersection Lines, Mean-Shift Cluster, Intersection Points Cluster
**Real-Time Object Detection in Occluded Environment with Background Cluttering Effects Using Deep Learning**

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**Abstract:** Detection of small, undetermined moving objects or objects in an occluded environment with a cluttered background is the main problem of computer vision. This greatly affects the detection accuracy of deep learning models. To overcome these problems, we concentrate on deep learning models for real-time detection of cars and tanks in an occluded environment with a cluttered background employing SSD and YOLO algorithms and improved precision of detection and reduce problems facing by these models. The developed method makes the custom dataset and employs a preprocessing technique to clean the noisy dataset. For training the developed model we apply the data augmentation technique to balance and diversify the data. We fine-tuned, trained, and evaluated these models on the established dataset by applying these techniques and highlight the results we get more accurately than without applying these techniques. The accuracy and frame per second of the SSD-Mobilenet v2 model are higher than YOLO V3 and YOLO V4. Furthermore, to employ various techniques like data enhancement, noise reduction, parameter optimization, and model fusion we improve the effectiveness of detection and recognition, we also make a graphical user interface system for the developed model with features of object counting, alerts, status, resolution, and frame per second. Subsequently, to justify the importance of the developed method analysis of YOLO V3, V4 and SSD were incorporated, which resulted in the overall completion of the proposed method.

**Keywords:** Object Detection and Recognition, Data Augmentation, YOLO (You Only Look Once), Mobilenet-SSD V2, Graphical User Interface

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**Quantum Image Resolution Enhancement Based on Quantum Wavelet Transform and Interpolation**

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**Abstract:** In this study, two quantum image resolution enhancement (QIRE-I and QIRE-II) schemes are proposed based on quantum wavelet transform and quantum interpolation. The original low resolution (LR) image is decomposed into four frequency subbands using single-level 1-D quantum Haar wavelet transform (QHWT). To preserve the edges and obtain a sharper high resolution (HR) image, quantum interpolation is applied on only three high-frequency subbands. A few simulation-based demonstrations are presented to illustrate the feasibility and effectiveness of two proposed schemes. The visual and quantitative results show the superiority of the proposed schemes over those simply using quantum interpolation.

**Keywords:** Quantum Information, Image Resolution Enhancement, Quantum Wavelet Transform, Quantum Interpolation
General (T1-3): Image, Video, Signal Processing

T1-3-5 14:50-15:05

Temporal Long-Term Frame Interpolation Using U-Net Discriminator

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Abstract: To improve the accuracy of frame interpolation over long time intervals in video data, we propose a frame interpolation model based on U-Net, which identifies each pixel. The two discriminators associated with existing interpolation methods are each extended to a U-Net configuration to discriminate videos and images for each pixel. By training the generator and discriminator based on the loss values by the U-Net, accurate image generation can be achieved. We performed comparisons on the KTH video dataset, and compared the proposed method with the conventional method. The results indicated that the quantitative scores were almost the same, however the visual evaluation revealed that the proposed method produced more accurate results.

Keywords: Frame Interpolation, Generative Adversarial Network (GAN), U-Net, Super-Resolution

T1-3-6 15:05-15:20

MSRCR with SVD and Guided Filter Research for Image Enhancement and Denoising

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Abstract: Multi-scale Retinex with the Color Restoration (MSRCR) algorithm with perfect dynamic range compression and color constancy, can recur the content of the image which may be blur or foggy. However, multi-scale Retinex algorithms may amplify the noises in the images while processing them. It not only decreases the quality of images but also interferes with target recognition and image retrieval. The method based on the MSRCR algorithm combines with a dual noise reduction algorithm of singular value decomposition and guided filter to implement the process of noise reduction firstly, and then enhancement, and denoising again. Experiments demonstrate that our method not only does not degrade the image quality like other denoising algorithms but also effectively reduces noise and maintains the result of the multi-scale Retinex algorithm. By subjective perception and objective evaluation, our method gains a better effect than the primary multi-scale Retinex algorithm.

Keywords: Multi-Scale Retinex with Color Restoration (MSRCR), Singular Value Decomposition (SVD), Guided Filter
Nonlinear Predictive Control of a Flexible Satellite Attitude Stabilization

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Abstract: In this paper, a nonlinear predictive controller is designed for the attitude stabilization control system of the flexible satellite with a pair of solar panels, considering the external disturbance and the rigid flexible coupling effect in the process of satellite operation. Firstly, the estimated information of unknown disturbance is given by a nonlinear disturbance observer, and the angular acceleration information which can’t be acquired by a satellite sensor is given by a super-twisting observer. Secondly, a nonlinear predictive controller is proposed to achieve the attitude stabilization control of the flexible satellite. Simulation results show that the designed controller can effectively suppress the vibration response of the flexible appendages and realize stabilization control of the satellite attitude rapidly and efficiently.

Keywords: Attitude Stability, Nonlinear Disturbance Observer, Super-Twisting Observer, Nonlinear Predictive Controller

Mixed Integer Programming Based Fuel-Optimal Guidance Strategy for Spacecraft Proximity Operations

Dawei FAN, Weiwei CAI, Leping YANG, Runde ZHANG, and Long XI
College Aerospace Science and Engineering, National University of Defense Technology, China

Abstract: This paper presents the fuel-optimal guidance strategy for spacecraft proximity operations with collision avoidance and waypoint constraints. The relative motion dynamics is firstly given, as well as the associated discrete form. Considering the multiple waypoint constraints, the fuel-optimal and collision free trajectory planning model is developed utilizing the mixed integer programming (MIP) framework, and then addressed by the Branch-and-cut search technique. Numerical simulations of two kinds of scenarios, namely flying around a resident space object (RSO) via multiple waypoints and approaching multiple drifting RSOs, are conducted to validate the performance the proposed fuel-optimal guidance strategy.

Keywords: Mixed Integer Programming, Fuel-Optimal Trajectory, Waypoint Constraints, Collision Avoidance
**Stochastic Output-Feedback Tracking Control with Second-Order Moment Process**

Ruitao WANG, Xiaoyu XU, and Wuquan LI  
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**Abstract:** This paper investigates the output-feedback tracking control problem of stochastic high-order nonlinear systems perturbed by second-order moment process. Compared with most of the existing results where only wiener process is considered, a high-gain homogeneous domination approach is used to construct the output-feedback controller. This controller ensures that the expectation of tracking error can be adjusted to be arbitrarily small and all the states of the closed-loop system are bounded in probability. Finally, a numerical example is given to demonstrate the feasibility of the control scheme.

**Keywords:** Second-Order Moment Process, Output-Feedback, Tracking, Stochastic High-Order Nonlinear Systems

**Stability Analysis of One-Step-Guess Estimator**

Zhiyu ZHAO and Hongbin MA

**Abstract:** This paper focuses on an extremely simple adaptive method, one-step-guess (OSG) estimator, which has been ignored for a quite long time for its simple form. Previous researches have been concerned with the application of OSG in the field of adaptive control and adaptive tracking. Although the stability of the OSG has been discussed, a further investigation is necessary to analyze stability of OSG. The contribution of this paper aims at taking a deep look at the stability of OSG. The result shows that this simple estimator can be stable under mild conditions, and the error is bounded.

**Keywords:** One-Step-Guess, Adaptive Control, Discrete-Time, Stability, Nonlinear System
General (T1-5): Robotics

T1-5-1 13:50-14:05

Kinematics Analysis and Simulation of Mobile Robot Based on Linkage Suspension

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Abstract: The complex kinematics modeling of mobile robot with connecting rod suspension is studied. According to the wheel center modeling method, the kinematic characteristics of the six wheels of the mobile robot under irregular terrain are analyzed and the kinematics theoretical model is established. Then, the kinematics simulation analysis is carried out through the virtual prototype technology to verify the rationality of structural design and the correctness of the kinematics theoretical model. Finally, the error test of the mobile robot prototype is executed, the minimum deviation error of the linear motion is 4.399 mm, the forward and backward in-situ turning error is 1.166 mm and 0.838 mm, respectively. The test results show that the kinematics theoretical analysis of the mobile robot is reasonable, the robot has good motion ability. The study provides a theoretical basis for the research of high-quality navigation and control system of the mobile robot.

Keywords: Mobile Robot, Linkage Suspension, Kinematic Theoretical Model, Error Experiment

T1-5-2 14:05-14:20

Web Page Remote Control for Raspberry Pi Mobile Robot Using ORB-SLAM

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Abstract: This paper presents a novel remote control framework for mobile robot, consisting of two core hardware systems: Raspberry Pi as the information processing computer, STM32 single chip microcomputer as the logic control computer and other auxiliary systems. Based on the mobile robot and RealSense D455 camera, Oriented FAST and Rotated BRIEF Simultaneous Localization and Mapping (ORB-SLAM3) algorithm is utilized to establish sparse map and location. The sparse map and more accurate synchronous positioning of the mobile robot environment are established. At the same time, in the actual SLAM environment map construction, we use the Web page as the interactive interface for the mobile robot’s remote control. Through the Web page, we can achieve the slow change of the position and posture of the mobile robot. Then the RealSense D455 camera can accurately obtain the surrounding environment information. Web pages are used to build human-computer interaction interface and establish remote slam map construction control, which greatly reduces the cost of system communication. And the interface is simple and easy to maintain. Finally, experiments show that the system can run stably, and the final effect is also good.

Keywords: Web Page, ORB-SLAM, Raspberry Pi
**General (T1-5): Robotics**

### T1-5-3 14:20-14:35

**An Implementation Method of Indoor 3D Semantic Map Reconstruction Based on ORB-SLAM3**

Chenxing XU, Xiaofeng LIAN, Ziwei TIAN, Maomao KANG, and Wei MA  
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**Abstract:** At present, in the research field of 3D semantic map construction in indoor environment, *RGB-D* camera is usually applied in the most existing methods. These methods have the disadvantages of high cost and large volume, as well as all the objects of indoor environment cannot be segmented effectively from semantical point of view in order to make the robot better understand the surrounding environment. For the above reasons, this paper proposes a lightweight method for reconstructing the 3D semantic map based on the Visual SLAM with ORB-SLAM3 framework and Mask R-CNN architecture. Firstly, based on the combination of monocular camera and IMU sensor, the ORB features of key frames are extracted for tracking and constructing the local 3D map. Then the real-time pixel level semantic segmentation of the image after dynamic feature points are removed by convolutional neural network (CNN) is used to add semantic information. In the detailed implementation process, the first step is to simplify the original ORB-SLAM3 system, so that the dynamic feature points are detected and eliminated only by monocular camera in the tracking phase. The second step is to segment the object and background as well as various objects in the different categories for each key frame. Finally, the semantic database is established, the semantics information is mapped to the 3D map which can updated at the same time.

**Keywords:** Indoor 3D Reconstruction, ORB-SLAM3, Mask R-CNN, Robot, Semantic Mapping

### T1-5-4 14:35-14:50

**TRVO: A Robust Visual Odometry with Deep Features**

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**Abstract:** Accurate localization is crucial for visual SLAM systems. However, most visual SLAM systems use traditional hand-crafted local features to find matches in two images, which are less stable in scenes with textures-less, motion blur or repetitive patterns, and cannot achieve the goal of lifelong SLAM. In this paper, we propose TRVO, a visual odometer that uses deep learning for feature matching. The deep learning network adopts the structure of CNN and Transformer, which can produce high-quality dense matches for a pair of images in an end to end form even in indistinctive scenes, where low-texture regions or repetitive patterns occupy most areas in the field of view. After the matching point pairs are obtained, the camera pose is solved in an optimized way by minimizing the reprojection error of the feature points. Experiments based on multiple dataset and real environments show that TRVO has higher relative positioning accuracy and robustness compared with the current mainstream visual SLAM systems.

**Keywords:** Feature Mapping, Deep Learning, Visual Odometry, Transformer
Sensorless Collision Detection for a 6-DOF Robot Manipulator

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Abstract: Safety is a very important consideration for collaborative robot, which stands for robot working with humans. This paper proposed an improved generalized momentum observer to detect collision of AR10, a 6-DOF cooperative robot. In the experiment, the friction force is identified by employing the LuGre friction model. With friction force and gravity calculated out, collisions are detected by the modified generalized momentum observer, which can distinguish collisions from normal moves in the case that dynamic model error is large. False collisions are avoided from the difference between the target velocity and the actual velocity. The final results of experiments are significative.

Keywords: Cooperative Robot, Collision Detection, Modified Momentum Observer

A Robust Visual Inertial Navigation System Based on Low-Cost Inertial Measurement Unit

Zelong ZHANG, Kaoru HIROTA, Yaping DAI, and Zhiyang JIA

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Abstract: A visual-inertial system (VINS) based on vision sensor is vulnerable to environment illumination and texture, the problem of initial scale ambiguity still exists in a monocular VINS system. The fusion of a monocular camera and an inertial measurement unit (IMU) can effectively solve the scale blur problem, improve the robustness of the system, and obtain higher positioning accuracy. Based on a monocular visual inertial navigation system (VINS-mono), a state-of-the-art fusion performance of monocular vision and IMU, an initialization scheme is designed which can calculate the acceleration bias as a variable during the initialization process so that it can be applied to low-cost IMU sensors. The experimental result on the EuRoc dataset shows that the initial values obtained through the initialization process can be efficiently used for launching nonlinear visual-inertial state estimator and positioning accuracy of the improved VINS-mono has been improved by about 8% than VINS-mono.

Keywords: SLAM, VIO, VINS-Mono, Sensors Fusion
Multi-Step Predictive Models for Excess Air Coefficient of Engine Based on TCN

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Abstract: Multi-step predictive model of engine excess air coefficient combined with PID control method based on oxygen sensor can effectively control the excess air coefficient. In order to improve the model prediction accuracy of excess air coefficient and the fitting accuracy of its first derivative and second derivative, this paper builds Time Convolution Neural (TCN) multi-step predictive models of excess air coefficient. Experimental results show that three step prediction MAPE of the excess of air coefficient by TCN is 0.319%, 0.750%, 1.33%, respectively. The MAE of first-order difference and second-order difference which is calculated from excess air coefficient are 0.00738 and 0.0084 respectively.

Keywords: Excess Air Coefficient, Multi-Step Predictive Model, First-Order Difference, Second-Order Difference, TCN

A Combined Prediction Model Based on Double Echo State Network with Improved Immune Genetic Algorithm (IIGA)

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1 College of Information Science & Technology, Beijing University of Chemical Technology, China, 2 Engineering Research Center of Intelligent PSE, Ministry of Education of China, China

Abstract: To improve the prediction accuracy of key variables in the industrial process, a combined prediction model based on a double-reservoir echo state network with improved immune genetic algorithm (IIGA) is proposed. Firstly, a double-reservoir ESN (DESN) model is established, then partial least squares (PLS) is introduced to calculate the output weight of DESN model to enhance the ability to deal with multiple correlation issues; Secondly, in order to reduce the parameters randomness in double-reservoir and prevent the local optimization, IIGA is proposed to optimize the reservoir parameters, which introduces the opposite operator to expand the search range. Based on the above, a combined prediction model IIGA-DESN-PLS is proposed; Third, the proposed IIGA is verified by the Griewank function. And the proposed combined prediction model is applied to the purified terephthalic acid (PTA) solvent system. The comparison results show that the combined prediction model has higher prediction accuracy and provides certain guidance for predicting key variables of industrial process.

Keywords: Combined Prediction Model, Double-Reservoir Echo State Network, Partial Least Squares, Immune Genetic Optimization Algorithm, Purified Terephthalic Acid
Identification of Steam Pressure Model for Once-Through Steam Generator

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Abstract: This paper presents an input-output model of once-through steam generator, which describes the relationship between feed-water pressure and steam pressure. The identification process of mathematical model combines mechanism and data modeling; model structure is determined by physical mechanism, and unknown parameters of given model are estimated via total least squares and linear optimization. Using operation data of real system, the validity of proposed model and parameter estimation method is verified. Calculation results shows that the proposed model can well interpret and predict the state of real system.

Keywords: Once-Through Steam Generator, Input-Output Model, Steam Pressure, System Identification, Total Least Squares, Linear Optimization

Rate and Temperature Dependent Hysteresis Online Identification for Magnetostrictive Actuator

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Abstract: An online model identification approach is proposed to describe the rate/temperature hystereses for magnetostrictive actuator in this article. Magnetostrictive hysteresis loops show asymmetric, rate-dependent phenomena under different input currents and experimental temperatures. It is difficult to apply a comprehensive model to accurately capture such hysteresis variation. The hysteresis offline identification study is conducted. However, the rate/temperature-dependent hysteresis cannot be described well via the offline method, due to the unmodeled dynamics and external disturbances. To this end, the online infinite impulse response (OIIR) and fractional order polynomial modified Prandtl Ishlinskii (FPMPI) integrated model is utilized for the rate/temperature-dependent hysteresis identification. Comparison of the online and offline identification results shows that the hysteresis online identification results are typically better than the offline results, at the level of one order of magnitude.

Keywords: Online Identification, Magnetostrictive, Rate/Temperature-Dependent, Hysteresis
Hybrid Gradient Descent Algorithms for the Exponential Autoregressive Model

Si-Min QIAN, Min GAN, and Guang-Yong CHEN
College of Mathematics and Computer Science, Fuzhou University, China

Abstract: The exponential autoregressive (ExpAR) model is a powerful tool for time series analysis and system modeling. In this paper, we focus on the parameter identification methods for ExpAR model. Taking advantages of the special separable structure, the ExpAR model is decomposed into two connected sub-models and a hybrid gradient descent algorithm is proposed. The proposed algorithm exploits the underlying idea of hierarchical identification principle to estimate the linear and nonlinear parameters of the model. To improve the identification efficiency, the proposed algorithm utilizes the Aitken strategy to accelerate the gradient descent method. Some simulation results confirm the efficiency of the proposed algorithm.

Keywords: ExpAR Model, Parameter Estimation, Aitken Method, Gradient Descent, Hierarchical Identification Principle
T2-1-1 15:30-15:45

**Deep Neural Network and Rule Based Framework for Distributed and Flexible Job-Shop Scheduling**

**Guanghao XU**, **Huifang LI**, **Ruitao YANG**, and **Fenxi YAO**

1School of Automation, Beijing Institute of Technology, China, 2The 28th Research Institute of China Electronics Technology Group Corporation, China

**Abstract:** With mass customization as a state-of-the-art production paradigm under the economic globalization situations, Distributed and Flexible Job-shop Scheduling (DFJS) becomes more attractive. Taking the idea of “data-driven intelligence”, while considering the complexity of distributed and flexible manufacturing system environments under the mass customization or even one-of-a-kind production, this paper proposes an intelligent optimization algorithm based on Deep Neural Networks (DNNs) and heuristic dispatching rules. Firstly, a 3-stage scheduling model including job scheduling, operation scheduling and operation ranking, which constitutes an integrated scheduling framework is established. Then, a DNN-based scheduling algorithm is proposed to optimize job scheduling and operation scheduling. Finally, we introduce a rule-based method to optimize operation sequencing. By integrating the above two methods, the whole job-shop scheduling process can be optimized simultaneously, so as to minimize the average tardiness penalty for the whole job set.

**Keywords:** Distributed and Flexible Job-Shop, Scheduling, One-of-a-Kind Production Modes, Deep Neural Network

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T2-1-2 15:45-16:00

**A General Variable Neighborhood Search for the Multiple Depots Multiple Traveling Salesmen Problem**

**Miao WANG**, **Bin XIN**, and **Qing WANG**

1School of Automation, Beijing Institute of Technology, China, 2Beijing Advanced Innovation Center for Intelligent Robots and Systems, China

**Abstract:** The multiple depots multiple traveling salesmen problem (MDMTSP) is studied in this paper. In this problem, multiple salesmen start from different depots and visit multiple cities. The objective is to find a tour for each salesman to minimize the total travel distance. A general variable neighborhood search (GVNS) approach is proposed in this paper. Three local search methods are designed in this approach, including $k$-reverse, $k$-same-as-previous, and $k$-same-as-next. The MDMTSP consists of two subproblems: one is to assign cities to salesmen, and the other is to solve the travel path of each salesman. The proposed GVNS approach is used to solve the first subproblem, and the second subproblem is solved by the famous Lin-Kernighan Heuristic (LKH). A state-of-the-art market-based approach is implemented as a competitor. Computational results show that the GVNS performs better than the market-based approach in 8 out of 10 instances.

**Keywords:** Combinatorial Optimization, Variable Neighborhood Search, Multiple Depots Multiple Traveling Salesmen Problem
Multi-Objective Scheduling Optimization for Mobile Energy Supplemented Micro-Grid

Shuai CHEN, Chengpeng JIANG, Jinglin LI, Jinwei XIANG, and Wendong XIAO
School of Automation and Electrical Engineering, University of Science and Technology Beijing, China

Abstract: Microgrid scheduling optimization is a complex optimization problem, existing research work is mainly focused on the energy scheduling optimization and the economic benefit scheduling optimization. This paper makes use of mobile charging equipment to provide supplement energy for microgrid with insufficient energy supply, and study the electric load sequence scheduling optimization problem. A multi-objective scheduling optimization model is built by comprehensively considering the benefit from staggered peak energy storage, equipment cost, charging cost and punishment cost caused by delayed charging, and a novel particle swarm optimization algorithm is proposed to maximize the economic benefit of the microgrid. Extensive experiments verify the efficiency of the proposed algorithm, and analyze the impacts of different parameters on the economic benefit.

Keywords: Multi-Objective Optimization, Microgrid, Scheduling Optimization, Mobile Energy Supplement

Multi-Objective Optimization for Meal Planning Using Multi-Island Genetic Algorithm

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Abstract: Food waste and food loss is becoming a big social problem in the world. The total amount of the household organic waste reached 2.7 million tons in 2019. The breakdown is that leftover is 27%, food thrown away before being eaten is 18%, and food scrap wasted during cooking is 55%. The main reason of throwing away food before being eaten is best-before date expiration. In this study, we aim to develop a recommender system for meal planning in a family. In practice, such recommender systems are required to not only extract user’s preferences but also suggest meal plans on the basis of caloric intake, remaining amount of food and expiration dates. This boils down to a multi-objective optimization problem. This paper therefore presents a method of multi-objective optimization for meal planning and recommendation. We use a multi-island GA to deal with the optimization problem and propose a framework of content-based recommendation where the user can interactively rate the menu candidates. Moreover, we design the objective functions to minimize the amount of expired food and adjust caloric intake. Furthermore, we conduct a preliminary experiment to discuss the applicability of the proposed method.

Keywords: Recommendation System, Multi-Objective Optimization, Multi-Island Genetic Algorithm, Meal Planning
General (T2-1): Intelligent Scheduling and Optimization
15:30-17:00, Nov. 2, 2021, Meeting Room 2

T2-1-5 16:30-16:45

An Ant Colony Algorithm for Electric Vehicle Routing Problem with Load Energy Consumption
Enqi LIU¹, Yaping DAI¹, and Hongfeng WANG²
¹School of Automation, Beijing Institute of Technology, China, ²School of Information Science and Engineering, Northeastern University, USA

Abstract: For solving the impact of load energy consumption in electric vehicle routing problem, an ant colony algorithm is realized in this paper. By adjusting three different pheromone update methods, the solution speed of the algorithm is improved, and the solution result is obtained when the objective function is minimized. The comparative simulation experiment analysis shows that the pheromone is initialized once, the incremental method is one step by step, and the volatilization method is global volatilization. The optimal route length value of this pheromone update strategy is at least 19% better than the strategy of other combinations in the paper.

Keywords: Load Energy Consumption, Ant Colony Algorithm, Pheromone Update Strategy, Electric Vehicle Routing Problem

T2-1-6 16:45-17:00

A Comparative Study on Evolutionary Algorithms for High-Speed Railway Train Timetable Rescheduling Problem
Shuxin DING¹,², Tao ZHANG¹,², Rongsheng WANG¹,²,³, Chunde ZHANG⁴, Sai LU⁵,⁶, and Bin XIN⁵,⁶
¹Signal and Communication Research Institute, China Academy of Railway Sciences Corporation Limited, China, ²The Center of National Railway Intelligent Transportation System Engineering and Technology, China Academy of Railway Sciences Corporation Limited, China, ³Postgraduate Department, China Academy of Railway Sciences, China, ⁴China Railway Beijing Group Corporation Limited, China, ⁵School of Automation, Beijing Institute of Technology, China, ⁶Key Laboratory of Intelligent Control and Decision of Complex Systems, Beijing Institute of Technology, China

Abstract: In this paper, a high-speed railway train timetable rescheduling (TTR) problem is presented, addressing the adjustment of the train timetable with a complete blockage in the station according to the train operation constraints. Four competitive evolutionary algorithms (EAs), i.e., a dual-model estimation of distribution algorithm (DM-EDA), self-adaptive differential evolution (SaDE), comprehensive learning particle swarm optimizer (CLPSO), and Covariance Matrix Adaptation Evolution Strategy (CMA-ES), are adopted to solve the formulated problem. The individual of the EAs is represented as the permutation of trains’ departure order in the disrupted station. The individual is decoded to a feasible schedule of trains using a rule-based method to allocate the running time in sections and dwell time in stations. For continuous space searching algorithms, the random key algorithm is used to obtain permutations from real vectors. Numerical experiments have been performed on 8 TTR instances. Experimental results demonstrate the superiority of SaDE in solving TTR.

Keywords: High-Speed Railway, Train Rescheduling, Disruptions, Evolutionary Algorithm, Combinatorial Optimization
Ultrasonic Inner Inspection of Crude Oil Pipeline Based on Bispectrum Dimension Reduction Method

Jian TANG¹, Guo-Xin ZHAO¹, Xiang-Dong JIAO¹, and Xue-Peng DING²

¹Beijing Institute of Petrochemical Technology, China, ²Central Research Institute of Building and Construction Co., Ltd., MCC Group, China

Abstract: The key technology of Ultrasonic inner inspection of crude oil pipeline is to obtain the residual thickness of pipeline wall by the analysis and processing of the ultrasonic echo signal. In order to solve the problem that the second-order statistics are easy to appear errors, bispectrum is proposed to process the echo signal with the least amount of computation in higher order statistics in this paper. Then bispectrum is projected into one-dimensional frequency space by the dimension reduction method, and the one-dimensional diagonal slice of bispectrum is extracted to analyse the characteristics of echo signal, which greatly improves the intuition of data processing. Experimental results show that the bispectrum dimension reduction method has high accuracy in processing ultrasonic echo signal, which is much better than the second-order statistics method. It is suitable for ultrasonic inner inspection of long distance crude oil pipeline.

Keywords: Crude Oil Pipeline, Ultrasonic Inner Inspection, Second-Order Statistics, Higher-Order Statistics, Bispectrum Dimension Reduction

Measurement of Femoral Neck and Leg Length in Total Hip Arthroplasty Based on Optical Positioning

Weibo NING¹, Jiaqi ZHU¹, Guijie ZHU¹, Hongjiang CHEN², Wenning HUANG¹, Jun HU², Yibiao RONG¹, Yuwei CAI¹, and Zhun FAN¹

¹Shantou University, China, ²Department of Orthopaedics, The First Affiliated Hospital of Shantou University Medical College, China

Abstract: In traditional total hip arthroplasty (THA), it is difficult to accurately measure the length of femoral neck when the replacement area is limited and deep. It may eventually lead to excessive difference in the length of two legs. This paper presents a method for measuring the length of femoral neck in THA based on optical positioning. During the operation, the end of the probe with a positioning ball was used to measure the length of the femoral neck in real time to assist surgeons in surgical decision-making. According to the comparison between the ideal length and the actual length, the femoral head prosthesis was reasonably selected for adjustment. As it is difficult to accurately and quickly measure the difference of two legs after the placement of prosthesis in traditional surgery, a spatial measurement method of medical anatomical points of two legs based on optical positioning is proposed. By measuring the length of the affected leg with a probe and comparing it with the length of the normal leg before operation, the feedback information of synchronous measurement is further verified. Experiments verify the feasibility of this method for the detection of leg length difference. The average error of these experimental measurements is within 1 mm.

Keywords: Total Hip Arthroplasty, Femoral Neck, Two Legs, Optical Positioning, Probe, Measurement
T2-2-3 16:00-16:15

A Complex Parameter Measurement Method of Metal Pipeline Using Tilt Angle Intersection

Shuang WANG and Xuefei MAO
School of Automation, Beijing Institute of Technology, China

Abstract: This paper proposes an eddy current nondestructive measurement method for metal pipeline parameters, which can measure the pipeline thickness and conductivity simultaneously. In this paper, the tilt angle intersection of the relative impedance changes of the coil, which is little affected by the tilt angle, is used. Based on the analytic solution of eddy current field model of the pipeline excited by the coil placed arbitrarily outside the pipeline, the law of the tilt angle intersection with the change of the pipeline parameters is obtained and an inverse method is established which utilizes the relationship between the frequencies of two tilt angle intersection points and the pipeline parameters. It has been found that the method has high measurement accuracy and can avoid the error caused by the deflection of the coil in a small range.

Keywords: Tilt Angle Intersection, Eddy Current Testing, Pipeline Parameters, Inversion Model

T2-2-4 16:15-16:30

Position Estimation Method Using Directional Amplitude Modulated Pulsed Light with Simulation Based on Real Environment Measurements

Seita SUKISAKI and Hajime NOBUHARA
Department of Intelligent Interaction Technologies, Graduate School of Systems and Information Engineering, University of Tsukuba, Japan

Abstract: We propose a position estimation method using directional amplitude-modulated pulsed light based on real-world measurements and their simulation as a position estimation method that can be used in small drones. The proposed method enables highly accurate position estimation in a real environment using commercially available LEDs and photodetectors.

Keywords: Location Estimation System, Simulation System, Modulation Signal Measurement Technology
**T2-2-5 16:30-16:45**

**Design and Realization of a Closed-Loop Constant Flow Rate Air Sampler Using Differential Pressure Sensor**

Bojin SHANG, Yaping DAI, Xiaohan WANG, Junyi YUAN, and Zhiyang JIA  
Key Laboratory of Intelligent Control and Decision of Complex System, School of Automation, Beijing Institute of Technology, China

**Abstract:** In order to improve the accuracy of detection of a certain pollutant in the air, a digital air sampler based on flow rate feedback is designed and realized. Compared with the previous generation air sampler, orifice plate is used as basic measurement mechanism, instead of float flowmeter. A differential pressure sensor based on thermal micro-flow measurement is used to measure the pressure difference of the orifice plate and calculate the flow rate. This air sampler is designed as a closed-loop system and the flow rate is measured digitally. Experiments show that the accuracy of the air sampler meets the needs of the client.

**Keywords:** Differential Pressure Flowmeter, Orifice Plate Flowmeter, Flow Measurement, Air Sampler

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**T2-2-6 16:45-17:00**

**Hydration and Dehydration Processes of Lactose Monohydrate Studied by THz Time Domain Spectroscopy**

Muhammad Adnan ALVI¹, Zhaohui ZHANG¹, Xiaoyan ZHAO¹, Yang YU¹, Tianyao ZHANG¹, and Jawad ASLAM²  
¹School of Automation and Electrical Engineering, University of Science and Technology Beijing, China, ²School of Mechanical and Manufacturing Engineering, National University of Science and Technology, Pakistan

**Abstract:** Terahertz spectroscopy is now extensively employed to distinguish different hydrate systems and physical characterization of pharmaceutical drug materials. In the present work, the absorption spectra of terahertz radiation is used to investigate the effect of heating process on the release of the bounding H₂O molecules present in α-Lactose monohydrate. Distinctive THz absorption spectra at various heating times were observed. The THz absorption spectra of α-lactose monohydrate and anhydrous α-lactose exhibit evident differences. The pure α-lactose monohydrate has clear absorption peaks at 0.53, 1.05, 1.11, 1.33, and 1.56 THz and a small peak at 0.8 THz. The complete dehydration of α-lactose monohydrate takes place at 145°C (418 K) in 15 minutes. Moreover, Terahertz refractive index of α-lactose monohydrate decreases during dehydration process. Application of Beer-Lambert’s law to dehydration process of α-lactose monohydrate was also studied by comparing THz absorption spectra at various heating times. It was found that remaining water contents following various heating times in α-lactose monohydrate had exhibited linear relationship with absorption coefficient spectra recorded at 0.53 THz and 1.35 THz for α-lactose monohydrate at different dehydration times.

**Keywords:** Terahertz Absorption, α-Lactose Monohydrate, Dehydrate
**Digitization-Oriented Business Ethics Judgement Knowledge Structure and Application**

**Fenglin PENG**  
Business School, Jianghan University, China

**Abstract:** The massive data formed in the process of corporate ethics management poses a challenge for the high-efficient and accurate business ethics judgement. Therefore, this paper establishes a Digitization-Oriented Business Ethics Judgement Knowledge Structure (DOBEJKS), defines its elements including entities, activities, information and relationships, and designs an application methodology of using the DOBEJKS to make business ethics knowledge extraction, knowledge reasoning and knowledge judgement. It provides a reference for effectively carrying out the intelligent judgement of business ethics based on data.

**Keywords:** Knowledge Structure, Business Ethics Judgement Application, DOBEJKS

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**A Basic Research to Develop a Method to Classify Game Logs and Analyze Them by Clusters**

**Akinobu SAKATA¹, Takamasa KIKUCHI², Ryuichi OKUMURA³, Masaaki KUNIGAMI¹, Atsushi YOSHIKAWA¹, Masayuki YAMAMURA¹, and Takao TERANO⁴**  
¹Tokyo Institute of Technology, Japan, ²Keio University, Japan, ³Mitsubishi Research Institute, Inc., Japan, ⁴Chiba University of Commerce, Japan

**Abstract:** The objective of this study is to show that it is possible to classify a set of simulation logs of a gaming simulation into several clusters, and to reveal the characteristics of the gaming results by analyzing them in clusters. This research is a stepping stone toward the development of a new analysis method that is somewhere between the approaches used in previous research, which statistically analyze all simulation logs of a gaming simulation and the analysis approach that closely observes a specific simulation log. In the former approach, when the simulation logs are divided into several clusters by characteristics, the values of statistical indicators extracted from all simulation logs are not enough to fully grasp the characteristics of the gaming results. The latter approach requires a lot of time and effort to analyze, and can only tell us about a small portion of the simulation logs. The analysis method we aim to develop compensates for the shortcomings of both approaches. We collected a large number of logs in an experiment using a gaming simulation we developed, classified the log set, and checked the distribution of log features in each cluster. As a result, we showed that the distribution of feature values among clusters is different.

**Keywords:** Gaming and Simulation, Agent-Based Simulation, Log Cluster Analysis
Web-Questionnaire-Based Method for Creating Corpus Containing a Large Number of Morphemes

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¹Tokyo University of Technology, Japan, ²Electrical Engineering Department, College of Engineering, Prince Sattam Bin Abdulaziz University, Kingdom of Saudi Arabia

Abstract: This paper presents a method of using the Web questionnaire to create a corpus that makes natural utterances such as conversations with a human. Subjects were presented with situations involving the use of web questionnaires in conversations with a human caregiver. The objective was to create a corpus with a high level of naturalness in speech. The advantage of this method is that it is easier to implement than conventional Wizard of Oz (WOZ) or the interview-style-based corpus creation methods. On the other hand, a downside of the proposed method is that since the subjects answer via a PC (machine), only simple utterances might be collected. Therefore, we give a lecture to the subjects that they talk to a human. As a result, the naturalness of speech is increased despite the subject answering via PC (machine). To establish the performance of our method, we compare the morphemes of its corpus alongside those from the interview style-based corpus in a conventional method. The outcomes suggest that the proposed method could collect utterances with higher naturalness of speech.

Keywords: Web Questionnaire, Spontaneity, Natural Language, Corpus, Probing Questions, Morpheme

Application of Neural Network Based on Long and Short Term Memory in Rumor Detection

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Abstract: In this paper, we optimize the variable parameters in the long-term and short-term memory neural network through the slap swarm algorithm, so that it can more accurately adapt to the actual needs of rumor detection data. According to an input text segment, the short-term memory neural network can processes the Chinese word segmentation, and then convert it into binary number form by hot coding method, so as to map word vector. In the experiment, we design the model carefully, train it repeatedly in the word vector data set, and optimize the parameters of the model through the bottle ascidian optimization algorithm. The practice shows that it has strong applicability to rumor recognition.

Keywords: Rumor Detection, Intelligent Optimization Algorithm, Salp Swarm Algorithm
Establishment of a Traceability Model of Fresh Milk Based on Blockchain

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Abstract: With the frequent occurrence of various food safety incidents in China, consumers’ trust in the quality and safety of food and the food supply chain has gradually declined. The food traceability system, as a storage system that can connect products from production to circulation and manage and query the traces of products, is of great significance to guarantee the quality and safety of various products. This article intends to build a blockchain traceability mechanism based on the theoretical analysis of blockchain technology, introduces the traceability model of fresh milk based on blockchain technology, and hopes to provide a reference for related research in blockchain traceability.

Keywords: Food Traceability, Blockchain, Hyperledger Fabric, Whole Food Production Chain
**General (T2-4): Fault Warning and Prediction**  
15:30-17:00, Nov. 2, 2021, Meeting Room 5

**T2-4-1  15:30-15:45**

**A Prediction Method of Driving Range Based on LSTM Combined with Causal Convolution**

**Zhe Zuo, Ning Xu, Zhenyu Zhang, Yuheng Yan, Weilong LV, and Ziyang Xu**  
School of Mechanical Engineering, Beijing Institute of Technology, China

**Abstract:** Accurate prediction of driving range of electric vehicles (EVs) is critically important to help optimize energy management. In this paper, a novel method to perform accurate driving range prediction is investigated using long short-term memory (LSTM) recurrent neural network combined with convolution layers. The data used in this paper are obtained from the National Monitoring and Management Platform for New energy vehicles. First, the data cleaning is applied to deal with abnormal values and missing values. Then, the datasets are constructed by the sliding window method. Finally, the LSTM model is built and the convolution layers are connected to the model. Dropout method is also introduced to prevent the model from overfitting. The results show that the proposed method can accurately predict the driving range, and the average RMSPE 0.099.

**Keywords:** Driving Range Prediction, LSTM, Deep Learning

**T2-4-2  15:45-16:00**

**Design of Predictive Alarm System for Artificial Pancreas**

**Wenjing Wu, Xiao Yang, and Dawei Shi**  
School of Automation, Beijing Institute of Technology, China

**Abstract:** This paper designs a predictive alarm system for artificial pancreas, which judges whether the closed-loop control of artificial pancreas is in a safe state according to the information transmitted by CGM and insulin pump. It also grades threat degree of different indicators to human safety when various information changes (such as connection information of equipment, blood glucose history, and prediction data). According to the different levels, the system prompts the corresponding warning signal and takes measures to effectively avoid the risk of warning system. Based on the existing human blood glucose metabolism model and Sage-Husa adaptive model, an improved adaptive Kalman filter algorithm is designed to predict the blood glucose data of the model to obtain the blood glucose future blood glucose prediction value and improve the accuracy of multi-step blood glucose prediction firstly. And then simulate the prediction algorithm. Next, the prediction value is used as the information source of the prediction alarm system, and the prediction alarm system for artificial pancreas is established to increase the security control constraints, so as to effectively avoid risks. Finally, experiments are carried out on UVA/Pavoda TIDM hardware in the loop simulation platform to test and verify the effectiveness of the predictive alarm system.

**Keywords:** Artificial Pancreas, Blood Glucose Prediction, Kalman Filter Prediction, Alarm System
Computer Vision-Based Monitoring and Safety Early Warning System for Gymnasiums

Bofan CHEN, Gengru CHEN, Zhaochen XIE, and Hongbin MA
Beijing Institute of Technology, China

Abstract: In order to ensure that the security team can timely and effectively deal with the emergency and all the competitions of the 2022 Beijing Winter Olympic Games went on smoothly, this paper focuses on how to apply multi-person pose estimation to the security field with the support of target detection, pose feature classification and behavior recognition algorithm. The main approach is to combine OpenPose key pose estimation with SVM classifier to develop the monitoring and safety early warning system for the dangerous behaviors of the audience. By identifying the key joint points of the human body, extracting motion characteristics and making use of the trained classifier, the system can automatically pull the alarm when audience has abnormal behaviors such as throwing objects towards athletes, so that the security team can quickly deal with the emergency.

Keywords: OpenPose, Multi-Person Pose Estimation, Support Vector Machine (SVM), Intelligent Monitoring
Research on Infrared Fault Warning Method of Hotline Tap Clamp of Substation Equipment Based on Hybrid Segmentation

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¹Taizhou Power Supply Branch of Jiangsu Electric Power Company, China, ²China Electric Power Research Institute, China

Abstract: The occurrence of substation equipment faults is usually associated with the heating of equipment components. Hotline tap clamps of substation equipment are important parts for carrying load currents and key parts for thermal fault potential. Therefore, a new hybrid early warning method for infrared faults of hotline tap clamp of substation equipment is proposed. A two-dimensional Otsu algorithm is used for coarse segmentation of infrared images to reduce the complexity of subsequent fine segmentation. Since the CV (Chan-Vese) model is not accurate enough for image segmentation with uneven grayscale. The differential information obtained by the Prewitt operator to detect the target edges is combined with CV model to improve the segmentation accuracy, and the fine segmentation of hotline tap clamp of substation equipment is achieved by the improved CV model. The temperature information is applied to the segmented images, and the fault warning of the hotline tap clamp of substation equipment is realized based on the relative temperature difference. The experimental results show that the method can improve the segmentation effect of infrared images and achieve the purpose of fault warning.

Keywords: Infrared Image, Image Segmentation, Two-Dimensional Otsu, CV Model, Prewitt Operator, Fault Warning

An XGB-Based Runtime Prediction Algorithm for Cloud Workflow Tasks

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School of Automation, Beijing Institute of Technology, China

Abstract: Cloud Computing and workflows provide a good deployment and execution environment for scientific applications, but effective scientific workflow management depends on the estimation of task execution time to a great extent. However, due to the diversity of task inputs, the heterogeneity of resources and the high dynamics of cloud environments, as the basis of task scheduling and resource allocation in cloud computing, the task runtime estimation still faces great challenges. In this paper, we propose an XGB (Extreme Gradient Boosting)-based workflow task runtime prediction method to mine the relationship between task runtime and its static and dynamic influencing factors through feature analysis to finally result in a prediction model for online use. To verify the effectiveness of our algorithm, a series of experiments are conducted over three real scientific workflow applications, and the experimental results show that the proposed method is superior to the existing algorithms in task runtime prediction accuracy.

Keywords: Cloud Computing, Workflows, Execution Time Prediction, Feature Analysis, XGB
PSO-SVM Optimized Kriging for Geological Modeling of Coal-Bearing Formation

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Abstract: The accuracy of kriging interpolation mainly depends on the selection of the variogram. In actual coal mine engineering, the number of drilling data in the same coal working face is small, and the amount of data that can be used as training is small, which leads to the low degree of fitting of the traditional variogram model. Therefore, this paper proposes an automatic fitting method for the variogram of the support vector regression machine based on particle swarm optimization (PSO-SVR). Using the powerful fitting ability of SVR when dealing with small samples and the powerful parameter optimization ability of PSO, the variogram can be reconstructed from actual data. Through the traditional kriging spherical model, PSO optimized spherical model (PSO-Spherical), and SVR model, a comparative analysis of the fitting correlation with the method in this paper is carried out. The experimental results show that the PSO-SVR reconstructed variogram has a higher fitting degree. The proposed method can provide support for coal seam thickness prediction and mining.

Keywords: Coal-Bearing Formation, Geological Modeling, PSO-SVR, Variogram

Analysis of the Influence of Inter-Generational Asset Inheritance on the Sustainability of Retirement Funds Using Social Simulation

Takamasa KIKUCHI and Hiroshi TAKAHASHI
Graduate School of Business Administration, Keio University, Japan

Abstract: In Japan, there has been great interest in life planning in pre- and post-retirement generations, and various policy simulations have been performed. However, few studies have analyzed the influence of intergenerational inheritance of assets on the sustainability of retirement funds. In this article, we performed clustering of the respondents’ attributes based on data obtained from individual questionnaires for those who plan to inherit their assets in the future. Based on the clustering results, we simulated the impact on the sustainability of retirement funds using our proposed simulation model of asset formation and withdrawal policies. The main findings are as follows. 1) For clusters with a low and high balance of financial assets, steady asset succession is an essential factor in increasing the sustainability of retirement funds. 2) It is imperative to properly manage the assets to be succeeded before asset succession is implemented.

Keywords: Social Simulation, Feature Analysis, Life Planning, Finance, Individual Questionnaire Data
Development of Ultrasonic Internal Detection Experimental System for Corrosion of Crude Oil Pipeline

Jian TANG¹, Guo-Xin ZHAO¹, Bo DAI¹, and Xue-Peng DING²

¹Beijing Institute of Petrochemical Technology, China, ²Central Research Institute of Building and Construction Co., Ltd., MCC Group, China

Abstract: Ultrasonic method is one of the important methods for internal corrosion detection of crude oil pipeline, and effective echo signal processing is its key technology. However, if the detection experiment is carried out on the in-service crude oil pipeline, the cost is very high, and it is almost impossible to study the echo signal processing technology. To solve this problem, an ultrasonic internal detection experimental system for crude oil pipeline corrosion is developed by simulating pipeline engineering detection environment, and the characteristics of multi-probe installation, working mode and instrument structure, etc. The system adopts the master-slave structure, 24 ultrasonic probes complete the transmission and reception of ultrasonic signals triggered by the synchronous clock signal, the detection board interacts with the computer through the network, and the offline analysis software automatically analyzes and processes the ultrasonic detection data by using 1.5 dimension spectrum estimation, so as to visually present the pipeline corrosion status and location. Finally, the effectiveness of the system is verified by the ultrasonic detection experiment of internal and external wall corrosion of Φ426 × 8 mm steel pipeline.

Keywords: Crude Oil Pipeline, Ultrasonic Internal Detection, Subsystem, 1.5 Dimension Spectrum, Offline Analysis

Design of Smart Campus System Based on Virtual Platform of Campus Card

Qichen HUANG, Yinru ZHU, Tongtong GAO, Yunji FENG, and Xuyang LIU
National Defense Science Park, Zhongguancun Campus, Beijing Institute of Technology, China

Abstract: Campus card is an important part of the construction of supporting facilities in colleges and universities, but there are widespread problems such as limited application scenarios, inability to meet the personalized needs of users, inability to realize remote business processing, and difficulties to carry out mobile payment. To solve the problems of campus card system in Beijing Institute of Technology, we design a campus card electronic payment platform to solve these problems. In this paper we first discuss the application scenarios and values of campus card electronic platform for student academic management, campus mobile payment and smart campus construction. Furthermore, relying on emerging technologies such as mobile-end micro-applications and face recognition technology, a reliable, convenient, extensible and highly integrated virtual campus card platform is built to realize a convenient campus era so as to shorten the waiting time for every payment scenario in school.

Keywords: Campus Card, Virtualization Platform, Smart Campus Construction
Analysis and Agent Simulation of State Transition of COVID-19 Positive Cases in Tokyo, Japan

Yasufumi TAKAMA
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Abstract: This paper estimates the state transition of COVID-19 positive cases by analyzing the data about confirmed positive cases in Tokyo, Japan. An agent simulation using the estimated transition probabilities as its parameters is also proposed. While the prediction of the number of newly infected persons is important for recognizing the future risk of spreading infectious diseases, understanding the state transition after they are confirmed to be positive is also important for estimating the number of required ICUs, hotel rooms for isolation, etc. This paper classifies the state after being positive into “in hotel/home for isolation,” “in hospital with a mild state,” “in hospital with a severe state,” “recovered,” and “dead” and estimates the transition probabilities among those states from the data about confirmed positive cases in Tokyo, Japan. The proposed agent simulation predicts the number of persons in each state using the obtained transition probabilities and the distribution of the number of days before moving to the next state as its parameters. This paper shows the simulation results of predicting the situation from August to November 2020.

Keywords: COVID-19, Agent Simulation, Data Mining

Multi-Scopic Simulation for Human-Robot Interactions Based on Multi-Objective Behavior Coordination

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Abstract: Recently, a multi-scopic approach has been applied to various research topics owing to the technological progress in computer science. For example, we can discuss a phenomenon from three different levels of macro-, meso-, and micro-scopic simulation. In the microscopic simulation, we can deal with the dynamics inside objects and internal states. In the mesoscopic simulation, we can deal with approximated dynamics between objects in a surrounding environment. In the macroscopic simulation, we can deal with spatiotemporal relationships between objects without dynamics. In this paper, we propose a multi-scopic simulation to discuss human-robot interactions. First, we discuss how to realize multi-scopic simulation for human-robot interactions. Next, we apply multi-objective behavior coordination to represent human and robot behaviors in mesoscopic simulation. Next, we apply the proposed method to navigation tasks of mobility support robots. Finally, we discuss the effectiveness of the proposed method through several simulation results.

Keywords: Multi-Scopic Simulations, Topological Mapping, Multi-Objective Behavior Coordination, Mobility Support Robots
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