

“智能通信技术赋能物联网”

哈尔滨工业大学 2021 年国际暑期学校项目介绍

一、哈尔滨工业大学电子与信息工程学院介绍

电子与信息工程学院始建于 1959 年，设有“信息与通信工程类”一个大类招生专业，包括通信工程、电子信息工程、信息对抗技术、遥感科学与技术、电磁场与无线技术五个专业。设有信息与通信工程一级学科及电磁场与微波技术二级学科。2007 年通信与信息系统二级学科被评为国家重点学科，信号与信息处理为国家重点培育学科，2017 年教育部双一流学科评估 A-，同年作为哈尔滨工业大学控制科学与工程学科群、计算机科学与技术学科群的重要组成部分入选世界一流学科建设名单。

学院有教学科研人员等 151 人，教授 50 人、副教授 79 人，同时具有博士生导师 63 人，硕士生导师 133 人。其中中国科学院和中国工程院院士 1 人，中组部特聘教授引进人才 1 人，特聘外专教授引进人才 1 人。国务院学位委员会学科评议组成员 1 人，国家杰青、国家级有突出贡献中青年专家 1 人，入选国家“百千万人才工程”2 人，科技部中青年科技创新领军人才 1 人，国家优青 2 人，省基金委杰青 1 人，“龙江学者”青年学者 2 人，省部级突出贡献中青年专家 9 人，教育部新世纪优秀人才 4 人。其中，双院士刘永坦教授为我国著名雷达及电子信息系统专家，2018 年获得国家最高科学技术奖。学院现有在校本科生 954 人，硕士研究生 379 人，博士研究生 255 人。

结合国际学术前沿和国家重大战略需求，学院已经形成新体制雷达与对海探测技术、空间信息网络、抗干扰数据链传输技术、移动通信系统与移动互联网、航天测控和工业智能测试、空间对地观测信息处理、微波智能材料、毫米波/太赫兹高分辨率成像技术等研究方向。作为宇航科学与技术、无线通信技术和信息

感知技术三个 2011 协同创新中心的重要成员，学院近五年来承担 973、863、自然科学基金、国防类基础科研和校企合作研究等科研项目 500 多项，累计经费突破 5 亿元；发表了 SCI 论文 400 余篇，授权专利 400 余项；获国家最高科学技术奖 1 项，中国专利奖银奖 1 项，国家科技进步一等奖 2 项、二等奖 2 项，省部级科技奖 30 余项，为国防装备建设和国家经济发展做出了重大贡献，奠定了双一流建设的基础。

2018 年，双院士刘永坦教授获得国家最高科学技术奖。刘永坦教授是我国著名雷达与信号处理技术专家，对海探测新体制雷达理论与技术奠基人和引领者。他领导和培育的创新团队，率先在国内开展了新体制雷达研究，技术成果“领跑”世界，成功实现工程应用，为我国筑起“海防长城”做出了卓越的贡献，在保卫祖国海疆中发挥着不可替代的作用。

二、国际暑期学校主题

本次国际暑期学校主题为：“智能通信技术赋能物联网”，主要从 5G、人工智能、智能物联网和工业大数据等相关领域的前沿技术出发，通过国际一流学者的系列课程和主题讲座，引导本科生了解先进信息和通信技术领域最新的发展现状及未来发展趋势，加深 5G、AI 以及物联网等技术对工业和人类生活影响的理解，深入理解日益智能化的信息通信技术在第四次工业革命和人工智能时代给世界格局（政治、经济、文化等）和人类生活模式带来的深远影响，培养本科生对未来信息通信技术、人工智能技术以及相关交叉研究领域的兴趣。

本次暑期学校的学术讲座部分将由哈尔滨工业大学电信学院、IEEE ComSoc Harbin Chapter 和 IEEE Communication Society 共同邀请学者，并组织实施。



三、国际暑期学校学习和活动内容

本次国际暑期学校从 2021 年 7 月 12 日开始, 7 月 23 日结束, 包括学术讲座、课堂教学和创新实践三个环节, 总体内容如下表所示。

模块	内容	学时	学分
学术 讲座	深度学习: 不是大规模 MIMO 无线通信系统的简单工具 Zhi Ding	2	2
	无线通信系统的空中联合学习 Yingjun Zhang	2	
	借助航空和空间网络实现全球连接 Mustafa A. Kishk	2	
	IRS 辅助的 RF 和光学无线通信: 建模, 设计和优化 Robert Schober	2	
	正交与否: CDMA 在 B5G 中的重新应用 Hsiao-Hwa Chen	4	
	5G IoT 网络 Yonghui Li	2	
	移动无线通信网络中的身份认证协议 Yi Qian	2	
	数字映射技术在 6G 和 IoT 中的应用 Yan Zhang	4	
	基于亚奈奎斯特信号处理的 GHz 带宽感知 Yue Gao	4	
	基于 AI 的 RAN 服务优化 Tao Chen	4	
	自动驾驶中的环境感知与建模 Cui ShiYong	2	
	基于遥感数据的变化检测 Tian JiaoJiao	2	
课程 教学	3D 视频信号压缩和通信国际前沿技术 Xiang Wei	16	1
实践 创新	智能门锁系统自主创新设计	16	1
	无线电测向射频信号源设计	16	1
学时合计		学分合计	
80		5	

四、学术讲座学者及报告简介



Zhi Ding, Dr. Zhi Ding (S'88-M'90-SM'95-F'03, IEEE) is Distinguished Professor of Electrical and Computer Engineering at the University of California, Davis. He received his Ph.D. degree in Electrical Engineering from Cornell University in 1990. From 1990 to 2000, he was a faculty member of Auburn University and later, University of Iowa. He has coauthored over 400 technical papers and two books. Dr. Ding is a coauthor of the text: Modern

Digital and Analog Communication Systems, 4th edition and 5th edition, Oxford University Press. Dr. Ding is a Fellow of IEEE and has been an active member of IEEE, serving on technical programs of several workshops and conferences. He served both as a Member and also the Chair of the IEEE Transactions on Wireless Communications Steering Committee from 2007-2001. Dr. Ding was the Technical Program Chair of the 2006 IEEE Globecom and the General Chair of the 2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). He served as an IEEE Distinguished Lecturer (Circuits and Systems Society, 2004-06, Communications Society, 2008-09). He received the 2012 Wireless Communications Recognition Award and the 2020 Education Award from the IEEE Communications Society. He currently also serves as the Chief Information Officer and Chief Marketing Officer of the IEEE ComSoc.

Title: Deep Learning: Not a Simple Hammer for Massive MIMO Wireless Communication Systems

The proliferation of advanced wireless services, such as virtual reality, autonomous driving and internet of things has generated increasingly intense pressure to develop intelligent wireless communication systems to meet networking needs posed by extremely high data rates, massive number of connected devices, and ultra low latency. Deep learning (DL) has been recently emerged as an exciting design tool to advance the development of wireless communication system with some demonstrated successes. In this tutorial, we review the principles of applying DL for improving wireless network performance by integrating the underlying characteristics of channels in practical massive MIMO deployment. We introduce important insights derived from the physical RF channel properties and present a comprehensive overview on the application of DL for accurately estimating channel state information (CSI) of forward channels with low feedback overhead. We provide examples of successful DL application in CSI estimation for massive MIMO wireless systems and highlight several promising directions for future research.



Yingjun Zhang, Angela Yingjun Zhang is a Professor at Department of Information Engineering, The Chinese University of Hong Kong. Her research interests are in optimization and learning in wireless communication systems and smart power grids. She is now an Associate Editor-in-Chief of IEEE Open Journals of the Communication Society and a Member of IEEE ComSoc Fellow Evaluation Committee. Previously, she has served as the Chair of the

Executive Editorial Committee of IEEE Transactions on Wireless Communications and a Founding Chair of IEEE ComSoc Smart Grid Communications Technical Committee. She is the co-recipient of the 2011 Marconi Prize Paper Award in Wireless Communications, the 2013 SmartGridComm Best Paper Award, and the 2014 IEEE ComSoc Asia Pacific Board Outstanding Paper Award. She won the 2006 Hong Kong Young Scientist Award as the only winner from engineering science. She is a Fellow of IEEE and a Distinguished Lecturer of IEEE ComSoc.

Title: Over-the-Air Federated Learning over Wireless Communication Systems

Federated learning (FL) enables distributed devices to collaboratively learn a shared model while keeping all the training data on device, alleviating concerns regarding privacy and communication costs. When applied to wireless systems, the physical layer aspects of wireless channels bring additional challenges and opportunities to FL mechanism design. In this tutorial, I will first introduce FL basics and its unique challenges in wireless fading channels. Then, I will discuss the state-of-art of the works on FL mechanism design in wireless channels. Finally, I will introduce our recent work that leverages the advanced PHY-layer techniques, such as RIS and relay, to enhance the FL performance and practicality.



Mustafa A. Kishk, he received the B.Sc. and M.Sc. degrees from Cairo University, Giza, Egypt, in 2013 and 2015, respectively, and the Ph.D. degree from Virginia Tech, Blacksburg, VA, USA, in 2018. He is a Postdoctoral Research Fellow with the Communication Theory Laboratory, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia. His current research interests include stochastic geometry, energy harvesting wireless networks, UAV-enabled communication systems, and satellite communications.

Title: Towards Global Connectivity Using Aerial and Space Networks

The United Nations (UN) has defined a set of sustainable development goals (SDGs) targeted for 2030 that include ending poverty, hunger, and inequalities, establishing high quality of education and medical services, to name a few. Achieving such goals requires advancement in many industries, which includes the internet and communication technology (ICT) sector. In particular, establishing high quality internet service provides opportunities to stimulate economy in poor communities, access to remote learning, access to digital records and remote patient monitoring, and help farmers improve productivity. In this context, and as the standardization of the fifth generation (5G) of wireless communication systems (WCSs) has been completed, and 5G networks are in their early stage of deployment, the research visioning and planning of the sixth generation (6G) of WCSs are being initiated. However, it is well-known that urbanized regions have been the major beneficiaries of the advances in the previous generations of WCSs. Hence, it is important to carry research with the focus on ensuring digital inclusion of rural and remote areas, which currently lack stable access to internet connectivity. In this talk, we focus on (i) possible

network architectures to establish backhaul connectivity in rural and remote areas, with emphasis on satellite-based solutions, (ii) current challenges facing internet access in rural areas, (iii) possible solutions to enhance internet access in rural areas, with emphasis on drone-based architectures, and (iv) existing solutions to improve the flight duration of drones and ensure stable coverage in rural areas.



Robert Schober, he (S'98, M'01, SM'08, F'10) received the Diplom (Univ.) and the Ph.D. degrees in electrical engineering from Friedrich-Alexander University of Erlangen-Nuremberg (FAU), Germany, in 1997 and 2000, respectively. From 2002 to 2011, he was a Professor and Canada Research Chair at the University of British Columbia (UBC), Vancouver, Canada. Since January 2012 he is an Alexander von Humboldt Professor and the Chair for Digital Communication at FAU. His research interests fall into the broad areas of Communication Theory, Wireless Communications, and Statistical Signal Processing. Robert received several awards for his work including the 2002 Heinz Maier Leibnitz Award of the German Science Foundation (DFG), the 2004 Innovations Award of the Vodafone Foundation for Research in Mobile Communications, a 2006 UBC Killam Research Prize, a 2007 Wilhelm Friedrich Bessel Research Award of the Alexander von Humboldt Foundation, the 2008 Charles McDowell Award for Excellence in Research from UBC, a 2011 Alexander von Humboldt Professorship, a 2012 NSERC E.W.R. Stacie Fellowship, and a 2017 Wireless Communications Recognition Award by the IEEE Wireless Communications Technical Committee. Since 2017, he has been listed as a Highly Cited Researcher by the Web of Science. Robert is a Fellow of the Canadian Academy of Engineering, a Fellow of the Engineering Institute of Canada, and a Member of the German National Academy of Science and Engineering. From 2012 to 2015, he served as Editor-in-Chief of the IEEE Transactions on Communications. Currently, he serves as Member of the Editorial Board of the Proceedings of the IEEE and as VP Publications for the IEEE Communication Society (ComSoc).

Title: IRS-aided RF and Optical Wireless Communication: Modeling, Design, and Optimization

Intelligent reflecting surfaces (IRSs) have the potential to transform both wireless radio frequency (RF) and free-space optics (FSO) communication channels into smart reconfigurable propagation environments. To realize the full potential of this new paradigm, careful physics-based modeling, scalable design, and efficient optimization techniques for IRS-assisted wireless systems have to be developed. In this presentation, we first consider IRS-assisted RF systems, for which we develop a physics-based model. Careful analysis of the proposed model reveals that large IRS with thousands of phase-shift elements are needed to compensate for the large end-to-end path-loss introduced by the multiplication of the individual path-losses of the transmitter-to-IRS and IRS-to-receiver channels. For scalable optimization we partition the IRS

unit cells into several subsets, referred to as tiles, which are optimized in two stages, namely an offline design stage and an online optimization stage. Subsequently, for IRS-assisted FSO systems, different options for realizing optical IRS are discussed. Then, we model the resulting geometric and misalignment losses (GML) of the end-to-end channel, where we take into account the impact of building sway. Models based on geometric optics and the Huygens-Fresnel principle are compared. Finally, promising directions for future research on both IRS-assisted RF and IRS-assisted FSO systems are provided.



Hsiao-Hwa Chen, Hsiao-Hwa Chen is currently a Distinguished Professor in the Department of Engineering Science, Taiwan Cheng Kung University. He obtained his BSc and MSc degrees from Zhejiang University, China, and a PhD degree from the University of Oulu, Finland, in 1982, 1985, and 1991, respectively. He authored or co-authored over 400 technical papers in major international journals and conferences, six books, and more than ten book chapters in the areas of wireless communications. He served as the general chair, TPC chair, and symposium chair for many international conferences. He is the founding Editor-in-Chief of Wiley's Security and Communication Networks Journal. He is the recipient of the best paper award in IEEE WCNC 2008 and the recipient of IEEE 2016 Jack Neubauer Memorial Award. He served as the Editor-in-Chief for IEEE Wireless Communications from 2012 to 2015. He was an elected Member-at-Large of IEEE ComSoc from 2015 to 2016. He is serving as TPC Chair for IEEE Globecom 2019. He is a Fellow of IEEE, IET, and BCS.

Title: To be orthogonal or not to be: CDMA technology revisited for B5G wireless

B5G wireless communications face a lot of serious challenges. Massive connectivity plus severe shortage of radio spectrum pose a big issue to implement wireless-everything, and the ultra-fast data rate requirement makes energy per bit extremely low to meet the minimum SNR requirement. On the other hand, traditional OMA will no longer be capable to ensure a very short latency in B5G systems, which is critical to time-sensitive wireless services, such as autonomous driving, remote surgery, etc. CDMA as an important NOMA scheme will play its vital role in B5G systems in a context of next-generation CDMA technologies. In this talk, we will revisit our research works on the NG-CDMA and will showcase what we have done so far as an effort to develop the NG-CDMA technologies, which include innovative signature code design based on REAL approach, multi-dimensional CDMA, space time spread coding (STSC) for MIMO applications, column-wise complementary coded CDMA for channel frequency/time selectivity mitigation, development of general code-domain NOMA schemes, single code cyclic shift (SCCS) multiple access, frequency diversity assisted CC-CDMA systems, etc.



Yonghui Li, Prof. Yonghui Li is a Professor and Director of Wireless Engineering Laboratory in School of Electrical and Information Engineering, University of Sydney. He is the recipient of the Australian Queen Elizabeth II Fellowship in 2008 and the Australian Future Fellowship in 2012. He is a Fellow of IEEE. His current research interests are in the area of wireless communications, with a particular focus on MIMO, millimeter wave communications, Wireless AI, machine to machine communications, Satellite communications and cooperative communications. He is now an editor for IEEE transactions on communications, IEEE transactions on vehicular technology. He also served as the guest editor for several IEEE journals, such as IEEE JSAC, IEEE Communications Magazine, IEEE IoT journal, IEEE Access. He received the best paper awards from IEEE International Conference on Communications (ICC) 2014, IEEE PIRMC 2017 and IEEE Wireless Days Conferences (WD) 2014.

Title: 5G IoT Networks

Connected smart objects, platforms and environments have been identified as the next big technology development, enabling significant society changes and economic growth. The entire physical world will be connected to the Internet, referred to as Internet of Things (IoT). The intelligent IoT network for automatic interaction and processing between objects and environments will become an inherent part of areas such as electricity, transportation, industrial control, utilities management, healthcare, water resources management and mining. Wireless networks are one of the key enabling technologies of the IoT. They are likely to be universally used for last mile connectivity due to their flexibility, scalability and cost effectiveness. The attributes and traffic models of IoT networks are essentially different from those of conventional communication systems, which are designed to transmit voice, data and multimedia. IoT access networks face many unique challenges that cannot be addressed by existing network protocols; these include support for a truly massive number of devices, the transmission of huge volumes of data burst in large-scale networks over limited bandwidth, and the ability to accommodate diverse traffic patterns and quality of service (QoS) requirements. Some IoT applications have much stringent latency and reliability requirements which cannot be accommodated by existing wireless networks. Addressing these challenges requires the development of new wireless access technologies, underlying network protocols, signal processing techniques and security protocols. In this talk, I will present the IoT network development, architecture, key challenges, requirements, potential solutions and recent research progress in this area, particularly in 5G massive connectivity and uRLLC.



Yi Qian, Yi Qian received a Ph.D. degree in electrical engineering from Clemson University, South Carolina, USA, in May 1996. He is currently a professor in the Department of Electrical and Computer Engineering, University of Nebraska-Lincoln (UNL). Prior to joining UNL, he worked in the telecommunications industry, academia, and government. Some of his previous professional positions include serving as a senior member of scientific staff and a technical advisor at Nortel Networks, a senior system engineer and a technical advisor at several startup companies, an assistant professor at the University of Puerto Rico at Mayaguez, and a senior researcher at the National Institute of Standards and Technology. His research interests include communication networks and systems, and information and communication network security. Prof. Yi Qian is a Fellow of IEEE. He was previously Chair of the IEEE Technical Committee for Communications and Information Security. He was the Technical Program Chair for IEEE International Conference on Communications 2018. He serves on the Editorial Boards of several international journals and magazines, including as the Editor-in-Chief for IEEE Wireless Communications. He was a Distinguished Lecturer for IEEE Vehicular Technology Society. He is currently a Distinguished Lecturer for IEEE Communications Society. Prof. Yi Qian received the Henry Y. Kleinkauf Family Distinguished New Faculty Teaching Award in 2011, the Holling Family Distinguished Teaching Award in 2012, the Holling Family Distinguished Teaching/Advising/Mentoring Award in 2018, and the Holling Family Distinguished Teaching Award for Innovative Use of Instructional Technology in 2018, all from University of Nebraska-Lincoln. Prof. Yi Qian is the principal author of a new textbook, *Security in Wireless Communication Networks*, to be published by Wiley in 2021.

Title: Authentication Protocols for Mobile Wireless Communication Networks

Authentication is a process for a system to verify the identity of a user who wishes to access the system. In a mobile wireless communication network, authentication is the first security mechanism that always be deployed to control the access of the network, so that only legitimate users or devices can be allowed to access the network and to use the services. This lecture presents the evolutions of the authentication protocols for mobile wireless communication networks. It starts with the 2nd generation GSM authentication protocol, to 3rd generation UMTS and 4th generation LTE authentications. The lecture will conclude with an overview for the current 5G system authentication approaches. The history of development of authentication protocols and lessons learnt for wireless network security designs will be presented.



Yan Zhang, Yan Zhang is a Full Professor at Department of Informatics, University of Oslo, Norway. He received a Ph.D. degree in School of Electrical & Electronics Engineering, Nanyang Technological University, Singapore. He received M.S. and B.S from Beihang University and Nanjing University of Post and Telecommunications, respectively. His current

research interests include: 6G and Internet of Things (e.g., transport, smart grid). He received the prestigious award Clarivate Analytics (previously Thomson Reuters) "Highly Cited Researcher" since 2018. He is IEEE Fellow and IET Fellow. He is an elected Fellow of Academia Europaea (MAE), an elected Fellow of Royal Norwegian Society of Sciences and Letters Academy (DKNVS) and an elected Fellow of Norwegian Academy of Technological Sciences (NTVA). He serves as the Chair of IEEE ComSoc TCGCC (Technical Committee on Green Communications & Computing). He is IEEE Communication Society Distinguished Lecturer and IEEE Vehicular Technology Society (VTS) Distinguished Speaker. He was IEEE VTS Distinguished Lecturer for two terms (2016-2018 and 2018-2020). He is a member of IEEE VTS Fellowship and Scholarship Committee. He is currently serving as an Area Editor/Senior Editor/Editor of 10 IEEE Transactions/Magazines, including IEEE Network Magazine; IEEE Communications Surveys & Tutorials; IEEE Transactions on Network Science and Engineering; IEEE Transactions on Industrial Informatics; IEEE Transactions on Vehicular Technology; IEEE Transactions on Green Communications and Networking; IEEE Internet of Things Journal; IEEE Systems Journal; IEEE Vehicular Technology Magazine and IEEE Blockchain Technical Briefs.

Title: Digital Twin for 6G and IoT

In this talk, we mainly introduce our recent studies on Digital Twin (DT) for 6G, Edge Computing, air-ground networks, and IoT. We will first introduce the main concepts and challenges related to Digital Twin and we will provide perspectives on why and how DT can be adapted for 6G. Then, we present a novel scenario DITEN (Digital Twin Edge Networks) and the research challenges related to offloading, edge association and resource optimization. Throughout the talk, we join DT and machine learning to add intelligence and present our ideas on utilizing machine learning (e.g., deep reinforcement learning, federated learning) for low-latency, privacy-preservation, and energy-efficiency in 6G networks. Finally, we point out several promising research directions when DT joins Intelligent Reflecting Surface (IRS), blockchain, and deep learning.



Yue Gao, Yue Gao is a Professor and the Chair of Wireless Communications at the University of Surrey, United Kingdom. He received a PhD degree from the Queen Mary University of London U.K. in 2007. He currently leads the antennas and signal processing lab and develops fundamental research into practice in the interdisciplinary area of smart antennas, signal processing, spectrum sharing, millimetre-wave and Internet of Things technologies in mobile and satellite systems. He has published over 200 peer-reviewed journal and conference papers, 3 patents, 1 book and 5 book chapters and 3 best paper awards. He is an Engineering and Physical Sciences Research Council Fellow from 2017. He was a co-recipient of the EU Horizon Prize Award on Collaborative Spectrum Sharing in 2016. Prof Gao is an elected member of the Board of Governors and the Distinguished Lecturer of the IEEE Vehicular Technology Society, the

Vice-Chair of the IEEE ComSoc Technical Committee Wireless Communication, and the past Chair of IEEE Technical Committee on Cognitive Networks. He served as symposia and track chair of various IEEE conferences. He is an Editor for the IEEE INTERNET OF THINGS JOURNAL, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY and IEEE TRANSACTIONS ON COGNITIVE NETWORKS.

Title: GHz Bandwidth Sensing by Sub-Nyquist Signal Processing

This presentation will present a new approach to design GHz bandwidth sensing (GBSense) systems to overcome Nyquist-rate sampling's bottleneck by developing sub-Nyquist sampling algorithms repurposing the existing expertise of intelligent antennas and reconfigurable transmission lines. The GBSense offers new creative and implementable possibilities over a real-time experimental platform framework without requiring Nyquist-rate sampling. The GBSense gives users access to a flexible hardware platform and application software that enables real-time over-air GHz bandwidth signal sensing, analysis and communication at both sub-6GHz and mm-wave frequency bands.



Tao Chen, Dr. Tao Chen is a senior researcher at VTT Technical Research Centre of Finland, the honorary professor at University of Kent, and the adjunct professor at University of Jyväskylä. He has more than 20 years of experience in the telecommunications sector. He has led several EU and national research projects, covering various topics from cognitive radio, green communications, to software defined networking and 5G radio access networks. Dr. Chen is technical editor of IEEE Wireless Communications Magazine and IEEE Transactions on Cognitive Communications and Networking. He has published more than 80 scientific publications. His current research interests include software defined networking for 5G mobile networks, AI for communications, dynamic spectrum access, energy efficiency and resource management in heterogeneous wireless networks.

Title: AI for RAN service optimization

Radio access networks (RAN) have become extremely complex. For instance, in 5G networks, frequency bands are equally shared among 5G base stations, which makes the network-wide resource coordination very challenge. The use of the artificial intelligent (AI)/machine learning (ML) can help manage this complexity. In the recent O-RAN initiative, the intelligence has been introduced as a native feature to support RAN control. This talk will include two parts. The first part will provide an overview on AI/ML for resource optimization problems in RAN. The focus of AI/ML algorithms will be on Markov decision process, reinforcement learning, and deep Q-learning. The second part will introduce the native AI/ML support under the O-RAN control framework. The state of the current O-RAN development will be examined, followed by the solutions to integrate the Open AI platform with O-RAN control framework. The details will be given on how to design AI/ML flow to support smart RAN services. Finally, future research

directions to apply AI/ML for RAN service optimization will be highlighted.



Shiyong Cui, obtained his PhD in computer science in 2014 from the Siegen University, Germany. Currently he is a senior scientist in machine learning and autonomous driving at Continental Inc. The current focus is the development of machine learning/deep learning for multi-sensor data fusion and comprehensive environment modeling and perception for autonomous driving. He has been leading the development of commercial systems for major OEM, such as BMW, Honda, Toyota, etc. Previously he had been working with the German Aerospace Center(DLR) for eight years. It was mainly involving large scale machine learning for big satellite data archive and the development of airborne imaging platform. He is a reviewer of major IEEE scientific journals, e. g., IEEE TGRS, IEEE JSTARS, IEEE TIP, IEEE GRSL, IEEE TII, IEEE ACCESS, ISPRS. He has published more than 50 papers in scientific journals and conferences.

Title: Environmental perception and modeling in autonomous driving

This presentation will give an introduction to environmental perception and modeling in autonomous driving. To reach a status of fully autonomous driving, a comprehensive understanding of the surrounding environment of ego vehicle is highly demanded. To this end, various sensors, like camera, radar, lidar, ultrasonic, are deployed to acquire a comprehensive modeling of the environment, which comprise ego motion and localization, traffic participants, road model, static environment, traffic control information, etc. This presentation will focus on these essential elements in environmental perception and modeling. Front technologies in machine/deep learning, computer vision, sensor fusion are involved in these topics and will be presented in this talk.



Jiaojiao Tian, is a senior researcher at German Aerospace Center (DLR). She received her Ph.D. degree in mathematics and computer science from Osnabrück University, Germany in 2013. Currently she leads the 3D Modelling group in Photogrammetry and Image Analysis Department, Remote Sensing Technology Institute (IMF). In 2011, she was a Guest Scientist with the Institute of Photogrammetry and Remote Sensing, ETH Zürich. She has published over 50 papers in international journals and conferences. Her research interests include change detection in 2D and 3D, digital surface model (DSM) generation, deep-learning based 3D point cloud semantic segmentation, object extraction, and classification.

Title: Change detection using remotely sensed data – from 2D to 3D

This presentation will focus on techniques and applications of remote sensing data based change detection in 2D and 3D. It will start with general considerations and techniques in 2D change detection. The traditional and deep learning based approaches and applications will be generally introduced. In the second part, important issues in 3D change detection methods will be addressed, including different types of 3D datasets and our recent work on fusion-based 3D

change detection. In the end, opportunities and challenges in change detection are highlighted.

五、课程内容介绍

3D 视频信号压缩和通信国际前沿技术（16 学时）

从 3D 视频的发展历史、应用场景出发，深入浅出地讲解 3D 视频的采集、编码、传输、渲染和质量评估中的技术关键点。通过本课程学习，引导学生了解 3D 视频的发展历史和 3D 视频的压缩标准，理解 3D 视频的压缩过程，掌握最基本的 3D 视频压缩方法。

六、实践创新

（1）《智能门锁的设计与实现》（16 学时，理论 2 学时+实践 14 学时）

为电子信息类专业实践创新活动，以教师讲授为辅、学生动手实践为主，以培养学生的工程意识、创新意识为目标，以电子电路的设计应用为基础，要求学生能够综合单片机、嵌入式系统、EDA 软件等知识和工程技能。经过需求分析、资料查询、方案论证、设计调试、指标测试、分析总结等过程，完成一个独立智能门锁的创新设计与实现。通过本课程的学习，学生可以掌握电子系统分析与设计的整个流程，形成系统级设计的理念，理解基本的物联网基本概念和技术架构，认识 AI 技术实现的基本过程，并同步锻炼工科人才培养中必需发展的团队合作能力。最终，以独立设计和开发完成的的中小型应用电子系统作为实践成果。

具体学时分配与授课内容如下。

类别	学时	授课与实践内容
理论学时	2 学时	智能门锁的概述、功能介绍和实现方法
实践学时	2 学时	STM32 开发板的基本使用方法，STM32 编程的入门介绍
	4 学时	智能门锁的基本系统的搭建，实现电子门锁的 STM32 单片机控制
	4 学时	基本智能门锁功能的实现-电子密码开门
	4 学时	扩展智能门锁功能实现-门禁、指纹开门

(2) 《无线电测向射频信号源设计》(16 学时, 理论 8 学时+实践 8 学时)

电子线路基础、数字逻辑电路和通信电子线路延伸的综合设计类实践课程。讲解频率合成、调制模块、伪随机序列、射频前端、电路布线布局等设计方法, 开发对应功能模块, 完成系统测试与调试。培养综合分析与设计能力, 以及开发操作能力, 增加创新意识。

课程主要对学生能力的要求: 1)了解无线电测向信号源的基本原理、掌握专用 DDS 芯片加控制器的设计方法和可编程 DDS 模块的设计方法, 具备系统设计与实现的统筹设计能力; 2)理解数字信号产生的工作原理、掌握频率合成方案的设计方法、调制模块的设计方法和伪随机序列的设计方法, 具备研究与设计数字信号产生方法的能力; 3)熟悉阻抗匹配、串扰消除、电磁兼容的电路布件布局布线方法, 掌握数字频率合成模块、数字调制模块、FPGA 控制 DAC 输出模块的硬件设计能力, 训练数据分析测试和模块调试的能力。

具体学时分配与授课内容如下。

类别	学时	授课与实践内容
理论学时	2 学时	专用 DDS 芯片加控制器的设计方法 可编程 DDS 模块的设计方法
	2 学时	频率合成方案的设计方法 调制模块的设计方法 伪随机序列的设计方法
	2 学时	数模转换器的 AD9783 芯片使用方法 数模转换器与 FPGA 接口的调试方法 低通滤波器模块的设计方法与制作
	2 学时	阻抗匹配的设计方法 串扰消除的技巧与方法 电磁兼容的布局布线方法
实践学时	2 学时	数字频率合成模块的实践
	2 学时	数字调制模块实现
	2 学时	FPGA 控制 DAC 输出模块的实现
	2 学时	信号源总体系统的测试与调试

七、其他活动安排

1. 校内专业实验室参观与交流

本次国际暑期学校计划安排学员参观哈工大博物馆、航天馆,电信学院雷达、通信、测控、遥感、微波相关科研和教学实验室,航天学院卫星研究所,机电学院机器人研究所。通过使学员近距离了解和感受哈工大的历史和传统,达到展示和宣传哈工大百年传承和世界一流工科强校的目的。

2. 刘永坦院士先进事迹报告

由报告团骨干成员宗华老师主讲,力求向学员展现坦先生身上强烈的家国情怀和科学精神,以及作为哈工大“八百壮士”一员的刘永坦院士如何在哈工大这块沃土一步步施展才华和怀揣理想、开创中国的新体制雷达之路的成才历程。

3. 户外活动

本次国际暑期学校计划安排学员参观机器人集团、731 遗址、北大荒纪念馆、东北抗联遗址遗迹,旨在突出龙江地方特色、突出实践教育,展现龙江人民艰苦奋斗的经历和不忘初心、开拓进取的精神。

八、国际暑期学校申报信息

1. 项目时间: 2021 年 7 月 12 日-7 月 23 日

2. 招生对象: 2018、2019 级优秀本科生

3. 联系方式: 刘老师, 18645599889

咨询 QQ 群: 1027017644 (加群请说明: 哈工大 2021 暑期学校-所在院校简称-姓名)

学院官网: <http://seie.hit.edu.cn/>

