Researcher Profiles

中德智能科学与技术研究中心

Sino-German Research Center for Intelligent Science & Technology

Introduction

The Sino-German Research Center for Intelligent Science and Technology (CDFIWT) is the central contact point at Tongji University for Chinese-German research and teaching in the field of Intelligent Systems. The characterising concept is the bilateral nature of the center; it supports Chinese and German researchers and students in their cross-national work. The center offers among others:

- Double Degree Programs (M.Sc.) For Sino-German Education
- Workshops and Conferences for Sino-German Scientific Exchange
- Third-Party Funded Projects for Sino-German Research
- Networking With Sino-German Companies for Talent and Technology Transfer

The central research focus of the CDFIWT is about **Intelligent Autonomous Systems**, which are able to interact with humans and the environment in real time. The research focus of the center is therefore formed significantly along the classical controller cycle of such intelligent agents: Sense, Learn, Plan, Act.

Developments in artificial intelligence, mechatronics, electronics, materials science, etc. are currently enabling the development of fundamentally new types of machines that – in contrast to earlier times – are increasingly able to act autonomously and perform more and more diverse tasks in increasingly unstructured environments, mostly in direct real-time interaction with humans and the environment. This development is currently taking place in many application areas and size scales, and has the potential to revolutionise previously unattainable size scales (e.g. micro- and nanomachines). Core features of the development are, besides the increasing intelligence and learning ability, also a fundamental expansion of the capability spectrum into areas that were previously inaccessible.

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For example, collaboration and networking of an increasingly large number of systems (swarms) or completely novel capabilities (e.g., shape-variant systems) can enable applications that were previously beyond the realm of possibility. In the context of this development, new intelligent and networked machines are emerging, which must be able to perceive their environment, possess their own knowledge and intention, be capable of learning, and ultimately have the ability to transfer this knowledge into goal-oriented actions.

Research Directions of the Center

Along this spectrum – Sense, Learn, Plan, Act – and the necessary communication with the environment, scientists at the CDFIWT work on various aspects of these research directions. **The focus of work at CDFIWT is on the control of intelligent systems, the exchange of information between systems and the environment, and specific aspects of environmental perception.**

The central research questions revolve around **control** and the intelligence inherent in the needed learning and control algorithms. The work covers a wide range along the vertical integration from top-level decision making algorithms to low-level hardware-in- the-loop controllers. Most important application areas of these technologies at CDFIWT are autonomous land-based vehicles and complex industrial factory control and scheduling. In the research projects, the researchers cover, all sub-areas from theory development and software-based simulation to experimental validation on prototypes.

The second focus of the group is on **Communication** of - mostly mobile - systems among each other, especially with the aim to enable the ever increasing requirements on bandwidth of wireless data transmission.

In the area of **Perception**, researchers are concerned with the further development and performance of computer vision in order to investigate specific questions about the influences on systems for environmental perception, again with the application focus on autonomous driving.

In addition to the described axis along the classical controller cycle, the work at CDFIWT can also be characterised with respect to its development status. According to the classical development phases, research leads to the continuous improvement of existing technologies, the creation of new solutions and the phasing out of old technologies and products. There is a close interplay and interdependence between the discovery of new possibilities (push) and the needs of society and the economy (pull). This technology development usually does not move in a linear fashion and not at a steady pace but often in iterative loops from theory development, experimental considerations and prototyping to product development and market readiness. At CDFIWT, researchers work in all areas of this spectrum. While certain concepts and ideas (e.g. the use of intelligent nano-machines) are still at the transition between theory and experimental research, other researchers at CDFIWT (e.g. in the field of autonomous driving) work closely with companies or are involved in start-ups that develop technology close to market maturity.

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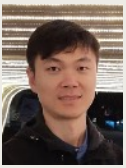

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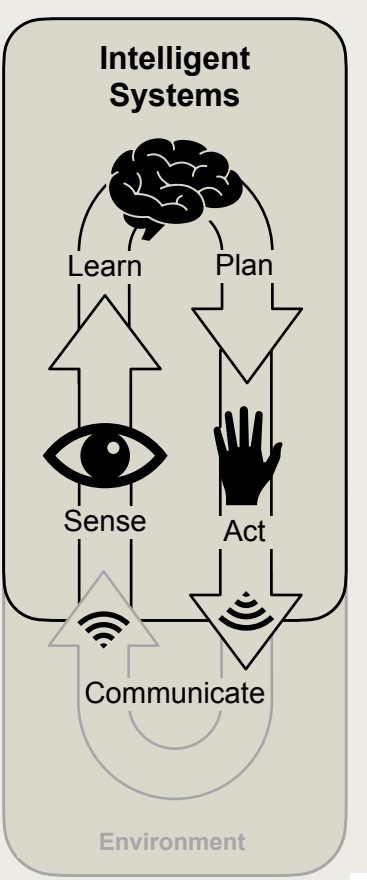

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Research Directions

- Model predictive control: stability, robustness, disturbance attenuation, FPGA-based implementation
- Automotive control: control of engines, transmissions and chassis, BMS
- Automated driving: multi-sensor fusion, planning and decision-making and motion cooperative control

Selected Publications

(1) H. Chen and F. Allgower. A quasi-infinite horizon nonlinear model predictive control scheme with guaranteed stability. Automatica, 34(10):1205-1217, 1998

(2) H. Chen and K. Guo, Constrained H-infinity control of active suspensions: An LMI approach, IEEE T. on Control Systems Technology, 13(3):412–421, 2005

(3) L. Guo, B. Gao and Y. Gao and H. Chen. Optimal energy management for HEVs in eco-driving applications using bi-level MPC. IEEE T. Intelligent Transportation Systems, 18(8):2153-2162, 2017

(4) Y. Zhang, B. Gao, L. Guo, H. Guo and H. Chen, Adaptive Decision-Making for Automated Vehicles Under Roundabout Scenarios Using Optimization Embedded Reinforcement Learning, IEEE T. on Neural Networks and Learning Systems, 32(12):5526-5538, 2021

张皓

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Research Directions & Results

- Autonomous systems, multi-agent systems, data based optimization and control, safety and security， multi-robot systems
- Published over 100 papers, and over 70 papers are published on Automatica and IEEE transaction magazine, 13 authorized invention patents. She won six provincial and ministerial awards, including one First Prize of Shanghai Natural Award, two First Prize of Shanghai Science and Technology Progress, and one Second Prize of Ministry of Education Natural Award.

Awards

- Young Changjiang Scholars of China
- Excellent Young Scholars in China
- Young scientists of China Society of Automation
- Associate editor of IEEE Intelligent Transportation Systems Magazine、SCIENCE CHINA Information Sciences

李莉

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Research Directions

- Manufacturing intelligence
- Multi-agent system cooperation and optimization
- Evolutionary algorithms
- Data-driven modeling and optimization
- Simulation-based optimization

Awards

- Automation and artificial intelligence Innovation Team Award, China Automation Society (Autonomous Intelligent System Team, Leader)
- First Prize of Technical Invention Award, China Automation Society (Data Based Scheduling and Control of Complex Production Systems, Rank 3)
- First Prize of Higher Education Teaching Achievement Award, China Automation Society (Construction and Practice off Excellent Talents Training System for Automation Specialty, Leader)

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Research Directions

- Intelligent Control of Robotic Systems and Self-driving Cars
- Control and Optimization of Multi-agent Systems
- Advanced Control Theory and Application
- Autonomous Intelligent Systems

Recent Publications

(1) Wang Zhuping & Zhang H. Autonomous Intelligent Systems, People's Posts and Telecom Press, 2020.

(2) Wang Z, Wang L, Zhang H, et al. Distributed Formation Control of Nonholonomic Wheeled Mobile Robots Subject to Longitudinal Slippage Constraints. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 2021,51(5):2992-3003. (IF:10.037)

(3) Yang X, Zhang H and Wang Z*. Data-based Optimal Consensus Control for Multi-agent Systems with Policy Gradient Reinforcement Learning. IEEE Transactions on Neural Networks and Learning Systems, doi: 10.1109/TNNLS.2021.3054685. (IF:10.4503)

(4) Wu Y, Zhang H, Wang Z*, & Huang C. Distributed Event-Triggered Consensus of General Linear Multi-agent Systems Under Directed Graphs. IEEE Transactions on Cybernetics. 2020, 52(1):608-619. (IF: 11.079).

郭露露

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Research Directions & Results

- Advanced control in connected and automated vehicles (CAVs)
- Vehicle cyber-physical security
- Model predictive control
- Machine learning and optimization
- Multi-scale predictive energy optimization with multi-source heterogeneous road and traffic information
- Domain knowledge-enhanced solution for hybrid predictive control;
- Vulnerability assessment for cybersecurity of CAVs.
- He has published over 35 SCI journal papers,

Awards

- First prize in the 2021 CAA technological invention
- 2020 CAA Excellent Doctoral Dissertation Award
- China Association for Science's 7th youth talent promotion project Technology.

沈润杰

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Research Directions

- Intelligent inspection robot
- Control technology of UAV in closed space
- Intelligent detection and fault diagnosis

Awards

- Second prize of National Science & Technology Progress Award. Key technology and application of low frequency fault diagnosis of large wind turbine and hydropower units, December 2016.
- First prize of Shanghai National Science & technology progress award. Complete set of technologies for on-line monitoring and diagnosis of ultra-low frequency faults of large new energy generating units, December 2013.

王平

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Research Directions

- Intelligent and Connected Vehicles/Cooperative ITS (C-ITS)
- On-board or roadside Multi-sensor information fusion
- Resource allocation in C-V2X Networking environments
- Task overloading in MEC architecture for ITS applications

Research Results

- Implemented cooperative intelligent driving, such as Automatic Valet Parking via MEC Sensing and Planning, Cooperative Adaptive Cruise Control based on C-V2X, Tele-Operated Driving based on 5G
- Built a 5G MEC test bed for intelligent and connected vehicles, and realized highly precise positioning and tracing through roadside multi-sensor fusion

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Research Directions

- Positioning and Navigation
- Wireless Communications and IoT
- Blockchain and AI

Research Community Roles

- Blockchain and AI: Editor-in-Chief of IET Blockchain
- Community Co-Chair of IEEE Blockchain
- Director of Shanghai Engineering Research Center for Blockchain Applications And Services (SERCBAAS)

Awards

- Positioning and Navigation: First Place in the Microsoft Indoor Localization Competition
- Gold Award in the China International College Students' "Internet+" Innovation and Entrepreneurship Competition

王超

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Research Directions

- Information theory and signal processing for wireless networks
- Vehicular communications
- Machine learning and data mining for intelligent transportation systems and smart energy systems

Recent Publications

(1) C. Wang, X. Li, P. Wang, and G. Min, “Combining Non-orthogonal Transmission with Network-Coded Cooperation: Performance Analysis under Nakagami-m Fading,” IEEE Trans. Commun., vol. 67, pp. 4073-4088, Jul. 2020

(2) C. Wang, P. Wang, F. Liu, and G. Min, “New Achievable Sum Degrees of Freedom in Half-Duplex Single-Antenna Multi-User Multi-Hop Networks,” IEEE Trans. Commun., vol. 66, pp. 2840-2854, Jul. 2018

(3) Y. Ren, F. Liu, Z. Liu, C. Wang, and Y. Ji, “Power Control in D2D-based Vehicular Communication Networks,” IEEE Trans. Veh. Technol, vol. 64, pp. 5547-5562, Dec. 2015

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Research Directions

- Experimental evaluation of digital communications
- Communications for vehicles (UAVs, high-speed trains, cars)
- Communications channel modeling
- Performance evaluation for communications
- Link-level and System-level simulation for communications

Recent Publications

(1) José Rodríguez-Piñeiro, Zeyu Huang, Xuesong Cai, Tomás Domínguez-Bolaño, and Xuefeng Yin. Geometry-based MPC tracking and modeling algorithm for time-varying UAV channels. IEEE Transactions on Wireless Communications, 20(4):2700–2715, April 2021.

(2) José Rodríguez-Piñeiro, Tomás Domínguez-Bolaño, Xuesong Cai, Zeyu Huang, and Xuefeng Yin. Air-to-ground channel characterization for low-height UAVs in realistic network deployments. IEEE Transactions on Antennas and Propagation, 69(2):992–1006, February 2021.

(3) José Rodríguez-Piñeiro, Zeyu Huang, Xuesong Cai, Tomás Domínguez-Bolaño, Xuefeng Yin, Yu Wang, and Hong Zhu. Channel multipath tracking method for low-altitude air-to-ground UAV based on geometric prior model. Chinese Patent Database, Dec 2020. Reference: 2020114887285.

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Research Directions

- Radio propagation channel characterization
- High-resolution parameter estimation
- Stochastic channel modeling and simulation
- Radar signal processing and target identification
- MIMO radar waveform design

Recent Publications

(1) Yin, X. * ; Wang, S.; Zhang, N. & Ai, B., "Scatterer Localization Using Large-Scale Antenna Arrays Based on a Spherical Wave-Front Parametric Model," in IEEE Transactions on Wireless Communications, vol. 16, no. 10, pp. 6543-6556, Oct. 2017.

(2) X. Yin, Y. He, C. Ling, L. Tian and X. Cheng, "Empirical Stochastic Modeling of Multipath Polarizations in Indoor Propagation Scenarios," in IEEE Transactions on Antennas and Propagation, vol. 63, no. 12, pp. 5799-5811, Dec. 2015.

(3) Ling, C.; Yin, X.*; Müller, R.; Häfner, S.; Dupleich, D.; Schneider, C.; Luo, J.; Yan, H. & Thomä, R. Double-Directional Dual-Polarimetric Cluster-Based Characterization of 70-77 GHz Indoor Channels IEEE Transactions on Antennas and Propagation, 2018, 66, 857-870

(4) Yin, X. & Cheng, X. Propagation Channel Characterization, Parameter Estimation, and Modeling for Wireless Communications John Wiley & Sons, IEEE, 2016.

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Research Directions

- Molecular Communication
- Internet of Nanothings
- Neural Communication
- Mobile APP, Artificial Intelligence

Recent Publications

(1) Q. Zhao, M. Li, L. Lin*, “Release Rate Optimization in Molecular Communication for Local Nanomachine-based Targeted Drug Delivery,” IEEE Transactions on NanoBioscience, 2021.

(2) C. Wu, L. Lin*, W. Guo, H. Yan, “Signal Detection for Molecular MIMO Communications with Asymmetrical Topology,” IEEE Transactions on Molecular, Biological and Multi-Scale Communications, vol. 6, issue 1, 2020, 60-70.

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Research Directions

- Environment perception of autonomous systems
- Reliability and safety of automated driving

Recent Publications

(1) Jian Nie, Jun Yan, Huilin Yin*, Lei Ren, Qian Meng. A Multimodality Fusion Deep Neural Network and Safety Test Strategy for Intelligent Vehicles. IEEE Trans. on Intelligent Vehicles.Volume: 6, Issue: 2. June 2021. pp.310-322

(2) Bin Ye, Huilin YIN*, Jun Yan, Wancheng Ge. Patch-based attack on traffic sign recognition. 2021 IEEE International Intelligent Transportation Systems Conference (ITSC). Indianapolis, IN, United States. September 2021.

(3) Huilin Yin, Jie Wang, Jia Lin, Qian Meng. A Memory-attention Hierarchical Model for Driving-behavior Recognition and Motion Prediction. International Journal of Automotive Technology. Vol. 22, No. 4, 2021.pp. 895–908.

(4) Huilin Yin, Ruining Wang, Boyu Liu, Jun Yan. On Adversarial Robustness of Semantic Segmentation Models for Automated Driving. 2022 IEEE Intelligent Vehicles (IV) Symposium. Aachen, Germany. June 5-9, 2022.

(5) Jia Lin, Jun Yan, Huilin Yin*, Wancheng Ge, Gerhard Rigoll. Improved 3D object detector under snowfall weather condition for autonomous driving. IEEE Trans. on Intelligent Transportation Systems. Submitted.

董延超

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Research Directions

- Multi Modal SLAM
- Heterogenous Computing,
- Geometry and Texture Reconstruction
- Few Shot Deep Learning
- UAV Based Exploration and Inspection

Research results

- Visual SLAM Acceleration Based on Heterogeneous Computing. Accelerate 10+ times the Front End and Back End of vSLAM system by taking the advantages of CPU and GPU.
- Bifocal-Binocular Visual SLAM System for Repetitive Large-scale Environment. Invent a novel bifocal-binocular camera system to be more stable and accurate.
- Fine-grained Penstock 3D Surface and Texture Reconstruction for Visual Inspection.

叶伟

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Research Directions

- Graph Neural Networks
- Graph Kernels
- Clustering
- Network Science

Recent Publications

(1) Ye, W., Askarisichani, O., Jones, A. and Singh, A., 2020. Learning Deep Graph Representations via Convolutional Neural Networks. IEEE Transactions on Knowledge and Data Engineering.

(2) Ye, W., Goebl, S., Plant, C. and Böhm, C., 2016, August. Fuse: Full spectral clustering. In Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 1985-1994).

康琦

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Research Directions

- Swarm Intelligence, Evolutionary Multiobjective Optimization
- Transfer Learning, Autonomous Intelligent System
- Anomaly Detection, Edge Intelligence
- Optimization and Control in Transportation, Energy and Industry Systems

Recent Publications

(1) Q. Deng, Q. Kang*, L. Zhang, et.al., Objective Space-based Population Generation to Accelerate Evolutionary Algorithms for Large-scale Many-objective Optimization, IEEE Transactions on Evolutionary Computation, doi: 10.1109/TEVC.2022.3166815, Apr. 2022

(2) X. Wang, Qi Kang*, M. Zhou, et.al., Multiscale Drift Detection Test to Enable Fast Learning in Non-stationary Environments, IEEE Transactions on Cybernetics, 51(7), pp. 3483-3495, Jul. 2021

(3) Qi Kang*, S. Yao, M. Zhou*, et.al., Effective Visual Domain Adaptation via Generative Adversarial Distribution Matching, IEEE Transactions on Neural Networks and Learning Systems, 32(9), pp.3919-3929, Sep. 2021

王中杰

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Research Directions

- Data Knowledge and Engineering
- Multi-Agent Cooperation and Intelligent Decision
- Industrial Artificial Intelligence
- Modelling, Optimization and Simulation for Complex Systems
- Digital Twin System

Recent Publications

(1) Jin Fan, Yang Yu, Zhongjie Wang etc. Partial label learning based on disambiguation correction net with graph representation. IEEE Trans. On Circuits and Systems for Video Technology. DOI 10.1109/TCSVT.2021.3139968, 2021.

(2) Zhao-Hui Liu, Zhong-Jie Wang, Chen Yang. Multi-objective resource optimization scheduling based on iterative double auction in cloud manufacturing. Advances in Manufacturing, 2019, 7(4): 374-388.

(3) Yu Y, Wang Z, Lu C. A Joint Filter Approach for Reliable Power System State Estimation [J]. IEEE Transactions on Instrumentation & Measurement, 2019, 68(1): 87-94.